HYDRA®
Quality by Witzenmann

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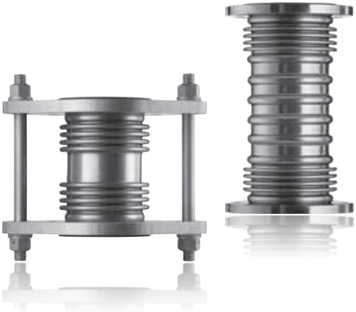
WITZENMANN

EXPANSION JOINTS

WITZENMANN
managing flexibility

EXPANSION JOINT MANUAL

OUR STANDARD EXPANSION JOINTS ARE DESIGNED ACCORDING TO DIN EN 14917:2022



Updated edition of the Manual of Expansion Joint Technology according to the new company standard and Pressure Equipment Directive with application of EN 14917:2021.

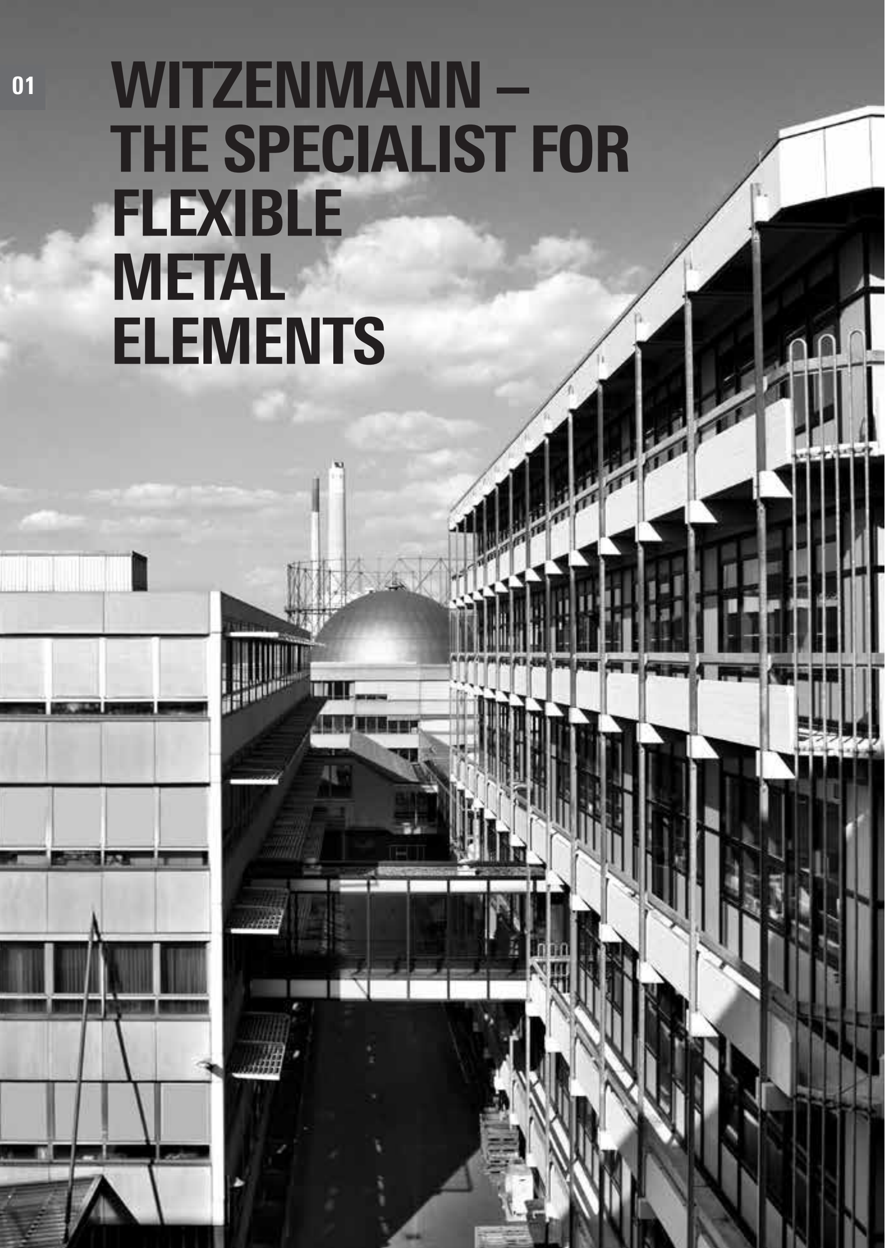
Updated: 05/2024

Subject to technical alterations.

You can also find technical information as a PDF download at www.flexperte.de

CONTENTS

WITZENMANN – THE SPECIALIST FOR FLEXIBLE METAL ELEMENTS



PROBLEM-SOLVING EXPERTISE

Whenever pipes expand due to frequent changes of temperature or pressure, when vibrations occur in pipework, whenever heavy loads have to be carried, when pressure-tight transport of media is essential, when high vacuum must be maintained – these are all situations where flexible metal elements are called for. These elements include expansion joints and metal bellows as well as metal hoses, automotive components and pipe supports. Witzenmann, the inventor of the metal hose and founder of the metal hose and expansion joint industry is your first port of call here. The basic invention, a metal hose that was developed and patented in 1885, was followed by a patent for the metal expansion joint in 1920.

Worldwide presence

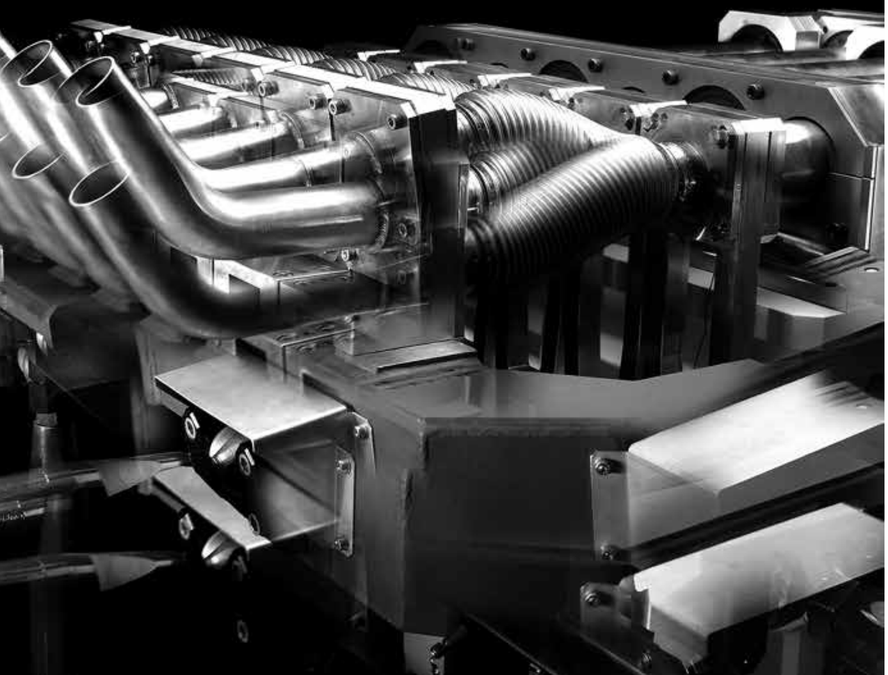
As an international group of companies with a total of more than 4,300 employees in 24 companies, Witzenmann stands today for innovation and high quality. With the broadest product range in the industry, Witzenmann offers problem solutions for decoupling vibrations, accommodating expansion in pipes, flexible installation and conveying media. Witzenmann is a development partner for industrial customers in the technical building equipment industry, automotive industry and numerous other markets, with in-house machine design, toolmaking and prototyping as well as extensive inspection and testing equipment. Crucial to the cooperation with customers are the consultancy services provided by the competence centre at the Witzenmann headquarters in Pforzheim, southern Germany. Teams of highly qualified engineers work in close collaboration with the customer on product developments and new expansion joint applications. From the preliminary design to series production.

Better products

This concentration of knowledge is the basis for the synergy that is evident in every product solution. Our products have an almost unlimited and diverse range of applications. However, they all have one thing in common – maximum safety even in the most extreme operating conditions. This applies to all Witzenmann solutions.

QUALITY MANAGEMENT

Before a newly developed flexible element goes into production, it passes through an extremely hard testing program in our modern development centre: electrodynamic vibration test rigs, hot gas and service life testing systems, corrosion testing and portable testing facilities.



These tests Witzenmann not only ensure that the products have an optimum configuration but also enable them to withstand all conceivable loads over a long period of time. Witzenmann has been working consistently to these high standards for a long time. In 1994, Witzenmann was the first company in this sector to gain accreditation to DIN ISO 9001. Here too, continuous development is occurring. Witzenmann currently has an approval according to the much stricter standard IATF 16949. These certifications are the basis for our leading position in the market.

GENERAL APPROVAL TESTS

Quality management system according to DIN ISO 9001
South West Technical Inspection Association (TÜV) inspection and confirmation as a manufacturer according to AD data sheet HP0, W0 and according to TRD 100

SPECIFIC APPROVALS (selection)

DVGW - German Technical and Scientific Association for Gas and Water

ÖVGW - Austrian Association for Gas and Water

ABS – American Bureau of Shipping, USA

BV – Bureau Veritas, France

DNV GL, Norway/Germany

LRS – Lloyd's Register of Shipping, United Kingdom

RINA – Registro Italiano Navale, Italien

BAM – Federal Agency for Material Research and Testing

VDE - Testing and Certification Institute

VdS – Association of Insurers

FM Global, USA

ASME – The American Society of Mechanical Engineers, USA

NBBI – The National Board of Boiler and Pressure Vessel Inspectors, USA

02

TIGHTLY ORGANIZED RESPONSIBILITY FOR QUALITY

Our quality assurance is organized on two levels. The central quality management is charged with the task of overall organizational and technological quality assurance measures. The quality departments of our business divisions manage quality planning, quality assurance and quality control in the course of handling the processing of orders. The quality assurance is independent of production in terms of organization. It is authorized to issue directives to all employees engaged in activities that influence quality.

Calculation and design

Our central departments provide the basis for calculating and designing our products. Our work is based on comprehensive theoretical investigations and tests. The individual business divisions finally implement the design work requirements, taking product-specific features and design requirements into account.

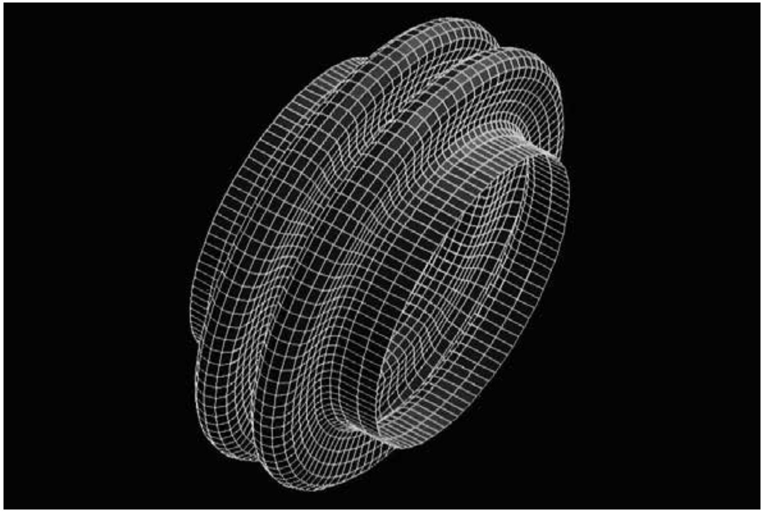


Fig. 2.1 FEM Structure of a metal bellows

Meticulous control of suppliers

We only work with suppliers who can provide proof of effective quality assurance. We demand test certificates for semi-finished products strip, sheet, pipes and wires, which comply with the intended purpose of the parts. We ensure that the supplied products meet our order and acceptance specifications by means of receiving inspections in our incoming goods department and material laboratory.

Continuous production monitoring

Our operational supervision is responsible for inspection and maintenance of manufacturing equipment and properly implemented production procedures in the production process according to provisions of the production documents provided.

Complete monitoring of welding processes

Welding processes are regulated based on written instructions. The qualification of the welders is ensured by means of examinations in accordance with EN ISO 9606-1/EN ISO 9606-4. The most important and frequently applied welding techniques are certified by means of process audits. The welding supervision meets the respective requirements according to AD Sheet HP3.

Supervision of measuring and testing equipment

All measuring and testing equipment is registered and documented. It is inspected for accuracy and reliability at regular intervals. The date of calibration is recorded by control marks.

QUALITY PUT TO THE TEST

Product audit

Extensive systematic audits carried out in the last few years have allowed us to take the step from empirical knowledge based on routine to the development of system knowledge. On one hand, this systematic knowledge is the precondition for product development and optimisation. On the other hand, it is necessary to meet the increasing demand of the market for information about all product properties. Especially in safety-relevant applications for the aerospace and automotive industry.

02

Materials testing

The demand for economic production is determined by a selection of suitable materials. Extensive knowledge of material properties is the precondition both for this selection processes and the demand for an increase in quality and safety.

Semi-finished parts for our products are high grade, mostly thin strips, wires, sheets or thin-walled pipes. The high quality requirements for our semi-finished parts are documented in our order and acceptance specifications. Apart from the stipulations of national and international standards and provisions, the quality requirements also include specific internal requirements concerning production and documentation. Incoming inspections ensure that the parts are inspected in compliance with geometrical, mechanical, technological and chemical properties required in our specifications.

The tasks of the material inspection department also include the execution of mechanical, technological and metallographical audits as well as process and acceptance audits of welding operations.

For non-destructive testing of elements and welding seams, X-ray as well as a visual inspection and penetration testing are used. Futhermore a leak test on the welded extpansion joints takes place.

Our material laboratory is recognised as a production-independent testing authority for destructive and non-destructive material testing with the approval to issue certificates of acceptance.

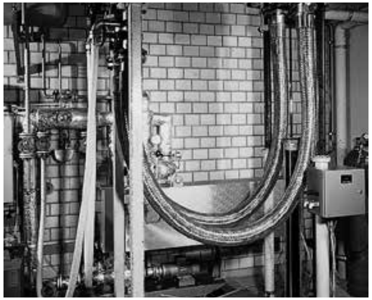


Fig. 2.2 Test bench for load cycle tests for hose asemblies of high nominal diameters in U-bend installation under internal pressure and fluid temperatures of up to 300 °C

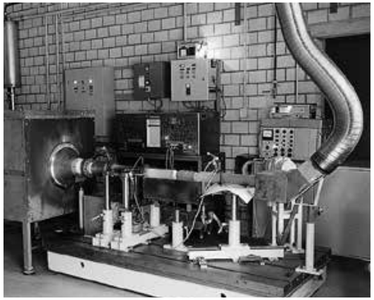


Fig. 2.3 Test bench for load cycle tests for flexible parts in exhaust systems with ex-haust gas temperatures of up to 1100 °C

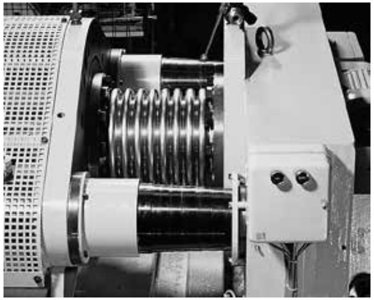


Fig. 2.4 Test bench for load cycle tests with an expansion joint DN 200

Fig. 2.5 Vibration test bench for simulation of complex application conditions

02

Damage analysis
Another task of the material inspection is the damage analysis of products that have failed during testing or operation. Metallographical inspections are usually carried out and the damage symptoms are documented by means of photographic images.

Quality of the expansion joints
In the interest of our customers, we place high demands on our expansion joints with regard to performance, quality and reliability.

For this reason, the quality-assurance process also inspects the incoming materials used for manufacturing, continuously monitors production and subjects the finished products to meaningful final inspections before leaving our plant.

In addition to that, destructive product and functional tests are performed with the expansion joints from current production.

The use of high-quality materials, optimised material-friendly manufacturing procedures, modern mechanical facilities and equipment – and not least of all – responsible, qualified personnel are the most important guarantees of quality for our products.

Fig. 2.6 Alternating bending machines for determining the fatigue behaviour of thin strips and sheets

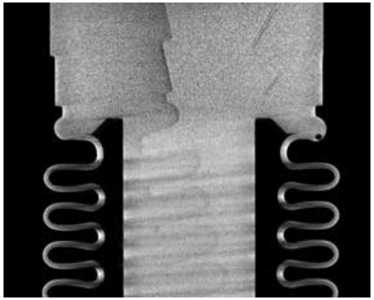


Fig. 2.7 Non-destructive testing by means of radiographic examination.

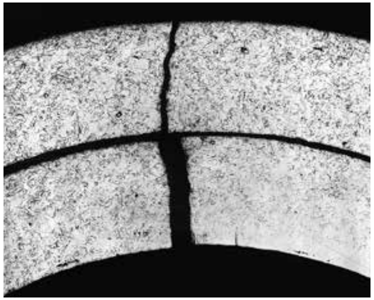


Fig. 2.8 Micrograph of a cross section on a fatigue fracture in a thin bellows ply

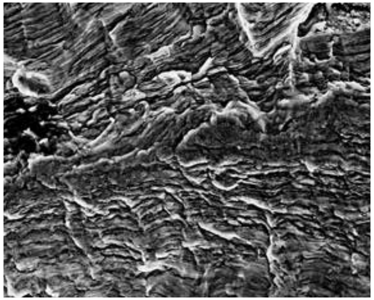


Fig. 2.9 Fatigue fracture under the scanning electron microscope

As part of the quality assurance, we have defined the minimum requirements stipulated for materials in ordering and acceptance specifications for the most important types.

Test certificates for the materials used can be requested subject to a charge. Strip material that is normally in stock can be confirmed with inspection certificate 3.1 or 3.2 according to DIN EN 10204.
Possible certificates of the conducted tests are listed in DIN EN 10204 (see Table).

We would like to point out here that the scope of the required material tests can have a significant impact on product and testing costs as well as on delivery times. For this reason, disproportionately stringent requirements should be avoided.

Name	Test certificate	Type	Contents of certificate	Conditions	Confirmation of certificate
2.1	Declaration of compliance with the order	non-specific	Confirmation of conformity with the order.	According to the delivery conditions of the order or, if requested, according to the official provisions and applicable technical regulations.	By the manufacturer.
2.2	Test report		Confirmation of conformity with the order stating results of nonspecific test.		
3.1	Inspection certificate 3.1	specific	Confirmation of conformity with the order stating results of specific test.		By the manufacturer's authorized inspection representative who is independent of the production department.
3.2	Inspection certificate 3.2			According to official regulations and applicable technical rules.	By the manufacturer's authorized inspection representative who is independent of the production department as well as by the authorized inspection representative authorised by the orderer or the authorized inspection representative stated in the official regulations.

THE EXPANSION JOINT

The various types of expansion joints (for examples see Figs. 3.1 and 3.2) serve to compensate movements in pipes, on machines and apparatus. The movements, which are always relative between two plant components, are caused by thermal expansion, pressure deformation, forces of gravity, misalignment or foundation settlements.

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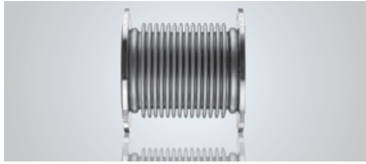

Fig 3.1 Axial expansion joint

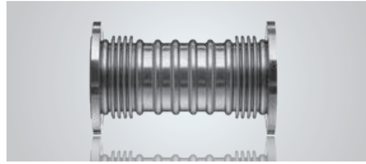

Fig. 3.2 Universal expansion joint

CONNECTIONS

Expansion joints are connected either by welding to the pipes or vessel walls or by flanging, e.g. to machine connecting pieces. The standard types of connection part are weld ends and flanges; in special cases screwed nipples are used. (Figs. 3.3 – 3.5).

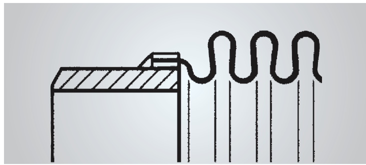

Fig. 3.3 Weld end

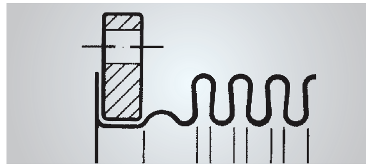

Fig. 3.4 Loose flange

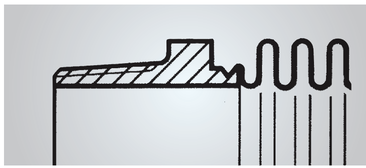

Fig. 3.5 Threaded nipple

THE BELLOWS AND ITS PRINCIPLE OF OPERATION

The basic flexible element of an expansion joint is the metal bellows, which is flexible on all planes due to its annular corrugations. This flexibility is utilized in the expansion joint in different ways according to the construction type (Fig. 3.6). The flexibility of the bellows is derived from the flexibility of the radial corrugation flanks (Fig. 3.7)

Fig. 3.6 Movements of the bellows

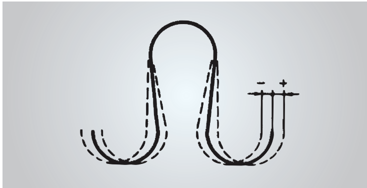

Fig. 3.7 Principle of operation of a bellows corrugation

In addition to flexibility, the metal bellows must have a certain pressure resistance. Flexibility and pressure resistance are contrary requirements, which in extreme cases result in different corrugation shapes. The lyre-shaped corrugation is a good compromise which combines considerable flexibility and an adequate pressure resistance (Figs. 3.8 – 3.10).

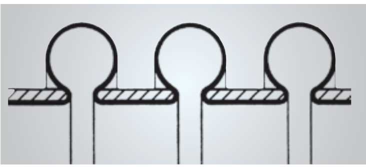

Fig. 3.8 Toroidal shape, extremely pressure resistant

Fig. 3.9 Diaphragms, extremely flexible

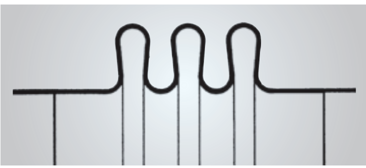

Fig. 3.10 Lyre-shape, pressure resistant and flexible

The lyre-shaped corrugation, to which the description below is targeted, can be adapted to specific requirements by altering its geometry. It is also possible to increase the number of plies; which leads to the multi-ply bellows as a technically favorable solution. (See also Chapter 10, "The Multi-ply Principle"). Figs 3.11 – 3.13 show an optical comparison of the various possible types of bellows.

Although the multi-ply bellows is relatively complicated with regard to its design and manufacturing process, it is used as the basic elastic element in our expansion joints thanks to its favourable characteristics. There, it has proven to be successful over many years, especially in designs subject to pressure loads.

Fig. 3.11. Single-ply bellows

Fig. 3.12. Double-ply bellows

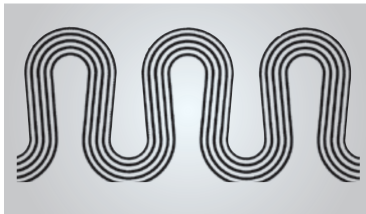

Fig. 3.13 Multi-ply bellows

RESTRAINT HARDWARE

03

The various types of restrained expansion joints are fitted with different types of restraint hardware corresponding to the respective functions which must absorb the axial pressure thrust and permits angular or lateral flexibility. The most important types of restraint hardware are shown in Figs. 3.14 – 3.17. The details of the hardware designs may differ. They are shown in the diagrams for the individual type series.

Fig. 3.14 Angular expansion joint "WRN"

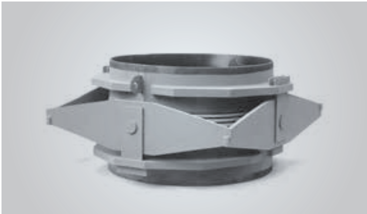

Fig. 3.15 Gimbal expansion joint "WRK"

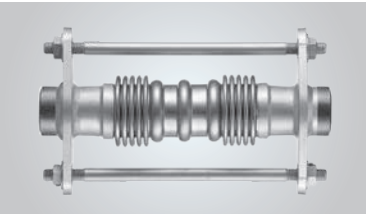

Fig. 3.16 Lateral expansion joint with tie rods and spherical washers "LRR"

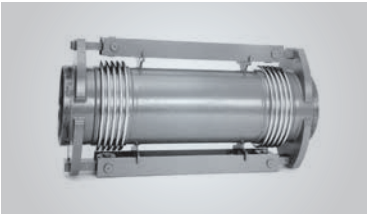

Fig. 3.17 Lateral expansion joint with gimbal joints "LRK"

ASSEMBLY PARTS

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There are a number of additional assembly parts which may be required from case to case. The most common are described below:

- **Inner sleeve**
  Internal pipe, usually made of stainless steel. It protects the bellows from direct contact with the flowing medium and reduces the flow resistance.
- **Guide sleeve**
  Pipe either inside or outside the bellows. It guides it at defined points or over the entire length to prevent buckling.
- **Protection cover**
  Pipe on the outside of the expansion joint. It protects the bellows from mechanical damage and from dirt accumulation in the corrugations, and acts as a carrier for thermal insulation.
- **Reinforcing rings**
  Rings in the root of the bellows corrugations to increase the pressure resistance of the bellows

TECHNICAL CHARACTERISTICS

HYDRA expansion joints are in line with the latest state of the art (concerning technology and manufacturing processes) and are fully-developed, flexible metal elements for universal use in modern pipe and plant construction.
Their outstanding characteristics are based on an ideal combination of design details resulting from intensive development work and several decades of practical experience.

The multi-ply bellows

The multi-ply bellows described above provides HYDRA expansion joints of all types with a series of technical and economic advantages, which are described in detail in Chapter 10, "The Multi-ply Principle"; they are only listed in brief here:

- Suitable for very high pressures
- Large movement absorption
- Compact size
- Low adjustment forces
- Optimum compensation in small spaces
- Early indication of leakage (in the event of damage) through check hole
- Total bursting safety
- Possibility of permanent leak monitoring for critical media
- Economic use of high-quality, corrosion-resistant materials, such as nickel-base alloys, iron-nickel-chromium alloys, titanium and tantalum
- Insulation against structure-borne noise up to 20 dB

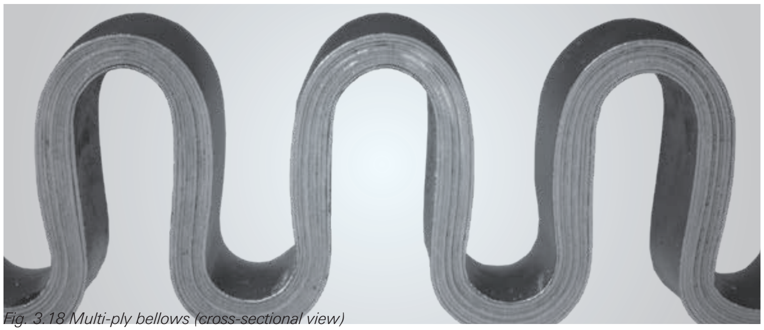


Fig. 3.18 Multi-ply bellows (cross-sectional view)

The weld connection

The connection between a multi-ply bellows made of austenitic stainless steel and a ferritic weld end (or flange) requires special welding procedures. Still more stringent demands are made on the design of the weld area and on the welding process when special alloys must be welded. Even though the weld seam is mechanically loaded only with a part of the axial pressure thrust, due to over pressure in the annular chamber of the corrugations and by the slight adjusting forces of the bellows on tension and compression, it must nevertheless remain absolutely tight throughout the entire operating period and thus is crucial to the quality of the expansion joint.

03

For this reason, special measures must be taken to ensure a low stress level. The bending moment produced by the movement of the bellows in the corrugation flanks is reduced before it reaches the weld connection:

- A raised bellows tangent generates a relieving counter torque
- Press-fitted rings reinforce the bellows cuff and thus reduce the stress level
- Cylindrical tangents reduce any possible residual bending stresses

The standard seam shown in Fig. 3.19 can verifiably be examined non-destructively. However due to the low stress level, the costly examinations necessary to assure the quality of other types of seam can be eliminated.
It is sufficient to perform a standard leak test.

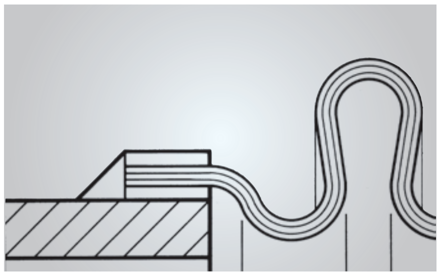


Fig. 3.19 Connection seam of bellows/weld end

The loose flange

Like fixed flanges, loose flanges offer the familiar advantages of flange connections, such as rapid assembly and exchangeability of components.

Since loose flanges are also not welded to the bellows, but form-fitted and assembled on it so that they are rotatable (Fig. 3.20), they have a number of additional advantages:

- The rotatability simplifies assembly allowing alignment of the flange holes
- The flanges are not in contact with the media, which may be aggressive, and can be made either of normal steel or special materials, such as aluminium and plastic
- The flanges can be protected against corrosion at relatively little costs by means of suitable coating or galvanization
- For single bellows plies special materials can be used which can't be welded to the other bellows plies or to the flange

Expansion joints with smaller nominal diameters can be fitted with loose flanges and lap joint stub ends, which largely offer the same advantages. The spacer bead shown in Fig. 3.20 simply keeps space clear for the screw assembly and prevents the risk of damage to the corrugations during assembly. Furthermore, the design enables the unhindered movement of the corrugations at either end.

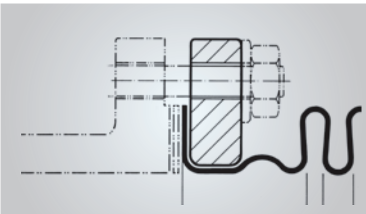


Fig. 3.20 Form-fitted connection between bellows and loose flange

The inner sleeve

Internal sleeves are used whenever expansion joints must be protected from:

- abrasion caused by solid particles in the flowing medium
- deposits of solid components in the corrugations
- vibrations generated by high flow velocities

Internal sleeves theoretically also reduce the pressure losses in the flow through the expansion joint. In practice however, these pressure losses are so low – roughly twice as much as those in a pipe of identical length – that the effort is rarely worthwhile.

Our expansion joints with loose flanges are provided with form-fitted pressed-in inner sleeves (Fig. 3.21) which can also withstand vibration loads.

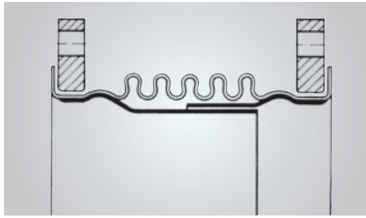


Fig. 3.21 Form-fitted inner sleeves

The patented restraint hardware

Hammer-shaped tie-bars inserted in plates (Fig. 3.22) combined with multi-ply bellows permit extremely short total lengths of our HYDRA restrained expansion joints. The full benefit of this is particularly apparent in hinge systems with angular expansion joints, since it also results in small overall dimensions for the hinge system and possibly reqired structures.

The hammer-shaped tie-bars are form-fitted to the plates and the plates are welded around the pipe so that the forces and stresses are evenly distributed. The effects of unintentionally overloading the restraint hardware, e.g. as a result of impulse pressure, are thus less drastic. The plate yields and deforms. Together with the effective safety against bursting of the multi-ply bellows, this acts as an efficient safety reserve.

Fig. 3.22 Hammer-shaped tie rod

CHOICE OF MATERIALS

03

The wide variety of applications for which our bellows are used necessitates an appropriate choice of materials.

In the tables in Chapter 17 we have listed the common materials we use and frequently used special materials with all necessary data in order to simplify the selection of suitable materials in each case.

The most important demands made on the material are:

- Corrosion resistance
- Temperature resistance
- Strength
- Welding properties
- Forming properties

Materials for general applications

Standard materials from the group of austenitic stainless steels are 1.4301, 1.4541, 1.4571 and 1.4404. These materials are particularly suitable to satisfy the requirements over a wide range of applications. With regard to quick availability and optimised storage, Witzenmann manufactures bellows from 1.4541 for general applications.

Material 1.4541 – standard for bellows production

1.4541 is used in the chemical industry, food industry, in exhaust systems, in district heating and compressor pipe systems and in cryogenics. Since titanium is added in 1.4541, unlike 1.4301, this material has better resistance to intercrystalline corrosion up to 400 °C.

Material 1.4571

Like the 1.4541, 1.4571 is used in the chemical industry, food industry, in exhaust systems, in district heating and compressor pipe systems as well as in cryogenics. 1.4571 has proven itself, above all, for decoupling elements in exhaust systems of motor vehicles and for use in drinking water piping. As with 1.4541, 1.4571 is stabilised with titanium, which increases its resistance to intercrystalline corrosion. In addition, molybdenum is added in 1.4571, so that it is more resistant to pitting corrosion than 1.4541, which can occur if chlorides are present.

Material 1.4301
For strip-wound hoses, which are used in, for example, exhaust systems of trucks, the high-alloy steel 1.4301 exhibits adequate corrosion resistance. The corrosion resistance is attributable to the elements chromium and nickel.

Material 1.4404
1.4404 is used for components in vacuum technology. It has also proven itself as hose material. The chemical composition largely matches that of 1.4571. In comparison to 1.4571, 1.4404 is not stabilised with titanium. Through a reduced carbon content of less than 0.03 %, however, it has a similar resistance to inter-crystalline corrosion. Due to the reduced carbon content, the strength properties are slightly lower than those of 1.4571.

MATERIALS FOR CORROSIVE MEDIA

Highly corrosive conditions require the use of special materials that should at least have the corrosion resistance of the connected pipe or fittings.

If in doubt, a higher-grade material should be chosen. In many cases, nickel-based alloys are suitable for this, a fact that is substantiated by good experiences. For expansion joint bellows the materials 2.4856 (Alloy 625) or 2.4610 (Alloy C-4) are preferred, for bellows of smaller size (diameter < 100 mm) the material 2.4819 (Alloy C-276).

In special cases, titanium or tantalum are the only alternative.

Material 2.4856 (Alloy 625)
Expansion joint bellows that are exposed to seawater are preferably made of Alloy 625. The molybdenum-containing material 2.4856 has excellent resistance to pitting, crevice corrosion and stress corrosion cracking.

Material 2.4610/2.4819 (Alloy C-4/C-276)
Bellows of these two materials are used in chemical and other process engineering plants. They are exceptionally resistant to hot acids, chloride-containing solutions or even chlorine gas up to temperatures of 400 °C.

MATERIALS FOR HIGH TEMPERATURES

For higher temperatures (>550 °C), where high scaling resistance is required, high-temperature or heat resistant steels are taken into consideration if they have adequate forming properties (e.g. 1.4828, 1.4876 or 2.4856).

Material 1.4828
The material 1.4828 has proven itself as strip-wound hose liner in decoupling elements and as expansion elements in manifolds of engines. Owing to its high silicon content, 1.4828 has good scaling resistance.

Material 1.4876 (Alloy 800 H)
The material 1.4876 is used where pressure loads occur in addition to high temperatures, e.g. in the inlet and outlet pipes of engine turbochargers. 1.4876, in which aluminium is added, has even better scaling resistance than 1.4828. Moreover, the chromium and nickel content is also significantly higher, but this makes it more expensive and reduces its suitability for forming. 1.4876 exhibits excellent creep rupture strength characteristics and is approved for components under pressure loads at temperatures above 550°C.

Material 2.4856 (Alloy 625)
If corrosive demands and high temperatures occur combined, the use of nickel-base alloy 2.4856 is frequently recommended.

EXPANSION JOINTS FOR AGGRESSIVE MEDIA

Suitability of metal expansion joints
Expansion joints with corrugated metal bellows are basically suitable for transporting critical fluids under pressure and temperature. The flexibility of the corrugated expansion joint bellows generally requires their wall thickness to be considerably smaller than all other parts of the system in which they are installed. As increasing the bellows' wall thickness to prevent damage caused by corrosion is not reasonable, it becomes essential to select a suitable material for the bellows element, which is sufficiently resistant against all expectable aggressive media during the entire lifetime. In many cases the bellows has to be manufactured from a material with even higher corrosion resistance than those of the system parts it is connected to.

In addition, possible corrosive environmental effects must be considered.

The material selection must take into account all possible kinds of corrosion, especially pitting, intercrystalline corrosion, crevice corrosion and stress corrosion cracking (SCC).

Selection of a suitable material
The material for the bellows plies is to be selected according to the specific aggressiveness of the operating fluid or the surrounding atmosphere. Recommendations for material resistance can be found in the resistance tables in Chapter 18.

Fittings, flange materials and materials for restraint hardware
When choosing materials for connection fittings, strength and welding properties are particularly important. For flanges and fittings, unalloyed steel and general structural steel is normally used. Where there are higher operating temperatures, heat resistant steels are used. Under higher stresses or lower temperatures, fine-grained steels and cryogenic steels are used.

Under corrosion-critical conditions, fittings of duplex steel, stainless ferritic or austenitic steels and nickel-based alloys are used.

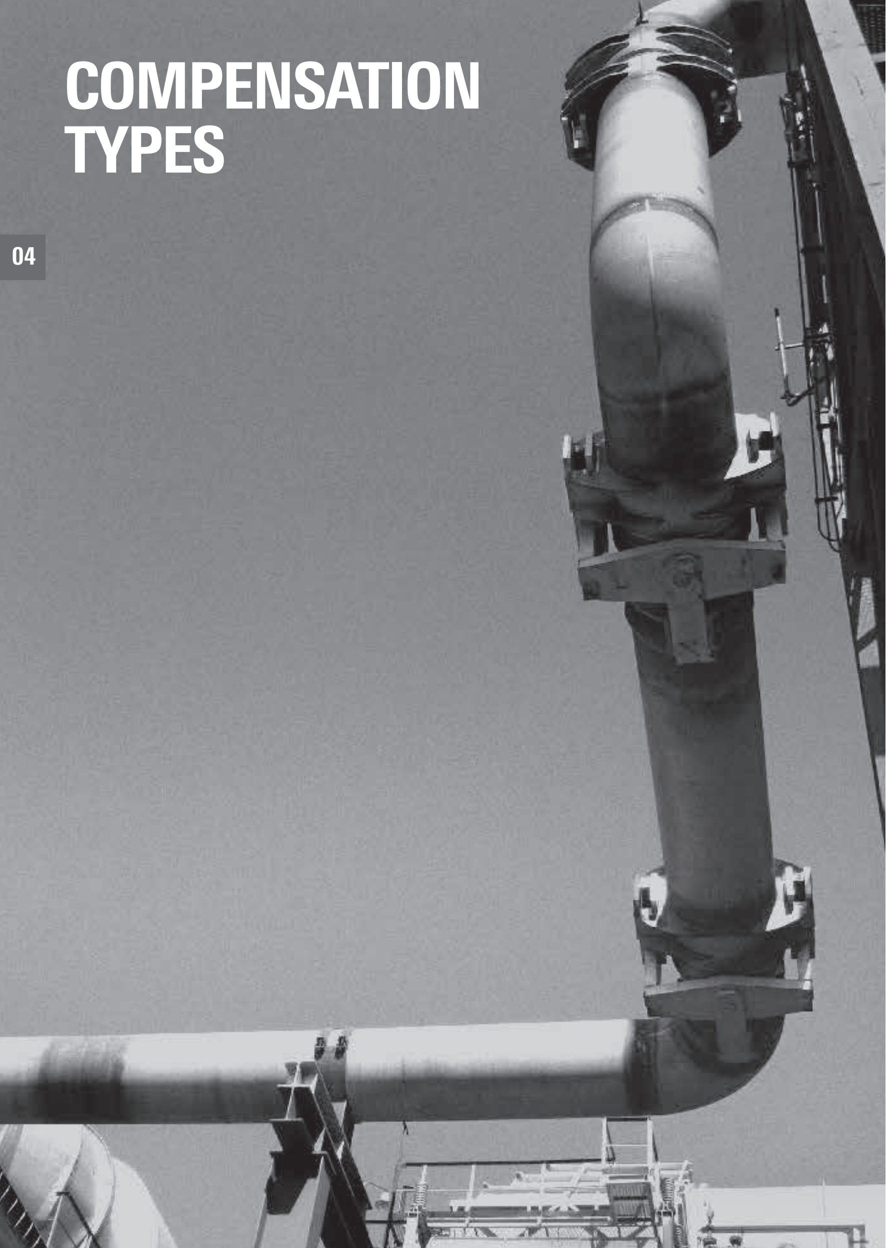
Responsibility of the manufacturer for the suitability of expansion joints
The expansion joints manufacturer is responsible for the design of the expansion joint according to the given pressure, temperatures and movements, and for the material concerning its formability and weldability.

Witzenmann contributes its wide scope of experience when assisting the operator in selecting a suitable material.

With regard to the influences of the operating conditions given in the plant only the operator can take full responsibility. The advice of the expansion joint manufacturer can only be given without obligation, i. e. without any liability for the material to be selected for the specific application.

03

COMPENSATION TYPES



In almost all technically oriented industrial sectors, expansion joints are needed for a safe operation of plants. They have to fulfil tasks, such as:

- Compensating thermal expansions in pipelines
- Decoupling vibrations of flexibly mounted aggregates from the connected systems
- Compensating relative movements between plant components elastically
- Insulating structure-borne noise
- Reducing forces and momentums at connections

The use of flexible, metallic expansion joints in modern plant and apparatus construction is not only necessary for technical reasons, it is equally important for meeting the demands of all industries for:

- Increased operating efficiency
- Reduced plant size
- Ease of installation
- Failure-free operation and
- Safety during incidents

HYDRA expansion joints meet all these requirements, and if chosen carefully and installed correctly are:

- Pressure resistant
- Vacuum-tight
- Temperature-resistant
- Corrosion-resistant
- Highly durable
- Reliable
- Maintenance-free

A comprehensive range of standard expansion joints are available. Our experienced engineers are always ready to examine the availability of specific designs for special applications. Their experience is based on decades of company experience in almost all branches of industry.

Engineering for the specific case

We are always willing to support you in optimising your compensation problems, as far as a feasible solution can be found. We also offer a special engineering service for solving specific problems:

- Optimisation of compensation systems using modern methods of pipe calculation
- Optimisation of the design of bellows and connection parts for special applications, supported by FE methods
- Development of special designs, including the necessary manufacturing processes (forming, welding, etc.)
- Performing a series of tests with special products or for special applications
- Support in solving corrosion issues, including material recommendations and corrosion tests

Compensation types and selection criteria

There are three basic types of compensation, namely:

- Compensation by elastic bending of pipe legs ("natural compensation")
- Axial expansion joints
- Restrained expansion joints (hinged expansion joints)

The relevant criteria are as follows:

- Magnitude and type of movement to be compensated
- Pipeline routing
- Forces and momentums acting on anchors and connections
- Installation space required for expansion joints
- Overall cost of compensation
- Assembly issues

This overview of criteria permits a qualitative comparison of the compensation types – either compensation with axial expansion joints or compensation with restrained expansion joints –and is an important decision-making aid.

Compensation by pipe bending

The question whether compensation, for example thermal expansion, is possible by the intrinsic elasticity of the pipe system is generally superfluous due to the fact that with large diameters pipe legs which are sufficiently long are not available (Fig.4.1). Extending the pipes artificially or laying them with bends is however usually not feasible for economic reasons, as demonstrated by numerous analyses. High-pressure steam pipes in power stations are one example of an exception made for technical reasons.

An examination can generally be restricted to pipe diameters less than DN 100, and is only advisable if, in addition to the stresses from internal pressure, the pipes can also absorb significant, alternating stresses from movement cycles without fatiguing prematurely.

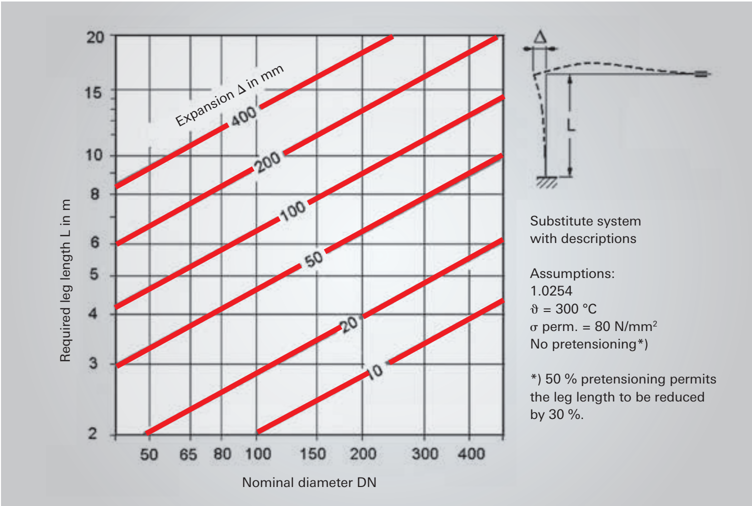


Fig. 4.1 Compensation by bending pipe legs ("natural compensation")

COMPARISON OF COMPENSATION TYPES

Axial expansion joints

Movement absorption:
- Small to medium axial movement absorption up to approx. 200 mm
- Additional lateral and angular movement absorption is possible
- Several axial expansion joints must be distributed over the length of the pipe section for large movements caused by long sections

Pipeline routing:
- No change in flow direction

Anchors and guides:
- Higher pressures and nominal diameters result in high anchor forces (Fig. 4.2)
- Anchors must be positioned at the corners of bent systems
- Long pipe sections with several axial expansion joints require intermediate anchor points
- Additional guides must be incorporated directly at the axial expansion joint

Installation space:
- Low space requirement, outside diameters only slightly larger than the pipe itself

Costs:
- Low price per unit (several expansion joints required for long pipe sections)
- Possibly high costs for anchors and guides

Assembly:
- Simple assembly and pretensioning of expansion joints
- Pipe sections must be guided exactly to give proper alignment
- Pressure test only possible when fully secured at anchors

Restrained expansion joints

Movement absorption:
- Medium to large perpendicular to the expansion joint axis, on one plane or on all planes (main elongation absorbed by lateral expansion joint, small residual elongations absorbed by the pipe)

Pipeline routing:
- Pipeline rerouting necessary
- Compensation with hinged expansion joints advisable if the pipe routing already contains bends

Anchors and guides:
- Relatively small load on anchors, even in pipes with high pressure, since the axial pressure thrust is absorbed by the restraint hardware
- Only the adjustment force of the expansion joints and the frictional forces of the supports are relevant
- The frictional forces may cause problems in long pipes with regard to the design of the anchors
- Normal guides are sufficient for the pipe (when lateral expansion joints are used, this results in additional forces and momentums on anchors and guides due to residual elongations)

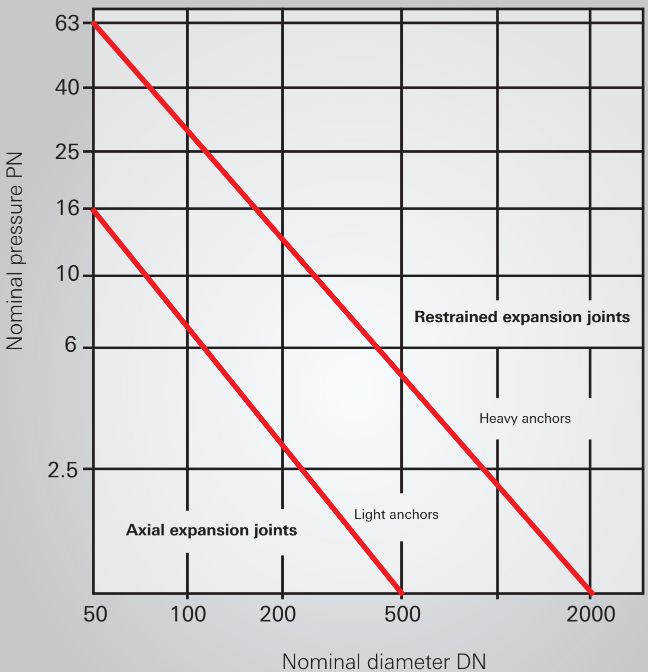
Installation space:
- More installation space required than with axial compensation, especially if the pipeline must be rerouted

Costs:
- Price per unit is higher than for axial expansion joints
- Angular expansion joints must be installed in pairs as a minimum
- In relation to movement, costs are comparable with those of axial expansion joints, if long pipe runs are compensated
- Anchors are cheaper

Assembly:
- Assembly of hinges is more complex
- Position of pivots and tie rods is very important
- Normal amount of work for pipe guiding
- Pressure test can be performed without anchors

OPERATING LIMITS OF AXIAL EXPANSION JOINTS

Fig. 4.2 provides a rough idea of the potential use of axial expansion joints in pipes. Please note the assumptions which have been made. A more detailed examination of the technical boundary conditions and a cost comparison are generally advisable before a final decision is taken. The most important criterion is the anchor force.



Assumptions:
- A permissible anchor force of 10 - 20 kN has been assumed for "light anchors", depending on the nominal diameter (building, pipe bridges, pipe connections)
- An anchor force of approximately 40-400 kN has been assumed for "heavy anchors" depending on the nominal diameter (e.g. pipelines laid in ducts)

Fig. 4.2 Operating limits of axial expansion joints

Anchor force

When axial expansion joints are used, the anchor force is made up of the axial pressure thrust F_P, the axial adjusting force F_δ and the friction of the supports F_R; these are calculated as follows:

Axial pressure thrust in kN
(see also Fig. 4.3)

(4.1) $F_p = 0.01\ A \cdot p$

Effective cross-section A in cm² (taken from dimension tables for axial expansion joints)
Pressure p in bar (maximum pressure, e.g. test pressure, should be used)

Axial adjustment force in kN

(4.2) $F_\delta = 0{,}001\ c_\delta \cdot \delta$

Axial spring rate c_δ in N/mm (taken from dimension tables for axial expansion joints)
Half overall deflection δ in mm (with 50% pretensioning)

Friction resistance of supports in kN

(4.3) $F_R = \Sigma\, F_L \cdot K_L$

Support load F_L in kN
Friction coefficient of supports K_L

Empirical values for K_L:

Steel / steel:	0.2 – 0.5
Steel / PTFE:	0.1 – 0.2
Roller bearings:	0.05 – 0.1

The significant share of the anchor force when axial expansion joints are used is contributed by the axial pressure thrust. The adjusting force is relatively insignificant in the multi-ply bellows we use.

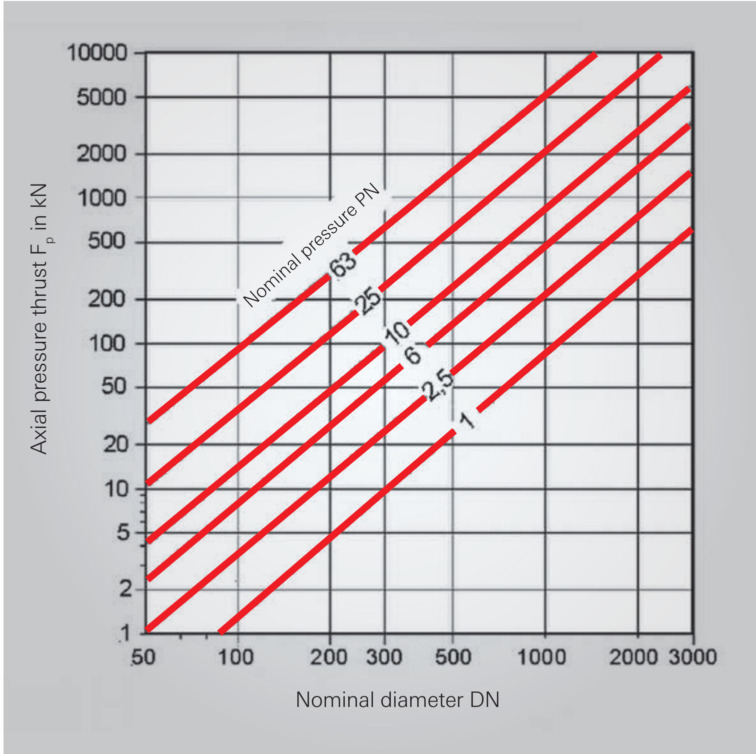


Fig. 4.3 Axial pressure thrust

Adjusting forces and moments

Adjusting forces and adjusting moments for expansion joints should be calculated using the spring rates given in the tables. The values given there are valid for the cold state (ambient temperature) only; smaller values must be expected in the operating condition, which is why the values given in the tables can be used for piping calculations. The deviations are practically negligible for temperatures up to 200 °C. At higher temperatures the reduction factors in the table below enable the spring rate to be estimated when using standard materials (1.4541 or 1.4876). In the case of very large deflections or operating pressures, the manufacturer should be involved during the calculation of the adjusting forces or moments.

Reduction factors for spring rates

Operating temperature ϑ in °C	200	300	400	500	600	700	800	900
Reduction factor K_c	0.93	0.9	0.86	0.83	0.80	0.75	0.71	0.67

Spring rate at temperature

(4.4) $$c_{i\vartheta} = K_c \cdot c_i$$

General spring rate c_i (taken from dimension tables)

RESTRAINED EXPANSION JOINTS

If restrained expansion joints are used, no load is placed on the pipe anchors by the axial pressure thrust. The load is transferred by the restraint hardware instead. The only loads placed on the anchors are the adjusting forces of the expansion joints and the friction of the supports, as well as any forces and moments resulting from movements of the pipe legs if residual elongations are transferred to the pipes in conjunction with lateral expansion joints. The friction resistance of the supports may become significant in this case, since the movement in long pipe sections can be transferred to a single compensation system, thereby moving several different supports.

Compensation with angular and lateral expansion joints
Restrained expansion joints have been considered so far as a single group, i.e. no distinction has yet been made between angular and lateral expansion joints. The basic question is whether a double-hinge system is sufficient for compensation or full compensation with three hinges is necessary.

Two hinges (angular expansion joints) – or alternatively one lateral expansion joint – can be used if the residual elongation from the pipe offset and the axial offset of the double hinge system resulting from the movement can be absorbed by the adjacent pipe legs by means of bending (see also Fig. 4.1), and if the forces and moments which are generated as a result can be taken by the system. The question as to whether it is better to use two hinges or one lateral expansion joint is generally related primarily to costs.

Compensation with pressure balanced expansion joints
In some cases pressure balanced expansion joints or straight section tie rods are the technically favorable but possibly more expensive alternative. The basic possibilities which are available are described in Chapter 12, "Axial Pressure Thrust and Pressure-balanced Designs".

The criteria for selecting the right type of compensation system which are discussed in this chapter should be sufficient in most practical situations to clarify which types of expansion joint should be used. The final decision may however depend on other data, for example on the total length of the expansion joints, which is determined later on. This frequently makes it necessary to revise the overall system. Drawing up a cost comparison is the only means of choosing the most economical of all the technically feasible systems. An economic consideration should not merely take into account the cost of the expansion joints; it should also include all miscellaneous costs related to the selected compensation type, namely:

- Anchors
- Guides and other supports
- Constructions/shafts
- Assembly work
- Miscellaneous

In case of doubt or complex applications please consult our specialists.

SYMBOLS USED TO REPRESENT SYSTEMS

Expansion joint symbols

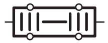
Designation	Plane illustration according to direction of movement		Isometric illustration
	in focal plane	perpendicular to the focal plane	
Axial expansion joint			
Angular expansion joint, single hinge			
Angular expansion joint, gimbal hinged			
Lateral expansion joint, flexible on one plane			
Lateral expansion joint, flexible on all planes (in circular plane)			

Fig. 4.4

Support symbols

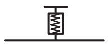
Designation	Display	Designation	Display
Anchor/Fixed point FP Intermediate anchor ZFP		Pipe shoe AL	
Sliding anchor GFP		Roller bearings RL	
Guide bearing FL		Spring hanger FH	
Two-way guide slide bearing KGL		Constant hanger KH	

Fig. 4.5

OVERVIEW OF THE MOST IMPORTANT COMPENSATION TYPES

Principle characteristics

Axial compensation (Fig. 4.6)

- Simple design
- Small to medium movement absorption
- Movement on all sides possible
- No rerouting of pipeline necessary
- High axial forces in conjunction with high pressure
- Strong anchors and good guides necessary

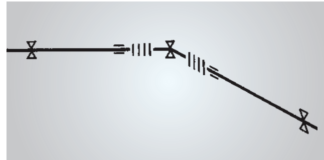


Fig. 4.6

Angular compensation (Fig. 4.7)

- Complex design
- Medium to large movement possible
- Axial movement not possible
- Pipeline rerouting necessary
- Relatively small load on anchors
- Normal guides adequate

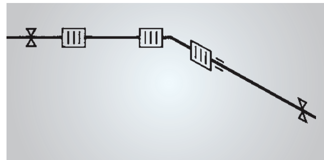


Fig. 4.7

Lateral compensation (Fig. 4.8)

- Relatively simple design
- Small to medium movement absorption
- Axial movement not possible
- Pipeline rerouting necessary
- Relatively small load on anchors
- Additional load from residual elongations
- Normal guides adequate (sometimes with clearance).

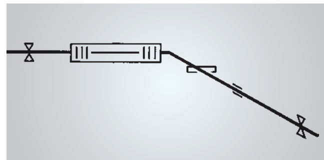


Fig. 4.8

SELECTION OF EXPANSION JOINTS

05

The basis for selecting the right expansion joint is our comprehensive standard range, whose individual series are designed and arranged according to nominal diameter, nominal pressure and nominal deflection. This allows a fast and safe choice, guarantees cost-effective, well-constructed designs and ensures short and reliable delivery times.
Wherever an expansion joint has to be designed for a very particular application, our engineers optimise the design to meet the customer’s engineering and economic specifications. Even in the initial quotation the exact dimensions are already determined.

DESIGN REGULATIONS

The manufacturer is responsible for providing a properly designed expansion joint. "State-of-the-art" design is indispensable for complying with national and international standards. Since many pressurised pipelines are covered by the EU's Pressure Equipment Directive, the associated expansion joints are also classified as pressurised components as defined by the directive and have to be CE marked.

The Pressure Equipment Directive (PED)
The PED applies to all expansion joints with a maximum permissible pressure PS > 0.5 bar, unless their specific application does not explicitly exclude this. For this reason, even our standard expansion joints meet the additional requirements of the Pressure Equipment Directive.

Since our expansion joints can be used in a vast range of applications, we have designed them in such a way that they can be used in all categories up to category IV.

Witzenmann has implemented a quality assurance system as described in the PED Annex III, Module H/H1 for the scope of design, manufacturing and distribution of expansion joints and metal bellows.

This also applies to all other conditions, like certification of the raw materials, manufacturing processes and personnel. This means customers can rely on design and selection of expansion joints in compliance with the PED. The execution in accordance with the PED takes place in defined modules, which are selected depending on the category. Hence, the scope of testing and documentation is defined accordingly.

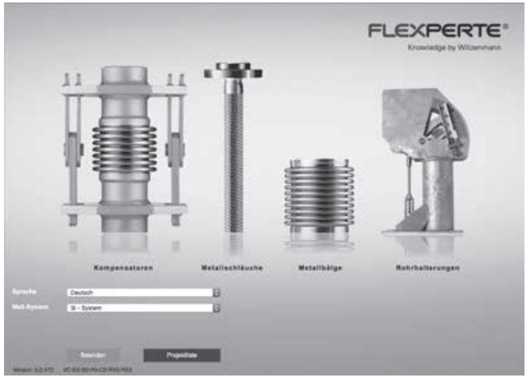
Witzenmann – Member of the EJMA
Witzenmann is a member of the "Expansion Joint Manufacturers Association" (EJMA). Each expansion joint produced by Witzenmann can be designed and manufactured in strict accordance with EJMA standards.

Detailed calculations to validate design in accordance with the latest edition of the EJMA standards are available to every customer.

FLEXPERTE – KNOWLEDGE BY WITZENMANN

FLEXPERTE® is a design tool for flexible metal elements. It is a specially developed software in accordance with the latest design codes and selects the products from the standard range to suit the particular application. In addition to choosing the expansion joints, the user can also design metal bellows, flexible metal hoses and pipe supports with the program.

When the operating conditions have been entered, the program offers a selection of suitable products along with all necessary information and drawings for direct further processing in the form of an inquiry or an order.



A fully functional version of the program for direct use is available at www.flexperte.com.

SYMBOLS USED IN FORMULAE

$\hat{a}$	Amplitude in mm
c	Spring rate
c_δ	Axial spring rate in N/mm
c_α	Angular spring rate in Nm/degree
c_λ	Lateral spring rate in N/mm
c_r	Friction factor in Nm/bar or N/bar
c_p	Pressure factor in Nm/Grad bar or N/mm bar
$c_{t\vartheta}$	Spring rate at temperature
A, B, C	Pipe sections in the hinge system in m
D_a	Bellows external diameter in mm
DN	Nominal diameter
K_1, K_2, K_3	Expansion joints in hinge system
K_p	Reduction factor for pressure
K_Δ	Reduction factor for movement
K_c	Reduction factor for spring rate
l	Corrugated length of bellows in mm
l*	Hinge distance / centre-to-centre distance of bellows in mm
l_z	Intermediate pipe length in mm
L	Length of a pipe section in m
N	Number of load cycles
PN	Nominal pressure
P_A	Operating pressure in bar
P_P	Test pressure in bar
P_{RT}	Cold pressure in bar
$R_{m/100000}$	creep rupture strength (100,000 hours until fracture) in N/mm^2
$R_{p\ 0.2}$	Yield strength with 0.2 % residual elongation in N/mm^2
$R_{p,RT}$	Yield strength at ambient temperature in N/mm^2
$R_{p,\vartheta}$	Yield strength at temperature in N/mm^2
α	Angular movement in one direction in degrees
$\overline{\alpha}$	Mean thermal expansion coefficient in mm/mK
α_o	Pressureless bending angle in one direction in degrees
α_1, α_2, α_3	Bending angles of expansion joints K_1, K_2, K_3 in degrees
δRT	Axial movement in one direction (elongation or compression) in mm
δ_{RT}	Cold value of axial movement in one direction in mm

Δ	Movement, general in mm
Δ_P	Pressure expansion in mm
Δ_ϑ	Thermal expansion in mm
$\Delta\vartheta$	Temperature difference in °C
λ	Lateral movement in one direction in mm
λ_o	Pressureless lateral movement in one direction in mm
ϑ	Temperature in °C
ϑ_o	Assembly temperature in °C
ϑ_A	Operating temperature in °C
ω_a	Axial natural frequency in Hz
ω_r	Radial natural frequency in Hz

Indices

o	pressureless, installation condition
c	for spring rate
calc	Calculated
A	Operating..., in relation to pipe section A
B	in relation to pipe section B
L	Dependent on number of cycles
N	Nominal …
i	ith value of a value quantity, substitute pointer for index of the movement type
P	Pressure-dependent
RT	At ambient temperature
reqd	Required
z	Intermediate pipe
zul.	Allowable
α	Dependent on angular movement
δ	Dependent on axial movement
λ	Dependent on lateral movement
ϑ	Temperature-dependent
Δ	Movement-dependent

PIPE SECTIONS

A pipe system must generally be subdivided into a number of suitable sections separated by anchors to ensure optimum compensation. The type of compensation must be taken into account here. Machines and vessels must be considered to be anchors if they are not flexibly supported.

Axial compensation

Only straight pipe sections without offsets are permissible. Long, straight sections must be subdivided by intermediate anchors if several axial expansion joints are required to compensate the complete pipe section. Only one expansion joint must be installed between each pair of anchors (or intermediate anchors).

Anchors must be installed at the corner points at which pipelines are rerouted. A sliding anchor may be installed instead if the axial expansion joint (or a universal expansion joint) can be subjected to lateral movement (Figs. 5.1 and 5.2).

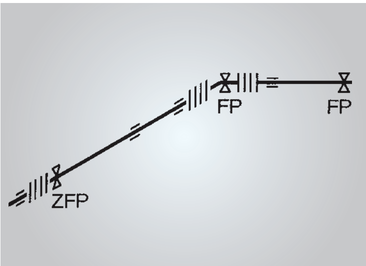


Fig. 5.1 Arrangement of axial expansion joints

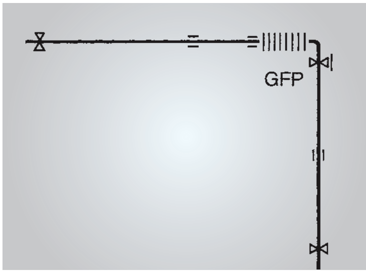


Fig 5.2 Arrangement of a universal expansion joint

Compensation with hinge systems

When a complex pipe system is subdivided into sections, the aim should be to achieve the basic subsystems shown in Figs. 5.3 to 5.5, namely U-system, L-system or Z-system. A straight pipe section is not suitable for compensation by hinged expansion joints. Thus, the pipeline is usually rerouted "artificially" by creating a U-system.

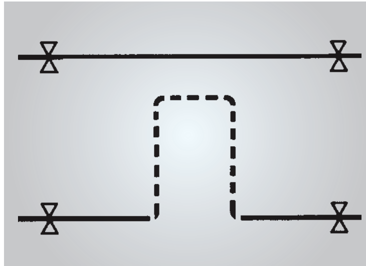


Fig. 5.3 Straight section, U-system

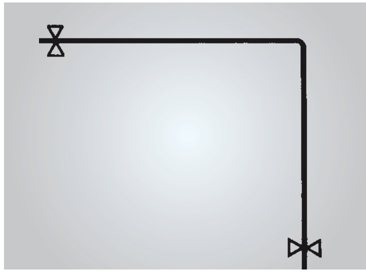


Fig. 5.4 L-system

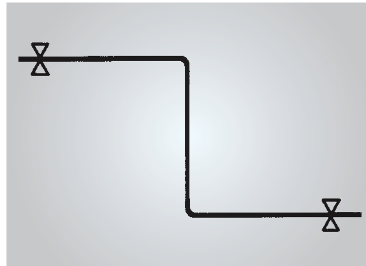


Fig. 5.5 Z-system

DETERMINING MOVEMENT VALUES

Relative movements to be absorbed by expansion joints may be:

- Pressure expansion
- Vibrations
- Compensation of misalignment
- Subsidence of the foundation
- Thermal expansion

The greatest movement values are generally caused by thermal expansions. This will be dealt with separately and in detail below.

Pressure expansion
Pressure expansion occurs at vessels and in pipelines as a result of a pressure load. It is, however, only significant in conjunction with large dimensions, which may have an important effect on compensation.
For estimating its magnitude it must be considered that in a long, closed cylinder the longitudinal stresses caused by pressure are half the magnitude of the circumferential stresses. If a full pressure utilisation is assumed, and taking the transversal contraction into account the following applies for standard steel with $R_{p\,0,2}$ = 210 N/mm² and E = 21 · 10⁴ N/mm² and S = 1,5 (safety factor for pressure vessels):

(5.1) $$\Delta_p \approx 0.1 \text{ mm/m}$$

This value is generally negligible, except, for example, in extremely high columns or vessels, such as blast furnace, whose axial pressure stretch may result in lateral loads for expansion joints with large diameters in connecting pipes.

There is no pressure expansion in pipes with axial expansion joints due to the lack of a longitudinal force.

Vibrations
Vibrations occur in machines where masses are moved (e.g. in turbo engines, piston engines and centrifuges). They are defined in terms of their frequency and amplitude. The frequencies are primarily dependent on the rotational speed. Furthermore, in this type of aggregate, it is possible to establish harmonic vibrations with a multiple of the speed but only a low amplitude.

The amplitudes of sustained vibrations in well-balanced machines are usually less than 1 mm, and are only higher temporarily during the start up phase and when traversing critical speeds (see also Chapter 13, "Vibrations and noise"). Centrifuges are an exception, in that considerably high vibration amplitudes can occur.

05

Compensation of misalignment
Expansion joints can be used to compensate assembly inaccuracies, provided that this is taken into account when they are chosen. Since only a one-off movement must be compensated, it can be theoretically be borne by the expansion joint without any impact on its service life. In practise, however, the corrugations can very soon become either fully or partially blocked, which means that normal movement will be impeded and the expansion joint will fail at a relatively early stage. This risk is especially high if a relatively short axial expansion joint is used to compensate lateral misalignments.

Subsidence of the foundation
Foundation or ground subsidences are also normally one-off movements, and may thus be greater for an expansion joint than the values specified for 1000 load cycles. If a one-off foundation subsidence is the only movement which is expected, even excessive forming of the corrugations may be acceptable, and the expansion joint will remain tight. Subsidences that occur when tanks are filled and which disappears again when they are drained must be dealt with according to the load cycles in the same way as other compensation movements.

If space must be created for assembling or dismantling components, suitable types of expansion joint can be used, namely so-called demounting parts (see Chapter 8, “Custom-built Design”, Fig. 8.16). The assembly procedures are generally so infrequent that the expansion joint can withstand large movements (until the corrugations are blocked).

Thermal expansions

The linear thermal expansion of metal components, referred to a temperature difference, can be determined by means of the material-related expansion coefficient.

Thermal expansion Δ_ϑ in mm

(5.2) $$\Delta_\vartheta = L \cdot \overline{\alpha} \cdot \Delta\vartheta$$

Component length L in m (e.g. pipe section between two anchors)
Mean thermal expansion coefficient $\overline{\alpha}$ in mm/mK (see Fig. 5.6)
Temperature difference $\Delta\vartheta$ in K (difference between operating temperature and assembly temperature)

Material	Temperature range from 20 °C to				
	100 °C	200 °C	300 °C	400 °C	500 °C
Ferrite	0.0125	0.013	0.0136	0.0141	0.0145
Austenitic steels 1.4541	0.016	0.0165	0.017	0.0175	0.018
Copper	0.0155	0.016	0.0165	0.017	0.0175
Aluminium alloy (AlMg3)	0.0237	0.0245	0.0253	0.0263	0.0272

Fig. 5.6 Mean thermal expansion coefficient $\overline{\alpha}$ in mm/mK

Taking assembly temperature into account

The assembly temperature can normally be taken to be ϑ_o = 15 to 20 °C when determining the temperature difference $\Delta\vartheta$, which must be taken into account in the movement calculation. At low operating temperatures of around 100 °C, it is necessary to proceed somewhat more precisely and to take a mean downtime temperature. A check must also be made to determine whether the pipe can still contract sufficiently at the lowest possible downtime temperature without the expansion joints being overstretched or the hinge system being geometrically overloaded. Particular attention must be paid to the possible extreme positions of the expansion joint or of the compensation system at the maximum and minimum outside temperatures, as well as to correct pretensioning at the prevailing assembly temperature in pipes which are usually cold and which only stretch or contract as a result of the prevailing outside temperature.

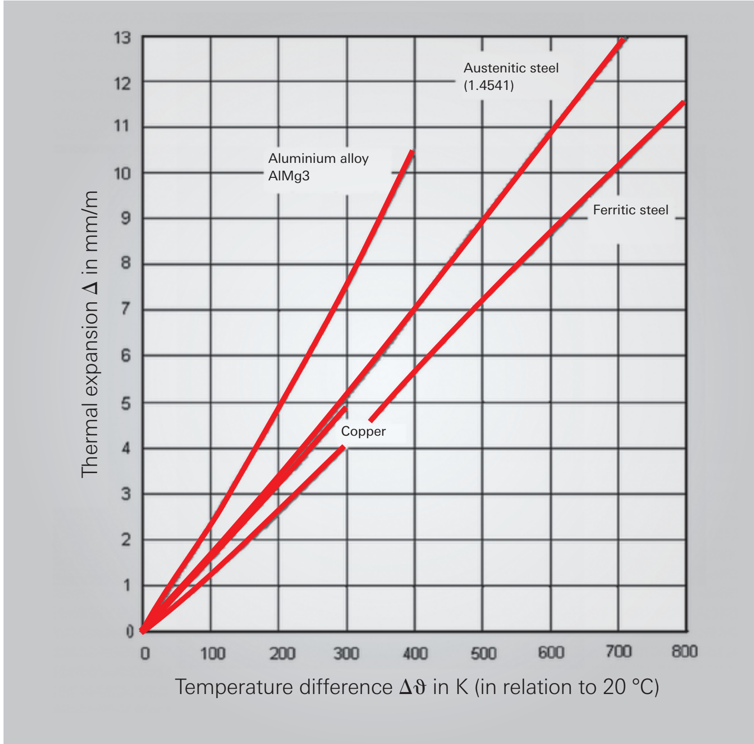


Fig. 5.7 Thermal expansion of metals

REAL MOVEMENT VALUES

The real deflection of the individual expansion joints can be determined from the previously established relative movements – usually thermal expansion – in the various pipe sections.

Axial and lateral movement absorption
If axial or lateral expansion joints are used, the movement values which are determined correspond to the real expansion joint deflections.

Angular absorption of movements
The movement values Δ must be converted to angular movements for hinge systems. A good approximation can be achieved with the aid of the graph below in Fig. 5.9.

The conversion is exact if the system is a simple double-hinge system with hinges arranged perpendicularly above one another. In other systems the angles are determined approximately, whereby the difference in relation to the exact angles is small and dependent on the arrangement of the hinges and at the magnitude of the movement which must be absorbed. The relevant movement value Δ must first be determined for the particular hinge system in accordance with Fig. 5.8a, 5.8b. Together with the hinge distances A and B, the expansion joint angle α must then be read from the graph (Fig. 5.9).

The hinge distances A and B should be as large as permitted by the overall construction, and should be such as to ensure small expansion joint bending angles and – above all – the smallest possible forces and moments in the pipe system. Distance C should be as small as possible.

The bending angles which are determined are real angles of the system at operating temperature, and are also valid when the cold system is pretensioned. If the system is to be operated without pretension, the angles obtained will be roughly twice as large, and correspondingly larger expansion joints will be necessary (Fig. 5.8a dn 5.8b).

The real bending angles must be converted into nominal angles in order to select the best expansion joints, whereby the potential effects of the operating temperature, the pressure utilisation and the number of load cycles are taken into account.

Since this applies generally to all types of movement, the section below refers to all types of expansion joint.

05

Definitions for Figs. 5.8a, 5.8b and 5.9
"Calculation of the bending angles of hinge systems"

Distances

A Main distance
U and Z-systems: Distance between the hinges in or at the pipe offset
L-system: Distance between the hinges in the same pipe run

B Secondary distance (three-hinge systems only)
all systems: Distance to the balancing joint
U-system: Distance basic hinge / crown hinge

C Corner distance (three-hinge systems only)
all systems: Distance between hinges across the corner
U-system: Distance designated "B"

Hinges

K_1 Outer hinge at section A

K_2 Second hinge at section A
(U-system: second basic hinge)

K_3 Second outer hinge/balancing joint (U-system: crown hinge)
Only exists in three-hinge systems!

Movements of the pipe strands

Δ_1 First main movement
Movement in first main section; assigned to K1

Δ_2 Second main movement
Movement in second main section

Δ_3 Secondary movement
Movement in pipe offset (Z-systems only)

Calculation of the bending angles in hinge systems

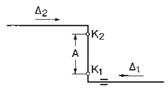
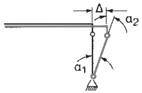
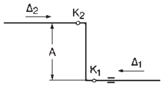
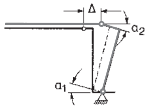
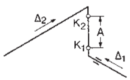
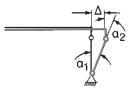
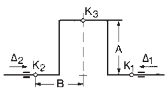
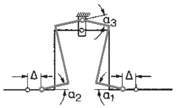
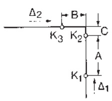
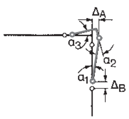
No.	Hinge system	Substitute system	Bending angle in degrees with 50% pretension
1	Double hinge 		$\Delta = \frac{1}{2}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1$
2	Double hinge in Z-arrangement 		$\Delta = \frac{1}{2}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1$
3	Double hinge 3-dimensional 		$\Delta = \frac{1}{2}\sqrt{\Delta_1^2 + \Delta_2^2}$ $\alpha_1 = (\Delta, A)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1$
4	Three-hinge in U-arrangement 		$\Delta = \frac{1}{4}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1$ $\alpha_3 = 2 \cdot \alpha_1$
5	Three-hinge in L-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_2 + \Delta_1 \frac{C}{OM})$ $\Delta_B = \frac{1}{2}\Delta_1$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 5.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1 + \alpha_3$

Fig. 5.8a

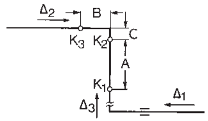
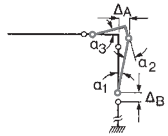
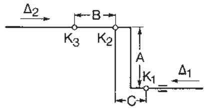
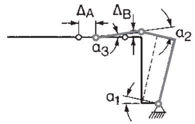
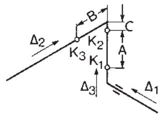
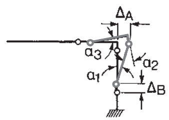
No.	Hinge system	Substitute system	Bending angle in degrees with 50% pretension
6	Three-hinge in Z1-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_1 + \Delta_2 + \Delta_3 \frac{C}{OM})$ $\Delta_B = \frac{1}{2}\Delta_3$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 5.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1 + \alpha_3$
7	Three-hinge in Z2-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_2 + \Delta_1)$ $\Delta_B = \Delta_a \frac{C}{A}$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 5.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1 + \alpha_3$
8	Three-hinge 3-dimensional 		$\Delta_A = \frac{1}{2}(\sqrt{\Delta_1^2 + \Delta_2^2} + \Delta_3 \frac{C}{OM})$ $\Delta_B = \frac{1}{2}\Delta_3$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 5.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 5.9 $\alpha_2 = \alpha_1 + \alpha_3$

Fig. 5.8b

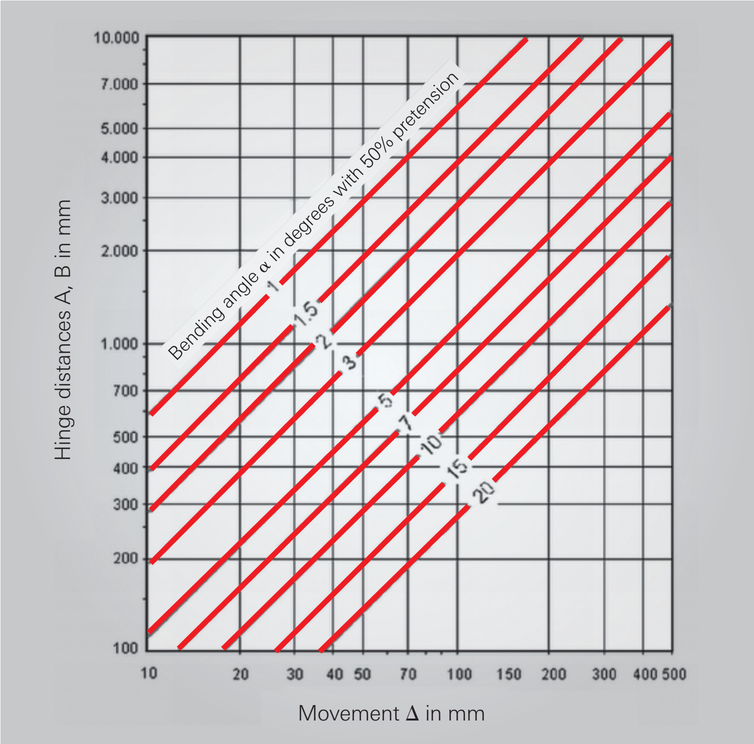


Fig. 5.9 Bending angles in hinge systems

Universal movement absorption

Single axial expansion joints and universal expansion joints comprising two bellows connected via an intermediate pipe can cope with all types of movement - axial, angular and lateral. The movement absorptions (axial, angular, lateral) stated in our standard range described subsequently are to be regarded as alternatives, i.e. the sum of their proportions in percentages shall not exceed 100 %.

If any additional requirements must be met, combinations of multiple axial and universal expansion joints can be designed.

The calculation formulae for permissible angular or lateral movements, equivalent to the nominal axial movement $2\delta_N$, are specified together with equations for determining the spring rates for these types of movement (extremely good approximated).

It is important to remember that the pressures valid for axial expansion joints are hardly ever permitted for universal expansion joints.

The necessary pressure reductions are shown in the graphs below (Fig. 5.11 and 5.14).

Bending angle (cf. Fig. 5.10)
Single bellows

(5.3) $$2\alpha_o = 2\delta_N \frac{115}{D_a}$$

Bending angle, pressureless $2\,\alpha_o$ in degrees
Overall, nominal axial movement $2\delta_N$ in mm
Bellows outside diameter D_a in mm

The permissible cold pressure for an angular movement is dependent on the maximum, effective bending angle α, and can be read from the graph in Fig. 5.11 in relation to the nominal pressure.

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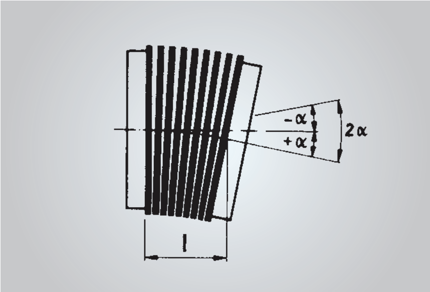


Fig. 5.10 Single bellows, angular

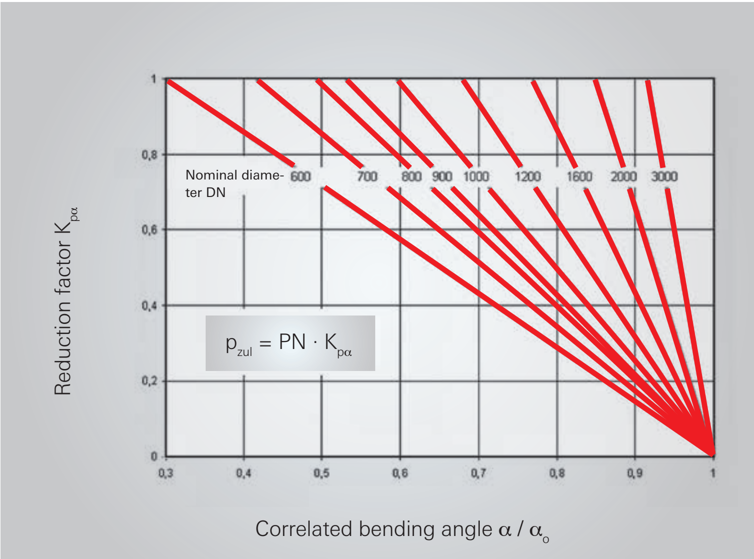


Fig. 5.11 Pressure reduction for single bellows during angular movement

Spring rate c_α in Nm/degree

Single bellows

(5.4.) $$c_\alpha = c_\delta \cdot 2.2 \cdot 10^{-6} \cdot D_a^2$$

Axial spring rate c_δ in N/mm, bellows outside diameter D_a in mm

Lateral movement (cp. Fig. 5.12, 5.13)

Single bellows (no pressure reduction)

(5.5) $$2\lambda_N = 2\delta_N \frac{l}{3D_a}$$

Double bellows (consider pressure reduction according to Fig. 5.14!)

(5.6) $$2\lambda_o = 2\delta_N \cdot \frac{2}{3D_a} \cdot \frac{l^2 + 3l^{*2}}{l + l^*}$$

Total lateral movement $2\lambda_N$ or $2\lambda_o$ in mm
Axial movement of the single bellows $2\delta_N$ in mm
Corrugated length of single bellows l in mm
"Hinge" Distance l* in mm ($l^* = l + l_Z$, with intermediate pipe length l_Z)

Spring rate c_λ in N/mm

Single bellows

(5.7) $$c_\lambda = c_\delta \cdot \frac{3}{2} \left(\frac{D_a}{l}\right)^2$$

Double bellows

(5.8) $$c_\lambda = c_\delta \cdot \frac{3}{4} \cdot \frac{D_a^2}{l^2 + 3l^{*2}}$$

Spring rate of the single bellows c_δ in N/mm (other values as defined above)

The permissible cold pressure for a lateral movement is dependent on the maximum effective lateral movement λ and can be read from the graph below (Fig. 5.14).

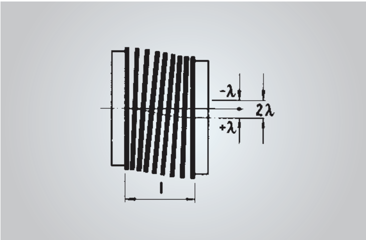


Fig. 5.12 Single bellows, lateral

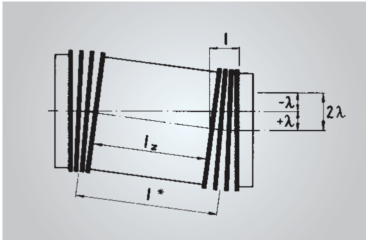


Fig. 5.13 Double bellows, lateral

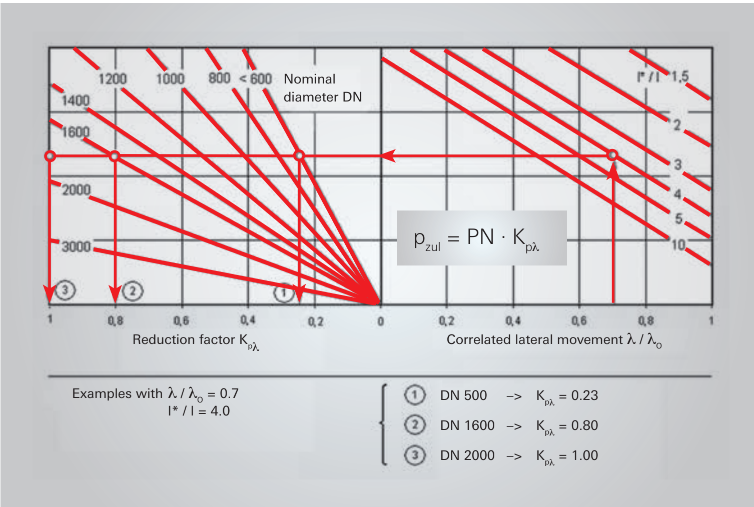


Fig. 5.14 Pressure reduction for universal expansion joint with two bellows during lateral movement

NOMINAL DIAMETER DN

The nominal diameter of an expansion joint depends on the dimensions of the pipe or the flange connections. Select an expansion joint to suit these criteria.

The standard wall thicknesses of weld ends are given in the tables. These thicknesses meet the requirements of the nominal pressure rating. If possible, standard wall thicknesses of welded pipes according to DIN EN 10220 have been chosen.

Flanges with dimensions acc. to DIN EN 1092-1 are initially used. The flange thicknesses of loose flanges have been adapted in each case to suit the stresses prevailing in the expansion joint and in some cases are different to those of standard flanges.
Flanges with other dimensions are possible, e.g. to the US standard (ASME) or non-standard flanges for special machine connections. Flanges with pitch circle diameters smaller than those given in DIN EN 1092-1 must be checked to ensure that the bolting is compatible with the bellows side.

NOMINAL PRESSURE PN

Our standard expansion joints are designed for a nominal pressure (PN) and arranged in PN ratings in the tables. (The nominal pressure parameter corresponds to the permissible operating pressure at ambient temperature, rounded to a PN nominal pressure rating according to DIN EN 1333. There are additional low pressure expansion joint types for PN1 available.) It is known that at higher temperatures the permissible pressure is lower than the nominal pressure because the characteristic strengths of the materials used are correspondingly lower at higher temperatures. The permissible pressure must be reduced accordingly.

The **reduction factor** is defined as:

$$K_{p\vartheta} = \frac{R_{p,\vartheta}}{R_{p,RT}} \quad (5.9)$$

$R_{p,\vartheta}$ yield strength in N/mm² at design temperature
$R_{p/RT}$ yield strength in in N/mm² at ambient temperature

The yield strength R_p is valid for the strength parameter over a wide temperature range. At higher temperatures the creep rupture strength plays a role. Our expansion joints are designed in such a way that the reduction can be based on the material of the bellows.
The choice of a suitable nominal pressure is based on the **cold pressure** P_{RT}. This must not be greater than the nominal pressure:

$$PN \geq P_{RT} = PS/K_{p\vartheta} \quad (5.10)$$

PS maximum permissible operating pressure in bar
$K_{p\vartheta}$ pressure reduction factor based on operating temperature

The **test pressure** PT must be at least equal to the larger of the two values given by the equations below:
for a water pressure test

$$P_T = \max \begin{cases} 1.25 \cdot PS \cdot \dfrac{f_0}{f} \\ 1.43 \cdot PS \end{cases} \quad (5.11)$$

for a gas pressure test

$$P_T = PS \cdot \frac{f_0}{f} \quad (5.12)$$

f_0 allowable stress in N/mm² for design conditions at test temperature
f allowable stress in N/mm² for design conditions at design temperature

The expansion joints are designed to withstand a test pressure of 1.43 times their nominal pressure. If a higher test pressure is required, this must be taken into account when determining the PN rating.

Temperature in °C	Reduction factor $K_{p\vartheta}$	Standard material combinations			
		Bellows	Weld end	Flange	Restraint hardware
20	1.00	1.4541	1.0345 (P235GH) seamless 1.0425 (P265GH) welded	1.0038 (S235JRG2) 1.0460 (P250GH)	1.0566 (P355NL1)
100	0.83				
150	0.78				
200	0.74				
250	0.71				
300	0.67				
350	0.64			1.5415 (16Mo3)	
400	0.62				
450	0.61		1.5415 (16Mo3)		1.5415 (16Mo3)
500	0.60				
550	0.59		1.4541	1.4541	1.4541
600	0.46	1.4876	1.4876	1.4876	1.4876
650	0.32				
700	0.19				
750	0.14				
800	0.08				
850	0.06				
900	0.03				

Fig. 5.15 Pressure reduction factor for the pressure (temperature-related)
Basis: $R_{p\ 1.0}$ – values for 1.4541 (cold-rolled strip) according to DIN EN 10028-7
$R_{m\ 100.000}$ – values for 1.4876 according to DIN EN 10095

NOMINAL DEFLECTION AND NOMINAL ANGLE

Nominal values are to be calculated from the determined real movement values so that it is possible to choose a suitable expansion joint from the tables. The nominal values are based on a service life of at least 1000 full load cycles at ambient temperature and maximum pressure utilization, and are valid for the standard bellows material 1.4541.
A load cycle here means the total movement of the expansion joint from a starting position to an extreme position on one side, then returning via the starting point to an extreme position on the other side and then back to the starting position.

The service life is influenced by
- Pressure utilization
- Movement size
- Pressure pulsation

plus other factors whose effects cannot be calculated or are unacceptable, such as
- Thermal shock
- Corrosion
- Pre-existing damage (improper installation, damaged corrugations, etc.)
- Resonance (e.g. flow-induced)

A temperature up to 500 °C has no influence on the amount of movement. Please consult us for higher temperatures.

The correction factors given below are valid for the standard materials 1.4541 (≤ 550 °C) and 1.4876 (> 550 °C). Other materials with comparable strength values behave very similarly and can be handled in a similar way. Materials whose characteristic values deviate considerably from the values mentioned here cannot be dealt with in this way accurately enough. This frequently needs a different approach. Please consult us if you wish to use special materials.

Pressure ratio P_{RT} / PN	1	0.8	0.6	0.4	0.2	0
Correction factor $K_{\Delta p}$	1.00	1.03	1.07	1.10	1.13	1.15

Fig. 5.17 Pressure influence on the amount of movement

Load cycles	Influencing factor $K_{\Delta L}$	Load cycles	Influencing factor $K_{\Delta L}$	Load cycles	Influencing factor $K_{\Delta L}$
500	1.15	10000	0.53	$5 \cdot 10^5$	0.20
1000	1.00	20000	0.44	$1 \cdot 10^6$	0.17
2000	0.82	$5 \cdot 10^4$	0.34	$2 \cdot 10^6$	0.14
4000	0.68	$1 \cdot 10^5$	0.29	$5 \cdot 10^6$	0.12
7000	0.58	$2 \cdot 10^5$	0.24	$1 \cdot 10^7$	0.11

Fig. 5.18 Influence of the load cycles on the amount of movement

General correction factor

(5.13) $$K_\Delta = K_{\Delta p} \cdot K_{\Delta L}$$

The entire correction factor K_Δ must not be greater than 1.15.

Required movement absorption cold

(5.14) axial: $$2\delta_{RT} = 2\delta / K_\Delta \leq 2\delta_N$$

(5.15) lateral: $$2\lambda_{RT} = 2\lambda / K_\Delta \leq 2\lambda_N$$

(5.16) angular: $$2\alpha_{RT} = 2\alpha / K_\Delta \leq 2\alpha_N$$

Cummulated movement

If an expansion joint is to accommodate movements with different numbers of load cycles, the respective cold values (related to 1000 load cycles) are determined first. Afterwards, the theoretical total deflection of the cumulated movement can be calculated reasonably accurately using the following equation:

(5.17) $$2\delta_{RTges.} = [\,\sum(2\delta_{RT,i})^4\,]^{1/4}$$

The cold movement and nominal pressure calculated as described above can now be used to select the necessary expansion joints from the standard range.

Pressure pulsations
Pressure pulsations or dynamic operating pressure superimposed on the static pressure have an influence on the service life. Their effect, which can be calculated, depends on the magnitude of the pressure fluctuations in relation to the nominal pressure and their frequency. Generally, pressure fluctuations are negligible. However, if the magnitude and frequency of pressure surges are expected to have a detrimental effect on the service life, please consult us.

When designing expansion joints it is usual to check the utilisation condition (related to load cycles):
$D = \sum (N_{i,reqd}/N_{i,calc}) \leq 1$.

MATERIAL

We have selected material combinations for standard expansion joints that are adequate for the majority of applications. The most important considerations for the choice of the bellows material are generally

- formability
- weldability
- temperature resistance
- strength
- corrosion resistance

Our standard material, 1.4541, an austenitic stainless steel, satisfies these requirements admirably for a wide range of requirements. For higher temperatures (ϑ > 550 °C), high temperature or heat-resistant steels can be used if they have sufficient ductility (e.g. 1.4876, 1.4828).

Under extremely aggressive conditions, special materials with a corrosion resistance at least equivalent to that of the adjoining pipe must be used. This is because the relatively thin plies of the bellows and their function as highly flexible compensation element does not permit any corrosion allowance. In case of doubt it is best to choose a higher-quality material for the bellows, at least for the inner ply. In many cases nickel-based alloys, with which we have had good experience, are suitable.

The choice of a suitable corrosion-resistant material should be based on the experience of the user, who is familiar with the particular characteristics of his system and his operating medium. The resistance tables in Chapter 18 can help with the selection. Please note that special materials with – in comparison to 1.4541 – completely different physical parameters (e.g. aluminium) will inevitably lead to different dimensions and performance data for the bellows.

Low temperatures
The standard can be used in temperatures down to ϑ = –10 °C without having to apply a reduction factor.

At lower temperatures low-temperature steels should be chosen for the ferritic parts. Fig. 5.16 specifies suitable materials approved to the EN 13445 or EN 14917 standard that enable the expansion joint to be fully utilized. At very low temperatures down to ϑ = -273 °C it is possible to use a design made completely from the austenitic material 1.4541.

Temperature in °C	bellows	Pipe	restraint hardware
-20	1.4541	1.0345 (P235GH) seamless	1.0566 (P355NL1)
-40		1.0425 (P265GH) welded	1.0566 (P355NL1)
-273		1.4541	1.4541

Fig. 5.16 Materials for low-temperature applications EN 13445-2

INNER SLEEVE

An inner sleeve is used to protect the bellows when deposits or abrasion are anticipated as well as if high flow velocities could excite the corrugations of the bellows and cause them to vibrate.

The diagram in Fig. 5.19 shows maximum values for flow velocities permissible without an inner sleeve. These figures are based on an unfavourable flow towards the corrugations.

The inner sleeve can also act as an internal guidance (in special versions) and is indispensable in such cases. In addition, it can also act as a support for an internal refractory lining, but in this case calls for a special design. If an inner sleeve is necessary but must not hinder lateral or angular movement, tapering or stepped sleeves can be incorporated (Fig. 5.20).

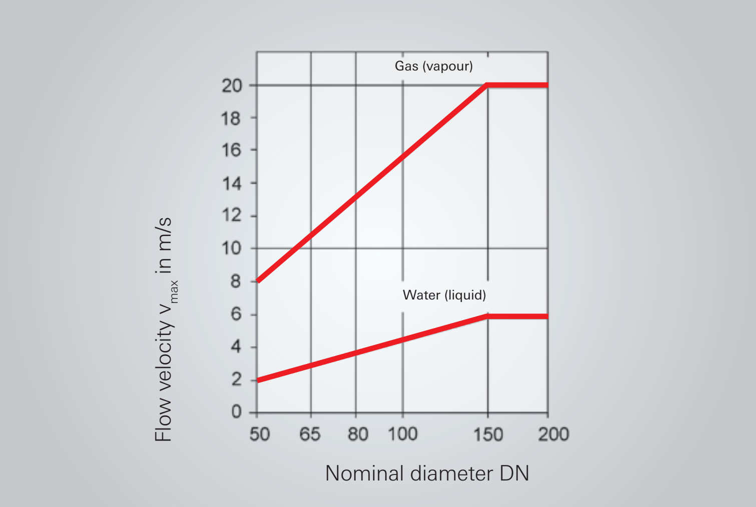


Fig. 5.19 Limiting values for usage of inner sleeves

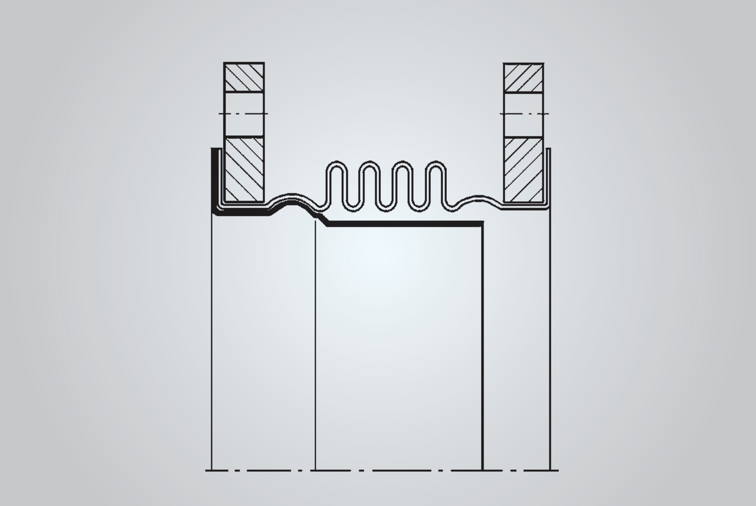


Fig. 5.20 Axial expansion joint with separate inner sleeve for lateral movement

STANDARD RANGES

06

General information

This manual deals with the expansions joints used for pipeline and for plant and apparatus construction. The expansion joints are designed for 1000 load cycles acc. to EN 14917:2021 in line with the standard operation mode of thermal plants, which corresponds to 20 years operation if the plant is started up and shut down once a week. Other designs are also possible.
The HYDRA expansion joints described here cover the essential needs of industrial applications as part of our wide range of flexible metallic elements:

Nominal diameters DN 15 – 3000
Nominal pressures PN 1 – 63

Larger expansion joints up to 12 m in diameter as well as for higher pressures can be supplied on request.

06

The standard expansion joints are of different construction types, such as axial, angular and lateral expansion joints, and are listed separately according to type series; in addition to the construction type, the type series also specifies such features as the connection type and any particularities of the design. The individual type series are classified according to the nominal pressure rating, the nominal diameter and the movement value.
The design of the standard expansion joints, of which variants can be supplied on request is defined initially in relation to the connections and materials:

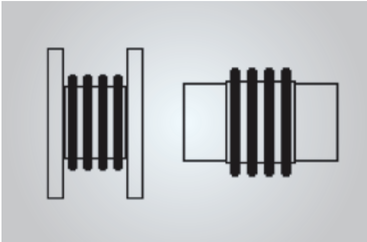
Connections

Weld ends according to ISO
Flanges according to EN 1092-1
Connectors according to other standards (e.g. ASME) are possible with minor changes of the expansion joint characteristics.

Materials

According to description of the individual types

Axial/universal expansion joints
- with flanges
- with weld ends



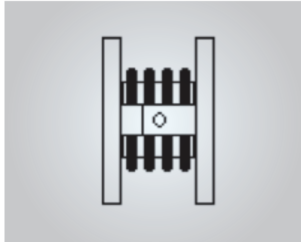
Series
ABN/AFN
UBN/UFN
ARN/URN

Nominal diameters
DN50 – DN2000

Pressure ratings
PN2.5 – PN40

Special features/main applications
Unrestrained expansion joints for pipeline and plant construction, with small spring rates and large movement absorption.

Angular expansion joints as single/gimbal hinge versions
- with loose flanges
- with plain fixed flanges



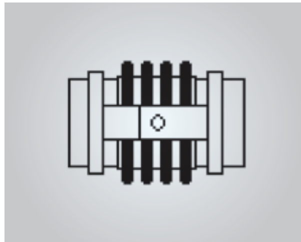
Series
WBN/WBK
WFN/WFK

Nominal diameters
DN50 – DN800

Pressure ratings
PN6 – PN25

Special features/main applications
Large bending angle, short overall lengths for use in chemical plants.

Angular expansion joints as single/gimbal hinge versions
- with weld ends



Series
WRN/WRK

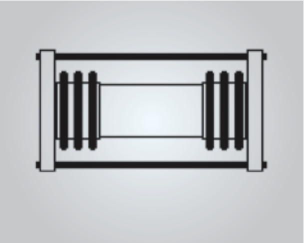
Nominal diameters
DN50 – DN800

Pressure ratings
PN2.5 – PN63

Special features/main applications
Large bending angle, short overall lengths, for use in pipeline and plant construction.

Lateral expansion joints for movement in all planes (circular plane)

- with loose flanges
- with plain fixed flanges



Series
LBR
LFR

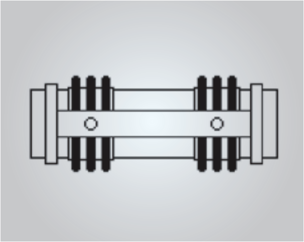
Nominal diameters
DN50 – DN500

Pressure ratings
PN6 – PN25

Special features/main applications
Can move in all directions in a circular plane, for use in pipeline and plant construction, as connection to machinery.

Lateral expansion joints for movement in one/all planes

- with weld ends



Series
LRR
LRN/LRK

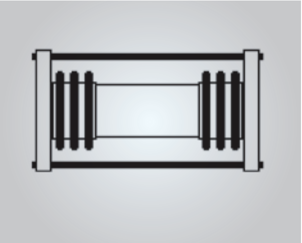
Nominal diameters
DN50 – DN2000

Pressure ratings
PN6 – PN63

Special features/main applications
Compact design, small spring rates for use in pipeline and plant construction.

Sound insulating expansion joints

- with tie rods and loose flanges



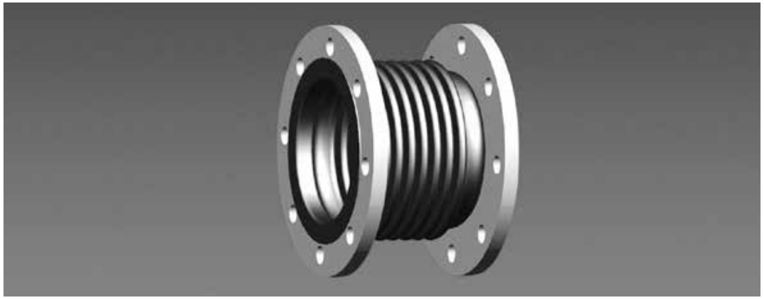
Series
LBS

Nominal diameters
DN50 – DN400

Pressure ratings
PN6 – PN25

Special features/main applications
Sound insulating design for use with vibrating elements, pumps.

AXIAL EXPANSION JOINTS WITH FLANGES TYPE ABN, AFN



06

Type designation

The type designation consists of 2 parts
1. Type series. defined by 3 letters
2. Nominal size. defined by 10 digits

Example

Type ABN: HYDRA Axial expansion joint with loose flanges
Type AFN: HYDRA Axial expansion joint with plain fixed flanges

Standard version/materials

Multi-ply bellows made of 1.4541
Flange made of S235JRG2 (1.0038) or P250GH (1.0460)
Operating temperature: up to 300 °C / 450 °C
Operating temperature „Low pressure (Exhaust)“: up to 550 °C

Type designation (example)

ABN	10	· 0150	· 064	· 0
Type	Nominal pressure (PN10)	Nominal diameter (DN150)	Movement absorption, nominal ($2\delta = \pm 32$ = 64 mm)	Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"

Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive. the following information is required for testing and documentation:

06

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________________
- Piping - nominal diameter DN ____________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ____________________
- Max./min. allowable temperature [°C] ____________________
- Test pressure PT [bar] ____________________

Optional:
- Category ____________________

Note

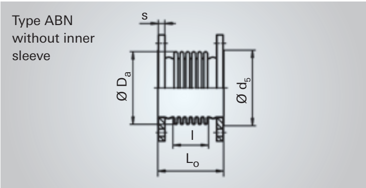
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

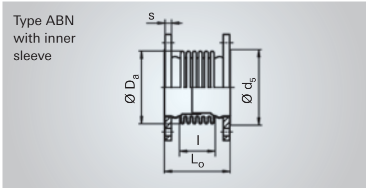
Operating condition „Low pressure (Exhaust)“

Expansion joints for low pressure (exhaust-gas) are designed for unpressurized applications (PS < 0.5 bar gauge pressure).
The Pressure Equipment Directive (PED) does not apply to this operating condition.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH LOOSE FLANGES

TYPE ABN 01... PN 1





Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 01...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling template as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
50	20	.0050.020.0	117	3.1	3.2	6	90	16
50	56	.0050.056.0	198	3.3	3.5	6	90	16
50	80	.0050.080.0	252	3.5	3.9	6	90	16
65	23	.0065.023.0	117	3.9	4	6	107	16
65	64	.0065.064.0	198	4.2	4.6	6	107	16
65	92	.0065.092.0	252	4.5	4.7	6	107	16
80	37	.0080.037.0	146	6.3	6.3	6	122	18
80	69	.0080.069.0	206	6.5	6.5	6	122	18
80	101	.0080.101.0	266	6.8	7.8	6	122	18
100	40	.0100.040.0	142	7	8	6	147	18
100	79	.0100.079.0	208	7.4	7.4	6	147	18
100	112	.0100.112.0	263	7.7	8.7	6	147	18
125	63	.0125.063.0	181	9.6	9.6	6	178	20
125	117	.0125.117.0	259	10.2	11.2	6	178	20
125	175	.0125.175.0	350	10.7	11.7	6	178	20
150	54	.0150.054.0	168	10.6	10.6	6	202	20
150	126	.0150.126.0	272	11.5	12.5	6	202	20
150	180	.0150.180.0	350	12.2	14.2	6	202	20
200	70	.0200.070.0	199	15.5	17.5	6	258	22
200	120	.0200.120.0	274	16.2	18.2	6	258	22
200	200	.0200.200.0	394	17.5	20.5	6	258	22

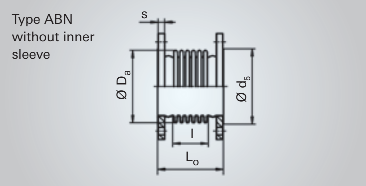
06

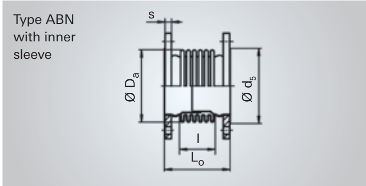
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	45	45.7	32	4	112	1.4	480
88.5	126	45.7	88	32	40	0.5	22
88.5	180	45.7	126	66	28	0.4	8
107	45	68.7	31	4	102	1.9	658
107	126	68.7	87	32	36	0.7	30
107	180	68.7	125	65	25	0.5	10
121	70	89.1	44	9	67	1.7	234
121	130	89.1	82	31	36	0.9	36
121	190	89.1	121	66	25	0.6	12
148	66	136.8	38	7	73	2.8	438
148	132	136.8	75	29	36	1.4	55
148	187	136.8	106	58	26	1	19
174	91	187.5	54	14	41	2.2	179
174	169	187.5	101	49	22	1.2	28
171	260	183.9	137	103	18	0.9	10
203	78	264.5	40	9	56	4.1	469
203	182	264.5	93	49	24	1.8	37
203	260	264.5	132	100	17	1.2	13
255	105	431.9	41	12	53	6.4	399
255	180	431.9	70	37	31	3.7	79
255	300	431.9	117	102	19	2.2	17

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH LOOSE FLANGES

TYPE ABN 01... PN 1





Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 01...	Overall length	Weight approx.		Flange[2]		
				without inner sleeve	with inner sleeve	drilling template as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
250	72	.0250.072.0	210	19.9	20.9	6	312	24
250	132	.0250.132.0	295	21	23	6	312	24
250	204	.0250.204.0	397	22.2	25.2	6	312	24
300	56	.0300.056.0	184	25.9	26.9	6	365	24
300	140	.0300.140.0	298	27.5	30.5	6	365	24
300	210	.0300.210.0	393	28.9	31.9	6	365	24
350	60	.0350.060.0	192	36.2	37.2	6	410	26
350	120	.0350.120.0	272	37.4	40.4	6	410	26
350	210	.0350.210.0	392	39.3	43.3	6	410	26
400	65	.0400.065.0	232	45.5	47.5	6	465	28
400	104	.0400.104.0	295	47.5	50.5	6	465	28
400	195	.0400.195.0	421	51.9	56.9	6	465	28
450	56	.0450.056.0	219	55.2	57.2	6	520	30
450	112	.0450.112.0	307	58.5	62.5	6	520	30
450	196	.0450.196.0	417	62.6	68.6	6	520	30
500	68	.0500.068.0	223	59.8	62.8	6	570	30
500	119	.0500.119.0	292	62.8	66.8	6	570	30
500	215	.0500.215.0	407	67.7	73.7	6	570	30
600	76	.0600.076.0	239	78.6	81.6	6	670	32
600	133	.0600.133.0	317	82.4	87.4	6	670	32
600	228	.0600.228.0	421	87.7	95.7	6	670	32

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Nominal movement absorption[1)]			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
312	102	660.5	33	10	62	11.4	753
312	187	660.5	60	33	34	6.2	122
312	289	660.5	93	78	22	4	33
365	76	915.9	21	5	91	23.1	2753
365	190	915.9	54	30	36	9.3	176
365	285	915.9	80	66	24	6.2	52
400	80	1104.5	22	5	82	25.3	2713
400	160	1104.5	44	20	41	12.6	339
400	280	1104.5	76	62	24	7.2	63
458	105	1445.5	18	6	212	85	5299
458	168	1445.5	29	14	132	53.1	1294
460	294	1452.2	54	46	69	27.7	220
513	88	1824.7	15	4	243	123.4	10953
513	176	1824.7	29	15	122	61.7	1369
513	286	1824.7	48	40	75	38	319
569	92	2252.2	15	4	215	134.4	10915
569	161	2252.2	27	13	123	76.8	2037
569	276	2252.2	46	37	72	44.8	404
674	104	3201.9	15	4	215	190.9	12134
674	182	3201.9	26	13	123	109.1	2264
676	286	3212	42	35	72	64.4	541

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

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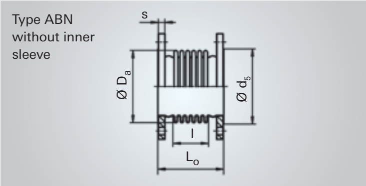
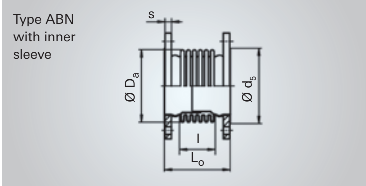
AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH LOOSE FLANGES

TYPE ABN 01... PN 1





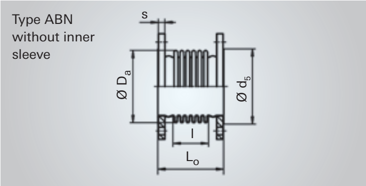
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 01...	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange[2] drilling template as per EN 1092	Flange[2] rim diameter	Flange[2] thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
700	80	.0700.080.0	218	63.7	68.7	6	775	20
700	120	.0700.120.0	274	66.8	72.8	6	775	20
700	220	.0700.220.0	414	74.7	83.7	6	775	20
800	84	.0800.084.0	230	78.3	83.3	6	880	20
800	126	.0800.126.0	288	82	89	6	880	20
800	231	.0800.231.0	404	89.3	100.3	6	880	20
900	84	.0900.084.0	234	82.9	88.9	6	980	20
900	126	.0900.126.0	294	87.2	95.2	6	980	20
900	210	.0900.210.0	414	95.6	107.6	6	980	20
1000	72	.1000.072.0	220	88	94	6	1080	20
1000	144	.1000.144.0	316	95.3	105.3	6	1080	20
1000	240	.1000.240.0	444	104.9	118.9	6	1080	20
1200	72	.1200.072.0	225	108.4	123.4	2.5	1280	20
1200	120	.1200.120.0	287	114.5	134.5	2.5	1280	20
1200	216	.1200.216.0	411	126.6	156.6	2.5	1280	20
1400	48	.1400.048.0	136	125.1	138.1	2.5	1476	20
1400	108	.1400.108.0	266	137.1	162.1	2.5	1476	20
1400	180	.1400.180.0	422	151.5	191.5	2.5	1476	20
1600	48	.1600.048.0	136	155.5	170.5	2.5	1676	20
1600	108	.1600.108.0	266	169.2	198.2	2.5	1676	20
1600	180	.1600.180.0	422	185.6	231.6	2.5	1676	20

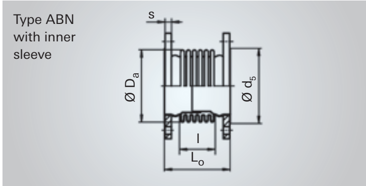
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] angular	Nominal movement absorption[1)] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	14	5	203	244	13376
780	168	4324.1	21	10	135	162.7	3963
780	308	4324.1	39	35	74	88.7	643
882	116	5588	13	4	220	342.3	17488
882	174	5588	19	10	147	228.2	5182
882	290	5588	32	27	88	136.9	1119
992	120	7133.1	12	4	238	471	22487
992	180	7133.1	18	9	158	314	6663
992	300	7133.1	29	26	95	188.4	1439
1095	96	8750	8	2	335	814.7	60780
1095	192	8750	17	9	168	407.4	7598
1095	320	8750	28	26	101	244.4	1641
1295	93	12330.8	8	2	331	1132.9	90056
1295	155	12330.8	13	6	198	679.7	19452
1295	279	12330.8	23	18	110	377.6	3335
1456	104	16015.7	4	1	922	4102.5	260788
1456	234	16015.7	9	6	410	1823.3	22895
1456	390	16015.7	15	17	246	1094	4945
1656	104	20816.1	3	1	1046	6051.1	384654
1656	234	20816.1	8	5	465	2689.4	33769
1656	390	20816.1	13	15	279	1613.6	7294

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH LOOSE FLANGES

TYPE ABN 01... PN 1





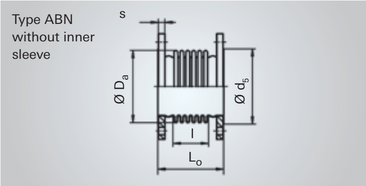
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 01...	Overall length	Weight approx.		Flange[2]		
				without inner sleeve	with inner sleeve	drilling template as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
1800	48	.1800.048.0	136	174	190	2.5	1876	20
1800	108	.1800.108.0	266	189.4	222.4	2.5	1876	20
1800	180	.1800.180.0	422	207.9	258.9	2.5	1876	20
2000	48	.2000.048.0	136	192.5	210.5	2.5	2076	20
2000	108	.2000.108.0	266	209.7	245.7	2.5	2076	20
2000	180	.2000.180.0	422	230.2	286.2	2.5	2076	20
2200	48	.2200.048.0	136	226.5	246.5	2.5	2276	20
2200	108	.2200.108.0	266	245.3	285.3	2.5	2276	20
2200	180	.2200.180.0	422	267.9	332.9	2.5	2276	20
2400	48	.2400.048.0	136	246.3	268.3	2.5	2476	20
2400	108	.2400.108.0	266	266.9	310.9	2.5	2476	20
2400	180	.2400.180.0	422	291.5	361.5	2.5	2476	20
2600	48	.2600.048.0	136	266.2	291.2	2.5	2676	20
2600	108	.2600.108.0	266	288.4	335.4	2.5	2676	20
2600	180	.2600.180.0	422	315.1	391.1	2.5	2676	20
2800	48	.2800.048.0	136	320.2	346.2	2.5	2876	20
2800	108	.2800.108.0	266	344.1	396.1	2.5	2876	20
2800	180	.2800.180.0	422	372.9	454.9	2.5	2876	20
3000	48	.3000.048.0	136	342.3	370.3	2.5	3076	20
3000	108	.3000.108.0	266	368	423	2.5	3076	20
3000	180	.3000.180.0	422	398.7	486.7	2.5	3076	20

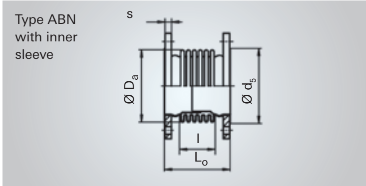
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
1856	104	26244.7	3	1	1170	8529.1	542176
1856	234	26244.7	7	5	520	3790.7	47598
1856	390	26244.7	12	13	312	2274.4	10281
2056	104	32301.7	3	1	1292	11593.9	736997
2056	234	32301.7	6	4	574	5152.8	64702
2056	390	32301.7	10	12	345	3091.7	13976
2256	104	38987	3	1	1414	15313.6	973454
2256	234	38987	6	4	628	6806.1	85461
2256	390	38987	10	11	377	4083.6	18460
2456	104	46300.7	2	1	1536	19751.1	1255534
2456	234	46300.7	5	4	683	8778.3	110225
2456	390	46300.7	9	10	410	5267	23809
2656	104	54242.6	2	1	1657	24968.9	1587221
2656	234	54242.6	5	3	737	11097.3	139344
2656	390	54242.6	8	9	442	6658.4	30098
2856	104	62812.9	2	1	1778	31029.8	1972493
2856	234	62812.9	4	3	790	13791	173168
2856	390	62812.9	7	8	474	8274.6	37404
3056	104	72011.5	2	1	1900	37996.1	2415327
3056	234	72011.5	4	3	844	16887.1	212045
3056	390	72011.5	7	8	507	10132.3	45802

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 02... PN 2.5





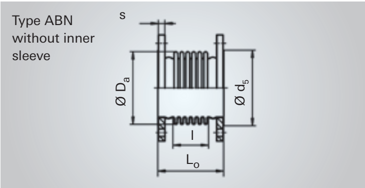
Nominal diameter	Nominal axial movement absorption 1)	Type ABN 02...	Overall length	Weight approx.		Flange 2)		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
50	20	.0050.020.0	117	3.1	3.2	6	90	16
50	40	.0050.040.0	162	3.2	3.4	6	90	16
50	70	.0050.070.0	244	3.8	4.2	6	90	16
65	23	.0065.023.0	117	3.9	4.1	6	107	16
65	60	.0065.060.0	189	4.2	4.6	6	107	16
65	87	.0065.087.0	263	4.8	5.8	6	107	16
80	27	.0080.027.0	126	6.2	6.2	6	122	18
80	64	.0080.064.0	196	6.5	6.5	6	122	18
80	92	.0080.092.0	275	7.2	7.2	6	122	18
100	46	.0100.046.0	153	7.1	8.1	6	147	18
100	73	.0100.073.0	197	7.3	7.3	6	147	18
100	98	.0100.098.0	286	9.5	10.5	6	147	18
125	45	.0125.045.0	155	9.4	10.4	6	178	20
125	81	.0125.081.0	207	9.8	9.8	6	178	20
125	140	.0125.140.0	372	13.8	14.8	6	178	20
150	45	.0150.045.0	155	10.5	10.5	6	202	20
150	81	.0150.081.0	207	10.9	11.9	6	202	20
150	160	.0150.160.0	392	16	18	6	202	20
200	60	.0200.060.0	184	15.3	16.3	6	258	22
200	110	.0200.110.0	271	17.2	19.2	6	258	22
200	190	.0200.190.0	419	22.7	24.7	6	258	22

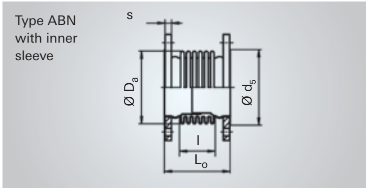
Bellows			Nominal movement absorption 1)		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	45	45.7	31	4	112	1.4	480
88.5	90	45.7	62	16	56	0.7	60
88.5	171	45.7	109	54	49	0.6	15
107	45	68.7	31	4	102	1.9	658
107	117	68.7	80	27	39	0.7	37
108	190	69.4	116	64	40	0.8	15
121	50	89.1	31	4	94	2.3	641
121	120	89.1	74	26	39	1	46
121	198	89.1	105	60	43	1.1	19
148	77	136.8	43	10	63	2.4	276
148	121	136.8	67	23	40	1.5	71
150	208	138.9	91	55	71	2.7	44
174	65	187.5	37	7	58	3	491
174	117	187.5	67	23	32	1.7	84
172	280	185.1	118	96	53	2.7	24
203	65	264.5	32	6	68	5	810
203	117	264.5	57	19	38	2.8	139
203	300	264.5	113	98	51	3.8	29
255	90	431.9	33	9	62	7.5	633
256	176	433.7	62	32	50	6.1	135
257	323	435.6	104	98	51	6.2	41

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 02... PN 2.5





Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 02...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
250	72	.0250.072.0	210	19.9	20.9	6	312	24
250	120	.0250.120.0	279	22.3	24.3	6	312	24
250	204	.0250.204.0	416	29.2	32.2	6	312	24
300	56	.0300.056.0	184	25.9	26.9	6	365	24
300	126	.0300.126.0	279	27.2	29.2	6	365	24
300	210	.0300.210.0	390	36.3	40.3	6	365	24
350	60	.0350.060.0	192	36.2	38.2	6	410	26
350	120	.0350.120.0	273	39.3	41.3	6	410	26
350	210	.0350.210.0	408	47.7	51.7	6	410	26
400	65	.0400.065.0	232	45.5	48.5	6	465	28
400	104	.0400.104.0	295	47.5	50.5	6	465	28
400	182	.0400.182.0	421	51.6	56.6	6	465	28
450	56	.0450.056.0	219	55.2	57.2	6	520	30
450	112	.0450.112.0	307	58.5	61.5	6	520	30
450	182	.0450.182.0	417	62.6	68.6	6	520	30
500	68	.0500.068.0	223	59.8	62.8	6	570	30
500	119	.0500.119.0	292	62.8	66.8	6	570	30
500	204	.0500.204.0	407	67.7	73.7	6	570	30
600	76	.0600.076.0	239	78.6	82.6	6	670	32
600	114	.0600.114.0	291	81.1	85.1	6	670	32
600	207	.0600.207.0	421	87.4	94.4	6	670	32

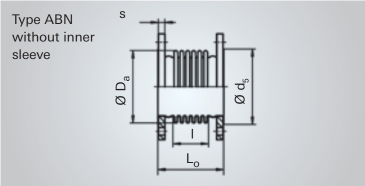
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
312	102	660.5	31	9	62	11.4	753
315	170	667.4	57	28	48	9	213
316	306	669.7	94	84	50	9.2	68
365	76	915.9	20	4	91	23.1	2753
363	171	910.6	43	21	46	11.6	273
371	280	932.1	80	65	52	13.5	119
400	80	1104.5	20	5	82	25.3	2713
402	160	1110.4	43	20	58	17.8	478
402	294	1110.4	73	62	60	18.6	148
458	105	1445.5	18	5	212	85	5299
458	168	1445.5	28	14	132	53.1	1294
458	294	1445.5	50	42	76	30.3	241
513	88	1824.7	14	4	243	123.4	10953
513	176	1824.7	28	14	122	61.7	1369
513	286	1824.7	46	38	75	38	319
569	92	2252.2	15	4	215	134.4	10915
569	161	2252.2	26	12	123	76.8	2037
569	276	2252.2	44	35	72	44.8	404
674	104	3201.9	14	4	215	190.9	12134
674	156	3201.9	21	9	143	127.3	3595
674	286	3201.9	38	32	78	69.4	583

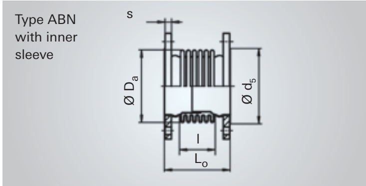
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 02... PN 2.5

06





06

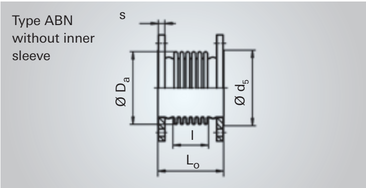
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 02...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
700	80	.0700.080.0	250	107.2	112.2	6	775	36
700	115	.0700.115.0	306	110.2	115.2	6	775	36
700	215	.0700.215.0	446	117.5	126.5	6	775	36
800	63	.0800.063.0	235	133.7	137.7	6	880	37
800	126	.0800.126.0	323	145.8	151.8	6	880	37
800	210	.0800.210.0	450	167.4	178.4	6	880	37
900	63	.0900.063.0	240	144.2	149.2	6	980	38
900	126	.0900.126.0	337	160.1	167.1	6	980	38
900	210	.0900.210.0	461	173	185	6	980	38
1000	72	.1000.072.0	264	171.9	176.9	6	1080	42
1000	115	.1000.115.0	334	186.1	194.1	6	1080	42
1000	220	.1000.220.0	466	200.7	215.7	6	1080	42
1200	72	.1200.072.0	269	210.4	224.4	2.5	1280	40
1200	120	.1200.120.0	333	219.4	238.4	2.5	1280	40
1200	210	.1200.210.0	461	236.2	270.2	2.5	1280	40

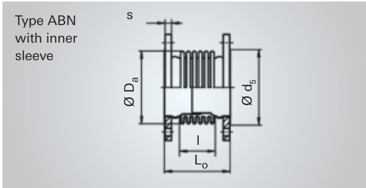
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	13	4	203	244	13376
778	168	4312.5	19	9	146	174.9	4262
776	308	4300.8	34	30	86	102.8	745
882	87	5588	9	2	294	456.3	41453
883	174	5594.7	19	9	221	342.8	7784
886	300	5614.6	33	28	164	256.3	1958
992	90	7133.1	8	2	317	628	53304
994	186	7148	17	9	229	455.5	9053
994	310	7148	29	26	138	273.3	1955
1096	96	8758.3	8	2	324	787.5	58748
1096	165	8758.3	13	6	302	734.1	18539
1096	297	8758.3	24	21	168	407.8	3179
1295	96	12330.8	7	2	511	1752	130705
1295	160	12330.8	12	5	307	1051.2	28232
1292	288	12301.3	20	17	189	644.9	5345

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 06... PN 6





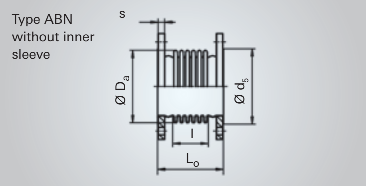
Nominal diameterr	Nominal axial movement absorption[1)]	Type ABN 06...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
50	19	.0050.019.0	117	3.1	3.2	6	90	16
50	52	.0050.052.0	199	3.6	3.9	6	90	16
65	23	.0065.023.0	117	3.9	4.1	6	107	16
65	41	.0065.041.0	153	4	4.2	6	107	16
65	72	.0065.072.0	273	6	6	6	107	16
80	27	.0080.027.0	126	6.2	6.2	6	122	18
80	42	.0080.042.0	156	6.3	6.3	6	122	18
80	77	.0080.077.0	283	8.6	9.6	6	122	18
100	33	.0100.033.0	131	6.9	7.9	6	147	18
100	59	.0100.059.0	185	7.6	8.6	6	147	18
100	87	.0100.087.0	274	10	11	6	147	18
125	30	.0125.030.0	142	9.3	10.3	6	178	20
125	58	.0125.058.0	185	10.1	10.1	6	178	20
125	98	.0125.098.0	303	13.2	14.2	6	178	20
150	40	.0150.040.0	161	10.9	10.9	6	202	20
150	72	.0150.072.0	227	12.9	13.9	6	202	20
150	124	.0150.124.0	366	18.6	20.6	6	202	20
200	40	.0200.040.0	159	15.6	16.6	6	258	22
200	80	.0200.080.0	232	18.3	20.3	6	258	22
200	140	.0200.140.0	350	25.2	27.2	6	258	22

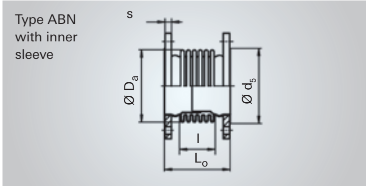
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
89	45	46	28	3.9	104	1.3	451
89	126	46	50	28	61	0.8	34
107	45	68.7	27	3.7	101	1.9	654
107	81	68.7	42	12	56	1.1	112
110	198	70.9	50	50	88	1.7	30
121	50	89.1	27	4.1	94	2.3	640
121	80	89.1	38	11	58	1.4	154
123	204	90.8	50	48	95	2.4	40
148	55	137	27	4.6	87	3.3	752
149	108	138	43	16	71	2.7	160
151	195	140	50	42	89	3.5	63
174	52	187	25	4	72	3.7	953
174	91	187	39	12	41	2.1	177
173	210	186	50	45	88	4.6	71
202	70	263	23	5.1	116	8.5	1189
203	135	264	39	18	113	8.3	313
205	272	267	50	61	102	7.6	70
256	64	434	19	3.6	138	17	2791
257	136	436	34	15	120	15	540
260	252	441	50	50	109	13	145

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 06... PN 6





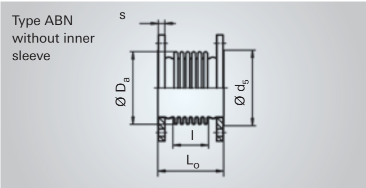
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 06...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
250	48	.0250.048.0	182	21.9	22.9	6	312	24
250	84	.0250.084.0	236	23.6	25.6	6	312	24
250	144	.0250.144.0	352	31.9	33.9	6	312	24
300	60	.0300.060.0	190	29	30	6	365	24
300	85	.0300.085.0	230	30.2	32.2	6	365	24
300	135	.0300.135.0	310	38.2	41.2	6	365	24
350	45	.0350.045.0	177	38.8	40.8	6	410	26
350	102	.0350.102.0	261	41.9	43.9	6	410	26
350	165	.0350.165.0	369	52.2	56.2	6	410	26
400	52	.0400.052.0	216	47.3	49.3	6	465	28
400	104	.0400.104.0	304	51.6	55.6	6	465	28
400	169	.0400.169.0	428	62.7	67.7	6	465	28
450	56	.0450.056.0	224	58.2	60.2	6	520	30
450	95	.0450.095.0	293	61.7	65.7	6	520	30
450	182	.0450.182.0	445	76.1	82.1	6	520	30
500	66	.0500.066.0	233	66.5	69.5	6	570	30
500	114	.0500.114.0	308	72.6	77.6	6	570	30
500	198	.0500.198.0	459	97.7	104.7	6	570	30
600	76	.0600.076.0	249	87.3	91.3	6	670	32
600	108	.0600.108.0	305	92.1	98.1	6	670	32
600	198	.0600.198.0	458	122.7	130.7	6	670	32

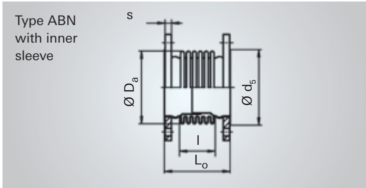
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
316	72	669.7	21	4	211	39.2	5200
316	126	669.7	37	13	120	22.4	970
319	240	676.6	63	44	110	20.7	247
371	80	932.1	22	5	183	47.4	5091
368	120	924	30	10	146	37.4	1784
374	198	940.2	49	28	128	33.3	585
402	63	1110.4	15	3	282	87	15075
400	147	1104.5	32	14	136	41.7	1328
405	253	1119.2	54	40	120	37.3	401
461	88	1455.6	14	4	361	145.9	12951
461	176	1455.6	28	14	180	72.9	1619
462	299	1459	46	40	148	60.2	463
515	92	1832.2	14	4	349	177.8	14443
513	161	1824.7	23	11	219	110.9	2943
515	312	1832.2	44	40	150	76.6	541
572	100	2264.8	15	4	414	260.3	17894
572	175	2264.8	25	13	236	148.7	3339
574	324	2273.3	44	41	208	131.5	861
677	112	3217	14	4	414	370.2	20288
675	168	3206.9	20	10	299	266.5	6492
678	319	3222	37	34	236	211.3	1428

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 06... PN 6





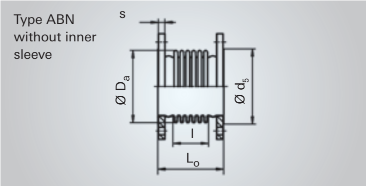
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]		
		ABN 06...		without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
700	60	.0700.060.0	224	111.3	114.3	6	775	36
700	115	.0700.115.0	310	126.8	133.8	6	775	36
700	200	.0700.200.0	442	152.5	161.5	6	775	36
800	63	.0800.063.0	251	150	154	6	880	37
800	105	.0800.105.0	317	161.4	168.4	6	880	37
800	210	.0800.210.0	482	190.1	202.1	6	880	37
900	63	.0900.063.0	253	164	169	6	980	38
900	105	.0900.105.0	319	176.9	185.9	6	980	38
900	210	.0900.210.0	484	209.4	222.4	6	980	38
1000	66	.1000.066.0	277	194.8	200.8	6	1080	42
1000	110	.1000.110.0	347	209.7	219.7	6	1080	42
1000	198	.1000.198.0	487	239.5	254.5	6	1080	42
1200	69	.1200.069.0	281	231.4	246.4	2.5	1280	40
1200	115	.1200.115.0	385	520.4	546.4	16	1290	57
1200	196	.1200.196.0	525	554.2	591.2	16	1290	57

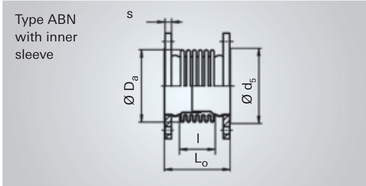
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
781	84	4329.9	9	2	564	677.9	66055
778	169.2	4312.5	18	9	413	494.7	11880
783	300	4341.6	32	28	255	307.4	2348
887	99	5621.2	9	3	856	1336.5	93758
887	165	5621.2	15	7	514	801.9	20252
887	330	5621.2	31	29	257	401	2531
996	99	7163	8	2	953	1896.5	133043
996	165	7163	13	6	572	1137.9	28737
996	330	7163	27	26	286	569	3592
1100	105	8791.5	8	2	974	2377.8	148289
1100	175	8791.5	13	7	584	1426.7	32030
1100	315	8791.5	23	21	325	792.6	5492
1296	105	12340.7	7	2	1092	3743.5	233458
1296	175	12340.7	11	6	655	2246.1	50427
1293	315	12311.1	19	17	404	1380.9	9569

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 10... PN 10





Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 10...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
50	22	.0050.022.0	134	5.6	5.6	16	92	20
50	46	.0050.046.0	222	6.5	6.5	16	92	20
65	18	.0065.018.0	116	6.4	6.4	16	107	20
65	48	.0065.048.0	215	7.9	7.9	16	107	20
80	20	.0080.020.0	125	7.5	7.5	16	122	20
80	41	.0080.041.0	169	7.8	8.8	16	122	20
80	54	.0080.054.0	227	9.2	10.2	16	122	20
100	26	.0100.026.0	133	9.3	9.3	16	147	22
100	42	.0100.042.0	169	9.6	10.6	16	147	22
100	80	.0100.080.0	298	13.4	14.4	16	147	22
125	30	.0125.030.0	151	11.9	11.9	16	178	22
125	45	.0125.045.0	178	13	14	16	178	22
125	85	.0125.085.0	306	16.6	17.6	16	178	22
150	32	.0150.032.0	160	16.4	17.4	16	208	24
150	64	.0150.064.0	220	17.6	18.6	16	208	24
150	95	.0150.095.0	310	21.7	22.7	16	208	24
200	40	.0200.040.0	168	21.5	22.5	10	258	24
200	76	.0200.076.0	236	23.1	25.1	10	258	24
200	110	.0200.110.0	300	28	30	10	258	24
250	44	.0250.044.0	186	27.7	28.7	10	320	26
250	84	.0250.084.0	256	33.2	35.2	10	320	26
250	130	.0250.130.0	420	42.3	45.3	10	320	26

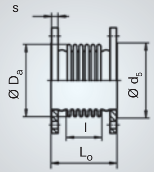
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	34	5	93	1.2	278
90	140	46.6	71	29	116	1.5	52
108	36	69.4	23	2	114	2.2	1164
110	132	70.9	62	24	136	2.7	105
121	44	89.1	22	3	192	4.8	1687
122	88	89.9	46	12	86	2.2	192
123	144	90.8	60	25	137	3.5	115
151	48	140	24	3	134	5.2	1559
149	84	137.9	39	9	92	3.5	343
152	210	141	72	44	131	5.1	80
171	56	183.9	23	4	148	7.5	1655
173	81.6	186.3	35	8	161	8.3	859
174	208	187.5	65	39	138	7.2	115
203	60	264.5	21	4	257	18.9	3603
203	120	264.5	42	15	128	9.4	450
205	208	267.4	63	38	136	10.1	160
257	68	435.6	20	4	242	29.3	4361
255.5	136	432.8	38	15	135	16.3	604
260	198	441.2	55	31	140	17.2	301
313	72	662.8	18	4	257	47.2	6265
319	140	676.6	35	14	189	35.5	1246
319	304	676.6	52	46	201	37.8	281

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

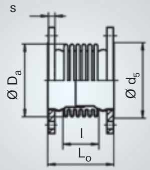
AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 10... PN 10

Type ABN without inner sleeve



Type ABN with inner sleeve



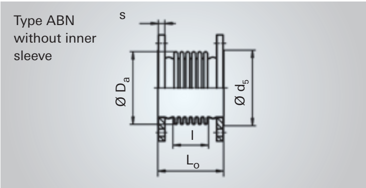
Nominal diameter	Nominal axial movement absorption[1]	Type ABN 10...	Overall length	Weight approx.		Flange[2]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
300	45	.0300.045.0	178	32.7	33.7	10	370	26
300	86	.0300.086.0	248	37.9	39.9	10	370	26
300	137	.0300.137.0	447	54.2	58.2	10	370	26
350	56	.0350.056.0	211	50.9	52.9	10	410	30
350	95	.0350.095.0	281	56.6	59.6	10	410	30
350	150	.0350.150.0	463	83.1	88.1	10	410	30
400	48	.0400.048.0	235	70.2	72.2	10	465	32
400	96	.0400.096.0	331	78.9	81.9	10	465	32
400	156	.0400.156.0	479	101.4	107.4	10	465	32
450	70	.0450.070.0	272	87.8	90.8	10	520	36
450	98	.0450.098.0	322	92.9	96.9	10	520	36
450	182	.0450.182.0	472	108.3	114.3	10	520	36
500	66	.0500.066.0	259	101.5	104.5	10	570	38
500	110	.0500.110.0	340	110.3	115.3	10	570	38
500	182	.0500.182.0	461	137.2	145.2	10	570	38
600	72	.0600.072.0	275	136.1	140.1	10	670	42
600	100	.0600.100.0	333	143.1	148.1	10	670	42
600	198	.0600.198.0	491	180.3	189.3	10	670	42
700	57	.0700.057.0	248	164.8	168.8	10	780	40
700	114	.0700.114.0	344	184.3	191.3	10	780	40
700	190	.0700.190.0	472	210.2	221.2	10	780	40

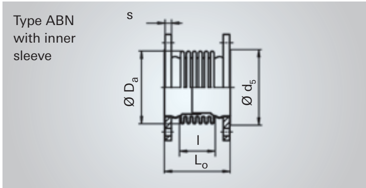
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
372	63	934.8	15	3	292	75.7	13122
372	132	934.8	30	11	215	55.8	2202
374	330	940.2	49	46	240	62.7	396
401	88	1107.4	18	4	283	87	7721
402	156.8	1110.4	30	14	225	69.3	1939
412	336	1140.1	46	44	310	98.1	597
464	96	1465.7	14	4	730	297.3	22180
464	192	1465.7	28	15	365	148.6	2772
467	338	1475.9	44	43	291	119.3	718
518	125	1843.6	17	6	564	289.1	12720
518	175	1843.6	23	12	403	206.5	4636
518	325	1843.6	44	41	217	111.2	724
575	108	2277.5	14	4	599	379	22339
573	189	2269.1	24	13	372	234.7	4518
577	308	2286	39	35	295	187.3	1357
679	116	3227.1	13	4	624	559.4	28583
676	174	3212	18	9	469	418.9	9512
681	330	3237.1	36	35	306	275.1	1737
785	96	4353.3	9	3	1142	1381	103031
785	192	4353.3	19	10	571	690.5	12879
785	320	4353.3	31	29	343	414.3	2782

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 16... PN 16



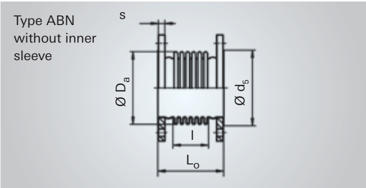


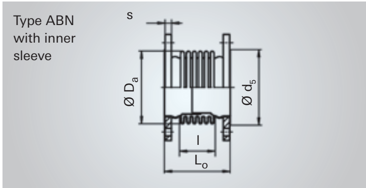
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]			Bellows			Nominal movement absorption[1]		Spring rate		
		ABN 16...		without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness	outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s	D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
–	mm	–	mm	kg	kg	-	mm	mm	mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
50	20	.0050.020.0	135	5.7	5.7	16	92	20	88.5	54	45.7	32	5	155	2	464
50	40	.0050.040.0	226	6.7	7.7	16	92	20	91	143	47.2	62	26	153	2	67
65	26	.0065.026.0	141	6.7	6.7	16	107	20	108	60	69.4	32	6	126	2.4	464
65	48	.0065.048.0	215	7.9	7.9	16	107	20	110	132	70.9	60	23	136	2.7	105
80	23	.0080.023.0	142	8	8	16	122	20	122	60	89.9	25	4	278	6.9	1325
80	50	.0080.050.0	215	9	9	16	122	20	123	132	90.8	54	20	150	3.8	149
100	31	.0100.031.0	151	10	10	16	147	22	153	65	142.1	29	6	174	6.9	1118
100	53	.0100.053.0	228	12	13	16	147	22	152	140	141	47	19	196	7.7	269
125	21	.0125.021.0	138	12.3	13.3	16	178	22	173	42	186.3	16	2	322	16.6	6489
125	42	.0125.042.0	184	13.4	13.4	16	178	22	174	87	187.5	33	8	192	10	906
125	59	.0125.059.0	232	14.1	15.1	16	178	22	173	135	186.3	47	18	139	7.2	271
150	24	.0150.024.0	145	16.2	16.2	16	208	24	204	45	265.9	15	2	316	23.4	7933
150	44	.0150.044.0	194	17.5	18.5	16	208	24	204	93	265.9	30	8	206	15.2	1212
150	66	.0150.066.0	246	19.9	20.9	16	208	24	205	144	267.4	42	18	196	14.5	482
200	30	.0200.030.0	160	23.6	24.6	16	258	26	261	54	443	15	2	479	59	13906
200	57	.0200.057.0	214	25.6	27.6	16	258	26	260	108	441.2	28	9	257	31.5	1857
200	97	.0200.097.0	377	34.7	36.7	16	258	26	262	270	444.9	48	37	276	34.1	322
250	32	.0250.032.0	197	34.2	35.2	16	320	29	319	76	676.6	13	3	603	113.3	13491
250	52	.0250.052.0	254	36.4	38.4	16	320	29	317	133	672	21	8	389	72.6	2821
250	103	.0250.103.0	383	47.2	50.2	16	320	29	320	260	678.9	40	30	300	56.5	575

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 16... PN 16





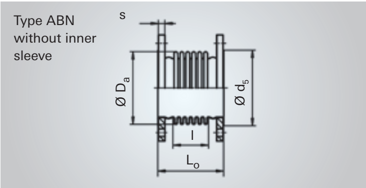
Nominal diameter	Nominal axial movement absorption[1]	Type ABN 16...	Overall length	Weight approx.		Flange[2]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
300	30	.0300.030.0	191	46	47	16	375	32
300	75	.0300.075.0	300	55	58	16	375	32
300	120	.0300.120.0	476	74.1	78.1	16	375	32
350	30	.0350.030.0	197	65	66	16	410	35
350	75	.0350.075.0	306	75.3	78.3	16	410	35
350	130	.0350.130.0	449	93.5	98.5	16	410	35
400	48	.0400.048.0	257	91.6	93.6	16	465	38
400	84	.0400.084.0	335	100.5	104.5	16	465	38
400	132	.0400.132.0	439	112.5	117.5	16	465	38
450	52	.0450.052.0	265	115.6	118.6	16	520	42
450	91	.0450.091.0	343	126	130	16	520	42
450	143	.0450.143.0	447	139.9	144.9	16	520	42
500	48	.0500.048.0	253	152.2	155.2	16	570	46
500	90	.0500.090.0	346	172.2	176.2	16	570	46
500	135	.0500.135.0	433	188.3	194.3	16	570	46

Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\gamma_N$	c_δ	c_α	c_γ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
376	63	945.7	10	2	845	221.8	38431
375	171.2	943	26	13	426	111.5	2616
376	345	945.7	45	45	327	86	497
408	63	1128.2	9	2	920	288.2	49917
409	171.2	1131.1	25	13	416	130.6	3064
412	312	1140.1	41	37	334	105.6	746
467	104	1475.9	13	4	946	387.9	24657
467	182	1475.9	23	12	541	221.6	4601
467	286	1475.9	36	30	344	141	1186
520	104	1851.3	13	4	954	490.5	31179
520	182	1851.3	22	12	545	280.3	5818
520	286	1851.3	35	29	347	178.4	1499
579	84	2294.5	11	3	996	634.9	61867
580	174.6	2298.7	20	10	660	421.3	9501
580	261.9	2298.7	30	23	440	280.9	2815

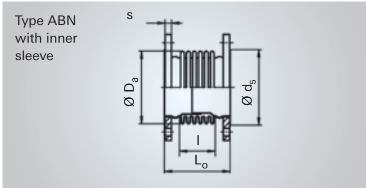
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 25... PN 25



Type ABN without inner sleeve



Type ABN with inner sleeve

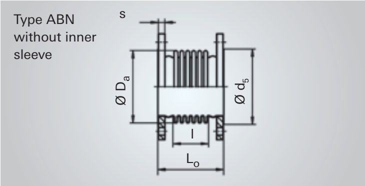
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 25...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
50	12	.0050.012.0	122	5.8	5.8	40	92	20
50	27	.0050.027.0	182	6.4	6.4	40	92	20
65	17	.0065.017.0	130	7.5	7.5	40	107	22
65	40	.0065.040.0	220	9	9	40	107	22
80	23	.0080.023.0	151	9.6	10.6	40	122	24
80	42	.0080.042.0	222	10.9	10.9	40	122	24
100	23	.0100.023.0	147	13.3	14.3	40	147	26
100	48	.0100.048.0	222	15.1	16.1	40	147	26
125	26	.0125.026.0	174	19.2	20.2	40	178	28
125	52	.0125.052.0	238	20.6	20.6	40	178	28
150	29	.0150.029.0	178	24	25	40	208	30
150	48	.0150.048.0	234	26.4	27.4	40	208	30
200	26	.0200.026.0	190	33.8	34.8	25	258	32
200	44	.0200.044.0	244	36	37	25	258	32
200	71	.0200.071.0	317	40.7	42.7	25	258	32
250	24	.0250.024.0	195	47.8	49.8	25	320	35
250	45	.0250.045.0	255	51.2	53.2	25	320	35
250	72	.0250.072.0	335	55.7	57.7	25	320	35
300	27	.0300.027.0	207	63	65	25	375	38
300	46	.0300.046.0	273	66.8	68.8	25	375	38
300	76	.0300.076.0	345	77.4	80.4	25	375	38

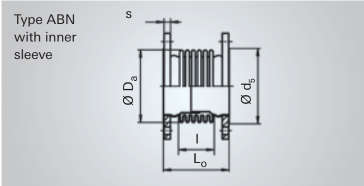
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
90	40	46.6	19	2	405	5.2	2249
91	99	47.2	42	12	221	2.9	203
111	44	71.6	22	3	273	5.4	1932
113	132	73.1	54	21	175	3.6	140
125	60	92.5	26	4	267	6.9	1312
125	130	92.5	45	17	222	5.7	232
152	52	141	20	3	310	12.2	3090
153	126	142.1	43	16	198	7.8	339
177	64	191.1	21	4	350	18.6	3116
175	128	188.7	39	14	206	10.8	454
207	64	270.3	19	4	376	28.2	4737
207	119	270.3	30	10	314	23.6	1143
261	72	443	13	3	855	105.3	13961
261	126	443	22	8	489	60.2	2605
263	198	446.8	35	20	353	43.7	767
323	60	685.8	10	2	1089	207.4	39604
320	120	678.9	18	6	649	122.4	5845
319	200	676.6	29	17	414	77.8	1338
376	66	945.7	9	2	1076	282.6	44600
370	132	929.4	16	6	755	195	7693
376	201.6	945.7	26	15	545	143.3	2424

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE ABN 25... PN 25





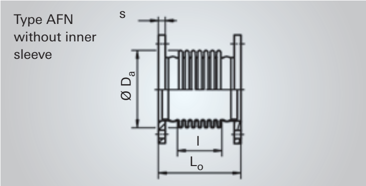
Nominal diameter	Nominal axial movement absorption[1)]	Type ABN 25...	Overall length	Weight approx.		Flange[2)]		
				without inner sleeve	with inner sleeve	drilling as per EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	d_5	s
–	mm	–	mm	kg	kg	-	mm	mm
350	30	.0350.030.0	223	97.1	99.1	25	410	42
350	50	.0350.050.0	271	101.9	103.9	25	410	42
350	75	.0350.075.0	343	108.7	111.7	25	410	42
400	32	.0400.032.0	273	136.7	139.7	25	465	48
400	56	.0400.056.0	348	146	149	25	465	48
400	96	.0400.096.0	499	169.1	175.1	25	465	48

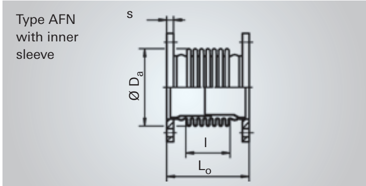
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
413	72	1143.1	9	2	1373	436	57832
413	120	1143.1	16	5	824	261.6	12492
411	192	1137.1	23	13	571	180.4	3364
466	100	1472.5	9	3	1934	791.1	54390
466	175	1472.5	15	8	1105	452	10149
469	324	1482.8	27	25	700	288.4	1889

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH PLAIN FIXED FLANGES

TYPE AFN 01... PN 1





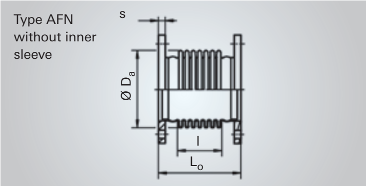
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 01...		without inner sleeve	with inner sleeve	drilling template as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
50	20	.0050.020.0	129	3.1	3.3	6	16
50	56	.0050.056.0	210	3.3	3.7	6	16
50	80	.0050.080.0	264	3.5	3.9	6	16
65	23	.0065.023.0	129	3.9	4.1	6	16
65	64	.0065.064.0	210	4.2	4.6	6	16
65	92	.0065.092.0	264	4.5	4.8	6	16
80	37	.0080.037.0	156	6.2	7.2	6	18
80	69	.0080.069.0	216	6.5	6.5	6	18
80	101	.0080.101.0	276	6.8	7.8	6	18
100	40	.0100.040.0	152	7	8	6	18
100	79	.0100.079.0	218	7.4	7.4	6	18
100	112	.0100.112.0	273	7.7	8.7	6	18
125	63	.0125.063.0	189	9.7	10.7	6	20
125	117	.0125.117.0	267	10.3	11.3	6	20
125	175	.0125.175.0	358	10.8	11.8	6	20
150	54	.0150.054.0	176	10.7	10.7	6	20
150	126	.0150.126.0	280	11.6	13.6	6	20
150	180	.0150.180.0	358	12.3	14.3	6	20
200	70	.0200.070.0	205	15.6	16.6	6	22
200	120	.0200.120.0	280	16.3	18.3	6	22
200	200	.0200.200.0	400	17.5	20.5	6	22

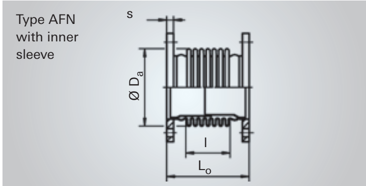
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	45	45.7	32	4	112	1.4	480
88.5	126	45.7	88	32	40	0.5	22
88.5	180	45.7	126	66	28	0.4	8
107	45	68.7	31	4	102	1.9	658
107	126	68.7	87	32	36	0.7	30
107	180	68.7	125	65	25	0.5	10
121	70	89.1	44	9	67	1.7	234
121	130	89.1	82	31	36	0.9	36
121	190	89.1	121	66	25	0.6	12
148	66	136.8	38	7	73	2.8	438
148	132	136.8	75	29	36	1.4	55
148	187	136.8	106	58	26	1	19
174	91	187.5	54	14	41	2.2	179
174	169	187.5	101	49	22	1.2	28
171	260	183.9	137	103	18	0.9	10
203	78	264.5	40	9	56	4.1	469
203	182	264.5	93	49	24	1.8	37
203	260	264.5	132	100	17	1.2	13
255	105	431.9	41	12	53	6.4	399
255	180	431.9	70	37	31	3.7	79
254	300	430.1	112	98	20	2.4	18

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH PLAIN FIXED FLANGES

TYPE AFN 01... PN 1





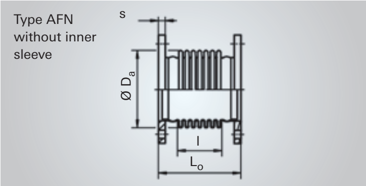
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 01...		without inner sleeve	with inner sleeve	drilling template as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
250	72	.0250.072.0	214	20	21	6	24
250	132	.0250.132.0	299	21.1	23.1	6	24
250	204	.0250.204.0	401	22.4	25.4	6	24
300	56	.0300.056.0	188	26	29	6	24
300	140	.0300.140.0	302	27.6	31.6	6	24
300	210	.0300.210.0	397	29	35	6	24
350	60	.0350.060.0	194	36.2	39.2	6	26
350	120	.0350.120.0	274	37.5	41.5	6	26
350	210	.0350.210.0	394	39.4	45.4	6	26
400	65	.0400.065.0	230	45.1	49.1	6	28
400	104	.0400.104.0	293	47.2	52.2	6	28
400	195	.0400.195.0	440	51.9	59.9	6	28
450	56	.0450.056.0	217	54.7	58.7	6	30
450	112	.0450.112.0	305	58	64	6	30
450	196	.0450.196.0	437	62.9	71.9	6	30
500	68	.0500.068.0	221	59.3	64.3	6	30
500	119	.0500.119.0	290	62.2	68.2	6	30
500	221	.0500.221.0	428	68.2	78.2	6	30
600	76	.0600.076.0	237	77.9	83.9	6	32
600	133	.0600.133.0	315	81.7	89.7	6	32
600	228	.0600.228.0	419	87	98	6	32

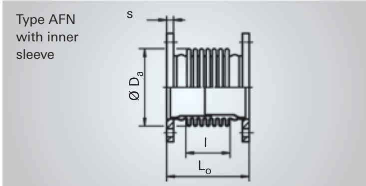
Bellows			Nominal movement absorption[1)]		Spring rate		
outside dia-meter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
312	102	660.5	33	10	62	11.4	753
312	187	660.5	60	33	34	6.2	122
312	289	660.5	93	78	22	4	33
365	76	915.9	21	5	91	23.1	2753
365	190	915.9	54	30	36	9.3	176
365	285	915.9	80	66	24	6.2	52
400	80	1104.5	22	5	82	25.3	2713
400	160	1104.5	44	20	41	12.6	339
400	280	1104.5	76	62	24	7.2	63
458	105	1445.5	18	6	212	85	5299
458	168	1445.5	29	14	132	53.1	1294
458	315	1445.5	55	50	71	28.3	196
513	88	1824.7	15	4	243	123.4	10953
513	176	1824.7	29	15	122	61.7	1369
513	308	1824.7	52	46	70	35.2	255
569	92	2252.2	15	4	215	134.4	10915
569	161	2252.2	27	13	123	76.8	2037
569	299	2252.2	50	43	66	41.3	318
674	104	3201.9	15	4	215	190.9	12134
674	182	3201.9	26	13	123	109.1	2264
676	286	3212	42	35	72	64.4	541

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH PLAIN FIXED FLANGES

TYPE AFN 01... PN 1





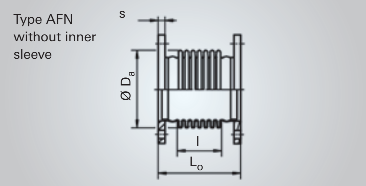
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 01...		without inner sleeve	with inner sleeve	drilling template as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
700	80	.0700.080.0	230	62.6	69.6	6	20
700	120	.0700.120.0	286	65.8	74.8	6	20
700	220	.0700.220.0	426	73.7	87.7	6	20
800	84	.0800.084.0	244	77	86	6	20
800	126	.0800.126.0	302	80.7	90.7	6	20
800	231	.0800.231.0	418	88	104	6	20
900	84	.0900.084.0	248	81.7	91.7	6	20
900	126	.0900.126.0	308	85.9	98.9	6	20
900	210	.0900.210.0	428	94.4	112.4	6	20
1000	72	.1000.072.0	234	86.7	97.7	6	20
1000	144	.1000.144.0	330	94	109	6	20
1000	240	.1000.240.0	458	103.6	125.6	6	20
1200	72	.1200.072.0	241	107.1	124.1	2.5	20
1200	120	.1200.120.0	303	113.2	135.2	2.5	20
1200	216	.1200.216.0	427	125.3	157.3	2.5	20
1400	48	.1400.048.0	152	123.6	135.6	2.5	20
1400	108	.1400.108.0	282	135.6	159.6	2.5	20
1400	180	.1400.180.0	438	150	187	2.5	20
1600	48	.1600.048.0	152	153.7	167.7	2.5	20
1600	108	.1600.108.0	282	167.4	194.4	2.5	20
1600	180	.1600.180.0	438	183.8	226.8	2.5	20

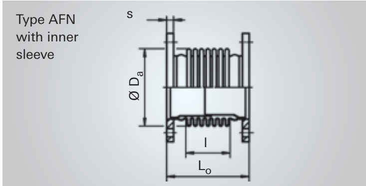
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	14	5	203	244	13376
780	168	4324.1	21	10	135	162.7	3963
780	308	4324.1	39	35	74	88.7	643
882	116	5588	13	4	220	342.3	17488
882	174	5588	19	10	147	228.2	5182
882	290	5588	32	27	88	136.9	1119
992	120	7133.1	12	4	238	471	22487
992	180	7133.1	18	9	158	314	6663
992	300	7133.1	29	26	95	188.4	1439
1095	96	8750	8	2	335	814.7	60780
1095	192	8750	17	9	168	407.4	7598
1095	320	8750	28	26	101	244.4	1641
1295	93	12330.8	8	2	331	1132.9	90056
1295	155	12330.8	13	6	198	679.7	19452
1295	279	12330.8	23	18	110	377.6	3335
1456	104	16015.7	4	1	922	4102.5	260788
1456	234	16015.7	9	6	410	1823.3	22895
1456	390	16015.7	15	17	246	1094	4945
1656	104	20816.1	3	1	1046	6051.1	384654
1656	234	20816.1	8	5	465	2689.4	33769
1656	390	20816.1	13	15	279	1613.6	7294

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH PLAIN FIXED FLANGES

TYPE AFN 01... PN 1





Nominal diameter	Nominal axial movement absorption[1)]	Type AFN 01...	Overall length	Weight approx.		Flange[2]	
				without inner sleeve	with inner sleeve	drilling template as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
1800	48	.1800.048.0	152	172	188	2.5	20
1800	108	.1800.108.0	282	187.5	218.5	2.5	20
1800	180	.1800.180.0	438	205.9	253.9	2.5	20
2000	48	.2000.048.0	152	190.4	208.4	2.5	20
2000	108	.2000.108.0	282	207.5	241.5	2.5	20
2000	180	.2000.180.0	438	228	281	2.5	20
2200	48	.2200.048.0	152	224.1	244.1	2.5	20
2200	108	.2200.108.0	282	242.9	281.9	2.5	20
2200	180	.2200.180.0	438	265.5	325.5	2.5	20
2400	48	.2400.048.0	152	243.7	264.7	2.5	20
2400	108	.2400.108.0	282	264.3	306.3	2.5	20
2400	180	.2400.180.0	438	288.9	353.9	2.5	20
2600	48	.2600.048.0	152	263.3	286.3	2.5	20
2600	108	.2600.108.0	282	285.6	330.6	2.5	20
2600	180	.2600.180.0	438	312.3	383.3	2.5	20
2800	48	.2800.048.0	152	317.1	342.1	2.5	20
2800	108	.2800.108.0	282	341.1	390.1	2.5	20
2800	180	.2800.180.0	438	369.8	445.8	2.5	20
3000	48	.3000.048.0	152	339	366	2.5	20
3000	108	.3000.108.0	282	364.7	417.7	2.5	20
3000	180	.3000.180.0	438	395.5	477.5	2.5	20

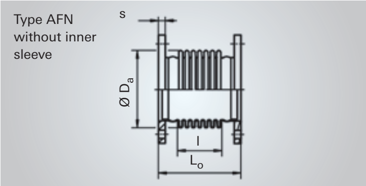
06

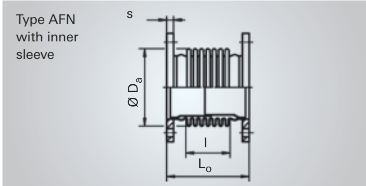
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
1856	104	26244.7	3	1	1170	8529.1	542176
1856	234	26244.7	7	5	520	3790.7	47598
1856	390	26244.7	12	13	312	2274.4	10281
2056	104	32301.7	3	1	1292	11593.9	736997
2056	234	32301.7	6	4	574	5152.8	64702
2056	390	32301.7	10	12	345	3091.7	13976
2256	104	38987	3	1	1414	15313.6	973454
2256	234	38987	6	4	628	6806.1	85461
2256	390	38987	10	11	377	4083.6	18460
2456	104	46300.7	2	1	1536	19751.1	1255534
2456	234	46300.7	5	4	683	8778.3	110225
2456	390	46300.7	9	10	410	5267	23809
2656	104	54242.6	2	1	1657	24968.9	1587221
2656	234	54242.6	5	3	737	11097.3	139344
2656	390	54242.6	8	9	442	6658.4	30098
2856	104	62812.9	2	1	1778	31029.8	1972493
2856	234	62812.9	4	3	790	13791	173168
2856	390	62812.9	7	8	474	8274.6	37404
3056	104	72011.5	2	1	1900	37996.1	2415327
3056	234	72011.5	4	3	844	16887.1	212045
3056	390	72011.5	7	8	507	10132.3	45802

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 02... PN 2.5





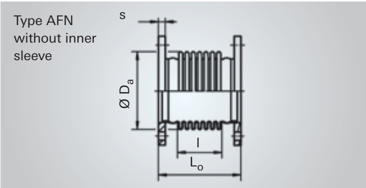
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 02...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
50	20	.0050.020.0	129	3.1	3.3	6	16
50	40	.0050.040.0	174	3.2	3.4	6	16
50	70	.0050.070.0	255	3.8	4.2	6	16
65	23	.0065.023.0	129	3.9	4.1	6	16
65	60	.0065.060.0	201	4.2	4.6	6	16
65	87	.0065.087.0	274	4.8	5.8	6	16
80	27	.0080.027.0	136	6.2	7.2	6	18
80	64	.0080.064.0	206	6.5	6.5	6	18
80	92	.0080.092.0	284	7.2	8.2	6	18
100	46	.0100.046.0	163	7.1	8.1	6	18
100	73	.0100.073.0	207	7.3	7.3	6	18
100	98	.0100.098.0	294	9.4	10.4	6	18
125	45	.0125.045.0	163	9.5	10.5	6	20
125	81	.0125.081.0	215	9.9	9.9	6	20
125	140	.0125.140.0	378	13.6	14.6	6	20
150	45	.0150.045.0	163	10.6	11.6	6	20
150	81	.0150.081.0	215	11.1	12.1	6	20
150	160	.0150.160.0	398	15.8	17.8	6	20
200	60	.0200.060.0	190	15.4	16.4	6	22
200	110	.0200.110.0	276	17.2	19.2	6	22
200	190	.0200.190.0	423	22.5	25.5	6	22

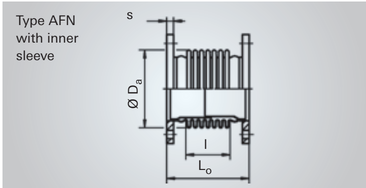
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	45	45.7	31	4	112	1.4	480
88.5	90	45.7	62	16	56	0.7	60
88.5	171	45.7	109	54	49	0.6	15
107	45	68.7	31	4	102	1.9	658
107	117	68.7	80	27	39	0.7	37
108	190	69.4	116	64	40	0.8	15
121	50	89.1	31	4	94	2.3	641
121	120	89.1	74	26	39	1	46
121	198	89.1	105	60	43	1.1	19
148	77	136.8	43	10	63	2.4	276
148	121	136.8	67	23	40	1.5	71
150	208	138.9	91	55	71	2.7	44
174	65	187.5	37	7	58	3	491
174	117	187.5	67	23	32	1.7	84
172	280	185.1	118	96	53	2.7	24
203	65	264.5	32	6	68	5	810
203	117	264.5	57	19	38	2.8	139
203	300	264.5	113	98	51	3.8	29
255	90	431.9	33	9	62	7.5	633
256	176	433.7	62	32	50	6.1	135
257	323	435.6	104	98	51	6.2	41

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 02... PN 2.5





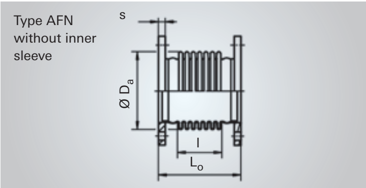
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2)]	
		AFN 02...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
250	72	.0250.072.0	214	20	21	6	24
250	120	.0250.120.0	282	22.3	24.3	6	24
250	204	.0250.204.0	418	28.9	31.9	6	24
300	56	.0300.056.0	188	26	29	6	24
300	126	.0300.126.0	283	27.3	31.3	6	24
300	210	.0300.210.0	392	36	42	6	24
350	60	.0350.060.0	194	36.2	39.2	6	26
350	120	.0350.120.0	274	39.1	43.1	6	26
350	210	.0350.210.0	408	46.9	53.9	6	26
400	65	.0400.065.0	230	45.1	49.1	6	28
400	104	.0400.104.0	293	47.2	52.2	6	28
400	182	.0400.182.0	419	51.3	59.3	6	28
450	56	.0450.056.0	217	54.7	57.7	6	30
450	112	.0450.112.0	305	58	64	6	30
450	182	.0450.182.0	415	62.1	70.1	6	30
500	68	.0500.068.0	221	59.3	64.3	6	30
500	119	.0500.119.0	290	62.2	68.2	6	30
500	204	.0500.204.0	405	67.2	76.2	6	30
600	76	.0600.076.0	237	77.9	83.9	6	32
600	114	.0600.114.0	289	80.4	87.4	6	32
600	207	.0600.207.0	419	86.7	97.7	6	32

Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
312	102	660.5	31	9	62	11.4	753
315	170	667.4	57	28	48	9	213
316	306	669.7	94	84	50	9.2	68
365	76	915.9	20	4	91	23.1	2753
363	171	910.6	43	21	46	11.6	273
371	280	932.1	80	65	52	13.5	119
400	80	1104.5	20	5	82	25.3	2713
402	160	1110.4	43	20	58	17.8	478
402	294	1110.4	73	62	60	18.6	148
458	105	1445.5	18	5	212	85	5299
458	168	1445.5	28	14	132	53.1	1294
458	294	1445.5	50	42	76	30.3	241
513	88	1824.7	14	4	243	123.4	10953
513	176	1824.7	28	14	122	61.7	1369
513	286	1824.7	46	38	75	38	319
569	92	2252.2	15	4	215	134.4	10915
569	161	2252.2	26	12	123	76.8	2037
569	276	2252.2	44	35	72	44.8	404
674	104	3201.9	14	4	215	190.9	12134
674	156	3201.9	21	9	143	127.3	3595
674	286	3201.9	38	32	78	69.4	583

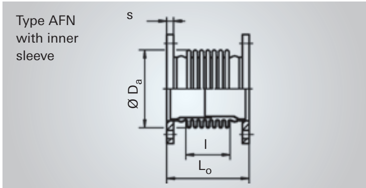
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 02... PN 2.5



Type AFN without inner sleeve



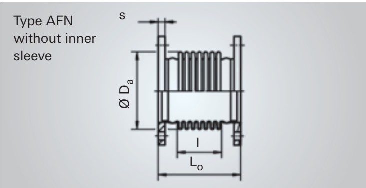
Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]		Bellows			Nominal movement absorption[1]		Spring rate		
		AFN 02...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness	outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
DN	$2\delta_N$	–	L_o	G	G	PN	s	D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
–	mm	–	mm	kg	kg	-	mm	mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
700	80	.0700.080.0	248	105	112	6	36	780	112	4324.1	13	4	203	244	13376
700	115	.0700.115.0	304	108	117	6	36	778	168	4312.5	19	9	146	174.9	4262
700	215	.0700.215.0	444	115.3	129.3	6	36	776	308	4300.8	34	30	86	102.8	745
800	63	.0800.063.0	233	131	137	6	37	882	87	5588	9	2	294	456.3	41453
800	126	.0800.126.0	320	142	153	6	37	883	174	5594.7	19	9	221	342.8	7784
800	210	.0800.210.0	446	162.5	178.5	6	37	886	300	5614.6	33	28	164	256.3	1958
900	63	.0900.063.0	238	141.3	147.3	6	38	992	90	7133.1	8	2	317	628	53304
900	126	.0900.126.0	334	156	169	6	38	994	186	7148	17	9	229	455.5	9053
900	210	.0900.210.0	458	168.9	186.9	6	38	994	310	7148	29	26	138	273.3	1955
1000	72	.1000.072.0	262	168.3	175.3	6	42	1096	96	8758.3	8	2	324	787.5	58748
1000	115	.1000.115.0	331	181.2	194.2	6	42	1096	165	8758.3	13	6	302	734.1	18539
1000	240	.1000.240.0	496	199.4	220.4	6	42	1096	330	8758.3	27	26	151	367	2317
1200	72	.1200.072.0	266	206.2	218.2	2.5	40	1295	96	12330.8	7	2	511	1752	130705
1200	120	.1200.120.0	330	215.2	238.2	2.5	40	1295	160	12330.8	12	5	307	1051.2	28232
1200	210	.1200.210.0	458	232.1	264.1	2.5	40	1292	288	12301.3	20	17	189	644.9	5345
1400	48	.1400.048.0	178	246.9	258.9	2.5	42	1456	104	16015.7	4	1	922	4102.5	260788
1400	108	.1400.108.0	308	258.9	281.9	2.5	42	1456	234	16015.7	9	6	410	1823.3	22895
1400	180	.1400.180.0	464	273.3	312.3	2.5	42	1456	390	16015.7	15	16	246	1094	4945
1600	48	.1600.048.0	186	336.6	350.6	2.5	46	1657	104	20828.9	3	1	997	5769.3	366743
1600	108	.1600.108.0	316	350.5	377.5	2.5	46	1657	234	20828.9	8	5	443	2564.1	32197
1600	180	.1600.180.0	472	367.1	411.1	2.5	46	1657	390	20828.9	13	15	266	1538.5	6955

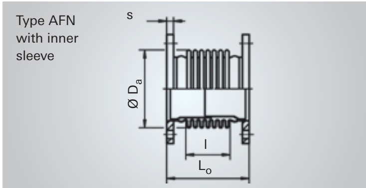
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 02... PN 2.5



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2)]	
		AFN 02...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
1800	48	.1800.048.0	194	408.1	424.1	2.5	50
1800	104	.1800.104.0	324	423.3	453.3	2.5	50
1800	176	.1800.176.0	480	441.8	491.8	2.5	50
2000	46	.2000.046.0	198	469.4	486.4	2.5	52
2000	105	.2000.105.0	328	485.7	519.7	2.5	52
2000	175	.2000.175.0	482	523.7	579.7	2.5	52

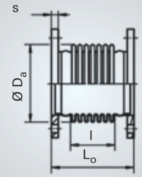
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
1857	104	26259.1	3	1	1115	8131.4	516898
1856	234	26244.7	7	5	520	3790.7	47598
1856	390	26244.7	11	13	312	2274.4	10281
2060	104	32365.5	3	1	1070	9621.9	611644
2056	234	32301.7	6	4	574	5152.8	64702
2078	388	32640.3	10	11	510	4625	21123

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

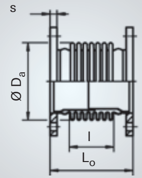
AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 06... PN 6

Type AFN without inner sleeve



Type AFN with inner sleeve



Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2)]	
		AFN 06...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
50	19	.0050.019.0	129	3.1	3.3	6	16
50	52	.0050.052.0	210	3.5	3.9	6	16
65	23	.0065.023.0	129	3.9	4.1	6	16
65	41	.0065.041.0	165	4	4.4	6	16
65	72	.0065.072.0	282	6	7	6	16
80	27	.0080.027.0	136	6.2	7.2	6	18
80	42	.0080.042.0	166	6.3	6.3	6	18
80	77	.0080.077.0	290	8.5	9.5	6	18
100	33	.0100.033.0	141	6.9	6.9	6	18
100	59	.0100.059.0	194	7.5	7.5	6	18
100	87	.0100.087.0	281	9.8	10.8	6	18
125	30	.0125.030.0	150	9.4	10.4	6	20
125	58	.0125.058.0	192	10.1	11.1	6	20
125	98	.0125.098.0	308	13	14	6	20
150	40	.0150.040.0	168	11	11	6	20
150	72	.0150.072.0	233	12.7	13.7	6	20
150	124	.0150.124.0	370	18.2	20.2	6	20
200	40	.0200.040.0	164	15.6	16.6	6	22
200	80	.0200.080.0	236	18.1	19.1	6	22
200	140	.0200.140.0	352	24.5	26.5	6	22

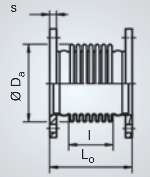
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	45	45.7	30	4	112	1.4	480
88.5	126	45.7	79	29	67	0.8	37
107	45	68.7	29	4	102	1.9	658
107	81	68.7	53	12	56	1.1	113
110	198	70.9	95	54	91	1.8	31
121	50	89.1	29	4	94	2.3	641
121	80	89.1	47	11	59	1.5	157
123	204	90.8	87	51	97	2.4	40
149	55	137.9	30	5	80	3.1	695
149	108	137.9	52	16	71	2.7	161
151	195	140	82	46	91	3.5	64
173	52	186.3	26	4	78	4	1029
172	94.5	185.1	44	12	78	4	307
173	210	186.3	79	48	89	4.6	72
202	70	263	28	6	117	8.6	1201
203	135	264.5	49	19	114	8.4	316
205	272	267.4	85	67	104	7.7	72
256	64	433.7	21	4	138	16.7	2797
257	136	435.6	42	17	121	14.7	545
260	252	441.2	72	52	110	13.5	146

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

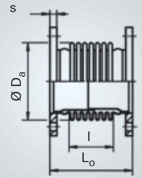
AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 06... PN 6

Type AFN without inner sleeve



Type AFN with inner sleeve



Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 06...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
250	48	.0250.048.0	184	21.6	22.6	6	24
250	84	.0250.084.0	238	23.3	25.3	6	24
250	144	.0250.144.0	352	31	34	6	24
300	60	.0300.060.0	192	28.6	30.6	6	24
300	85	.0300.085.0	232	29.9	33.9	6	24
300	135	.0300.135.0	310	37.3	41.3	6	24
350	45	.0350.045.0	177	38.1	40.1	6	26
350	102	.0350.102.0	261	41.1	44.1	6	26
350	165	.0350.165.0	367	50.5	55.5	6	26
400	52	.0400.052.0	213	46.5	48.5	6	28
400	104	.0400.104.0	301	50.8	55.8	6	28
400	169	.0400.169.0	424	61.4	68.4	6	28
450	56	.0450.056.0	221	57.1	60.1	6	30
450	95	.0450.095.0	290	60.7	65.7	6	30
450	182	.0450.182.0	441	74.4	82.4	6	30
500	66	.0500.066.0	229	64	68	6	30
500	114	.0500.114.0	304	70.1	77.1	6	30
500	198	.0500.198.0	453	93.9	103.9	6	30
600	76	.0600.076.0	245	84.8	90.8	6	32
600	108	.0600.108.0	301	89.6	96.6	6	32
600	198	.0600.198.0	452	117.9	129.9	6	32

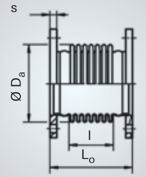
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
316	72	669.7	21	4	211	39.2	5200
316	126	669.7	37	13	120	22.4	970
319	240	676.6	63	44	110	20.7	247
371	80	932.1	22	5	183	47.4	5091
368	120	924	30	10	146	37.4	1784
374	198	940.2	49	28	128	33.3	585
402	63	1110.4	15	3	282	87	15075
400	147	1104.5	32	14	136	41.7	1328
405	253	1119.2	54	40	120	37.3	401
461	88	1455.6	14	4	361	145.9	12951
461	176	1455.6	28	14	180	72.9	1619
462	299	1459	46	40	148	60.2	463
515	92	1832.2	14	4	349	177.8	14443
513	161	1824.7	23	11	219	110.9	2943
515	312	1832.2	44	40	150	76.6	541
572	100	2264.8	15	4	414	260.3	17894
572	175	2264.8	25	13	236	148.7	3339
574	324	2273.3	44	41	208	131.5	861
677	112	3217	14	4	414	370.2	20288
675	168	3206.9	20	10	299	266.5	6492
678	319	3222	37	34	236	211.3	1428

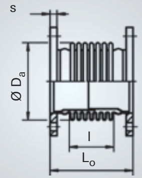
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

06

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 06... PN 6





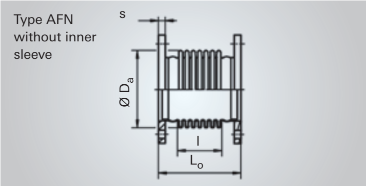
Nominal diameter	Nominal axial movement absorption[1]	Type AFN 06...	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange[2] drilling as per EN 1092	Flange[2] thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
700	60	.0700.060.0	220	107.2	111.2	6	36
700	115	.0700.115.0	305	121.7	130.7	6	36
700	200	.0700.200.0	436	146.4	159.4	6	36
800	63	.0800.063.0	245	142.8	147.8	6	37
800	105	.0800.105.0	311	154.3	165.3	6	37
800	210	.0800.210.0	476	182.9	198.9	6	37
900	63	.0900.063.0	247	156.3	163.3	6	38
900	105	.0900.105.0	313	169.2	180.2	6	38
900	210	.0900.210.0	478	201.7	220.7	6	38
1000	66	.1000.066.0	271	185.5	193.5	6	42
1000	110	.1000.110.0	341	200.5	214.5	6	42
1000	198	.1000.198.0	481	230.3	251.3	6	42
1200	69	.1200.069.0	275	222.3	235.3	2.5	40
1200	115	.1200.115.0	379	507.3	531.3	16	57
1200	196	.1200.196.0	519	541	576	16	57

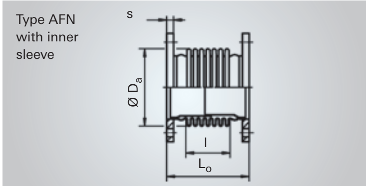
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] angular	Nominal movement absorption[1] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
781	84	4329.9	9	2	564	677.9	66055
778	169.2	4312.5	18	9	413	494.7	11880
783	300	4341.6	32	28	255	307.4	2348
887	99	5621.2	9	3	856	1336.5	93758
887	165	5621.2	15	7	514	801.9	20252
887	330	5621.2	31	29	257	401	2531
996	99	7163	8	2	953	1896.5	133043
996	165	7163	13	6	572	1137.9	28737
996	330	7163	27	26	286	569	3592
1100	105	8791.5	8	2	974	2377.8	148289
1100	175	8791.5	13	7	584	1426.7	32030
1100	315	8791.5	23	21	325	792.6	5492
1296	105	12340.7	7	2	1092	3743.5	233458
1296	175	12340.7	11	6	655	2246.1	50427
1293	315	12311.1	19	17	404	1380.9	9569

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 10... PN 10





Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2)]	
		AFN 10...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
50	22	.0050.022.0	142	5.6	5.6	16	20
50	46	.0050.046.0	228	6.5	6.5	16	20
65	18	.0065.018.0	124	6.4	6.4	16	20
65	48	.0065.048.0	220	7.8	8.8	16	20
80	20	.0080.020.0	132	7.5	7.5	16	20
80	41	.0080.041.0	176	7.8	7.8	16	20
80	54	.0080.054.0	232	9	10	16	20
100	26	.0100.026.0	138	9.2	10.2	16	22
100	42	.0100.042.0	174	9.5	9.5	16	22
100	80	.0100.080.0	300	13.1	14.1	16	22
125	30	.0125.030.0	156	11.9	11.9	16	22
125	45	.0125.045.0	182	12.8	12.8	16	22
125	85	.0125.085.0	308	16.2	17.2	16	22
150	32	.0150.032.0	162	16.1	16.1	16	24
150	64	.0150.064.0	222	17.2	18.2	16	24
150	95	.0150.095.0	310	21.1	23.1	16	24
200	40	.0200.040.0	170	21.3	22.3	10	24
200	76	.0200.076.0	238	22.8	23.8	10	24
200	110	.0200.110.0	300	27.3	29.3	10	24
250	44	.0250.044.0	186	27.4	28.4	10	26
250	84	.0250.084.0	254	32.1	33.1	10	26
250	130	.0250.130.0	418	41.1	44.1	10	26

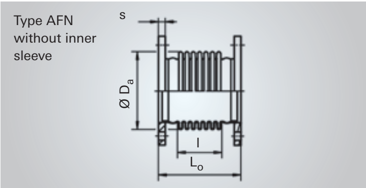
06

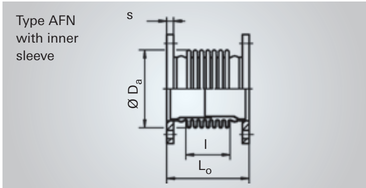
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	34	5	93	1.2	278
90	140	46.6	71	29	116	1.5	52
108	36	69.4	23	2	114	2.2	1164
110	132	70.9	62	24	136	2.7	105
121	44	89.1	22	3	192	4.8	1687
122	88	89.9	46	12	86	2.2	192
123	144	90.8	60	25	137	3.5	115
151	48	140	24	3	134	5.2	1559
149	84	137.9	39	9	92	3.5	343
152	210	141	72	44	131	5.1	80
171	56	183.9	23	4	148	7.5	1655
173	81.6	186.3	35	8	161	8.3	859
174	208	187.5	65	39	138	7.2	115
203	60	264.5	21	4	257	18.9	3603
203	120	264.5	42	15	128	9.4	450
205	208	267.4	63	38	136	10.1	160
257	68	435.6	20	4	242	29.3	4361
255.5	136	432.8	38	15	135	16.3	604
260	198	441.2	55	31	140	17.2	301
313	72	662.8	18	4	257	47.2	6265
319	140	676.6	35	14	189	35.5	1246
319	304	676.6	52	46	201	37.8	281

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 10... PN 10





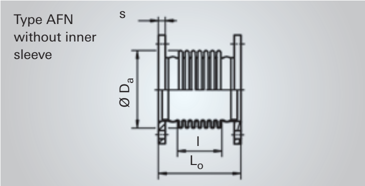
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 10...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
300	45	.0300.045.0	177	32	34	10	26
300	86	.0300.086.0	246	36.8	39.8	10	26
300	137	.0300.137.0	444	52.4	58.4	10	26
350	56	.0350.056.0	207	49.5	52.5	10	30
350	95	.0350.095.0	276	54.6	58.6	10	30
350	150	.0350.150.0	479	82.3	89.3	10	30
400	48	.0400.048.0	229	67.2	70.2	10	32
400	96	.0400.096.0	325	75.9	80.9	10	32
400	156	.0400.156.0	471	97.3	105.3	10	32
450	70	.0450.070.0	266	83.8	88.8	10	36
450	98	.0450.098.0	316	88.9	94.9	10	36
450	182	.0450.182.0	466	104.3	112.3	10	36
500	66	.0500.066.0	253	96.9	101.9	10	38
500	110	.0500.110.0	334	105.7	112.7	10	38
500	192	.0500.192.0	481	134.7	144.7	10	38
600	72	.0600.072.0	269	130.2	136.2	10	42
600	100	.0600.100.0	327	137.1	144.1	10	42
600	198	.0600.198.0	483	172.5	184.5	10	42
700	57	.0700.057.0	240	155.8	159.8	10	40
700	114	.0700.114.0	336	175.3	185.3	10	40
700	190	.0700.190.0	464	201.1	214.1	10	40

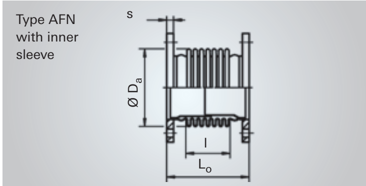
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
372	63	934.8	15	3	292	75.7	13122
372	132	934.8	30	11	215	55.8	2202
374	330	940.2	49	46	240	62.7	396
401	88	1107.4	18	4	283	87	7721
402	156.8	1110.4	30	14	225	69.3	1939
412	360	1140.1	49	51	289	91.5	486
464	96	1465.7	14	4	730	297.3	22180
464	192	1465.7	28	15	365	148.6	2772
467	338	1475.9	44	43	291	119.3	718
518	125	1843.6	17	6	564	289.1	12720
518	175	1843.6	23	12	403	206.5	4636
518	325	1843.6	44	41	217	111.2	724
575	108	2277.5	14	4	599	379	22339
573	189	2269.1	24	13	372	234.7	4518
576	336	2281.7	41	40	282	178.7	1088
679	116	3227.1	13	4	624	559.4	28583
676	174	3212	18	9	469	418.9	9512
681	330	3237.1	36	35	306	275.1	1737
785	96	4353.3	9	3	1142	1381	103031
785	192	4353.3	19	10	571	690.5	12879
785	320	4353.3	31	29	343	414.3	2782

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 16... PN 16





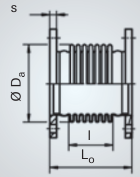
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]		Bellows			Nominal movement absorption[1]		Spring rate		
		AFN 16...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness	outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
DN	$2\delta_N$	–	L_o	G	G	PN	s	D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
–	mm	–	mm	kg	kg	-	mm	mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
50	20	.0050.020.0	142	5.7	5.7	16	20	88.5	54	45.7	32	5	155	2	464
50	40	.0050.040.0	231	6.6	6.6	16	20	91	143	47.2	62	26	153	2	67
65	26	.0065.026.0	148	6.6	6.6	16	20	108	60	69.4	32	6	126	2.4	464
65	48	.0065.048.0	220	7.8	8.8	16	20	110	132	70.9	60	23	136	2.7	105
80	23	.0080.023.0	148	7.9	7.9	16	20	122	60	89.9	25	4	278	6.9	1325
80	50	.0080.050.0	220	8.9	9.9	16	20	123	132	90.8	54	20	150	3.8	149
100	31	.0100.031.0	155	9.8	9.8	16	22	153	65	142.1	29	6	174	6.9	1118
100	53	.0100.053.0	230	11.7	12.7	16	22	152	140	141	47	19	196	7.7	269
125	21	.0125.021.0	142	12.1	12.1	16	22	173	42	186.3	16	2	322	16.6	6489
125	42	.0125.042.0	187	13.1	13.1	16	22	174	87	187.5	33	8	192	10	906
125	59	.0125.059.0	235	13.8	14.8	16	22	173	135	186.3	47	18	139	7.2	271
150	24	.0150.024.0	147	15.9	15.9	16	24	204	45	265.9	15	2	316	23.4	7933
150	44	.0150.044.0	195	17.1	18.1	16	24	204	93	265.9	30	8	206	15.2	1212
150	66	.0150.066.0	246	19.3	20.3	16	24	205	144	267.4	42	18	196	14.5	482
200	30	.0200.030.0	158	22.8	22.8	16	26	261	54	443	15	2	479	59	13906
200	57	.0200.057.0	212	24.8	25.8	16	26	260	108	441.2	28	9	257	31.5	1857
200	97	.0200.097.0	374	33.6	35.6	16	26	262	270	444.9	48	37	276	34.1	322
250	32	.0250.032.0	193	33.4	34.4	16	29	319	76	676.6	13	3	603	113.3	13491
250	52	.0250.052.0	250	35.6	37.6	16	29	317	133	672	21	8	389	72.6	2821
250	103	.0250.103.0	377	45.6	47.6	16	29	320	260	678.9	40	30	300	56.5	575

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

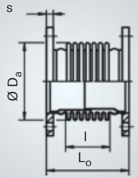
AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 16... PN 16

Type AFN without inner sleeve



Type AFN with inner sleeve



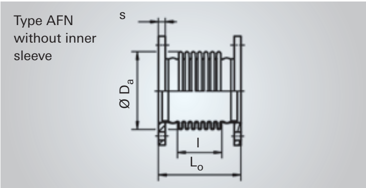
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Flange[2]	
		AFN 16...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
300	30	.0300.030.0	186	44.5	46.5	16	32
300	75	.0300.075.0	294	52.7	56.7	16	32
300	120	.0300.120.0	468	71.1	77.1	16	32
350	30	.0350.030.0	192	62.7	64.7	16	35
350	75	.0350.075.0	300	72.5	76.5	16	35
350	130	.0350.130.0	441	89.8	95.8	16	35
400	48	.0400.048.0	249	86.9	89.9	16	38
400	84	.0400.084.0	327	95.8	100.8	16	38
400	132	.0400.132.0	431	107.7	114.7	16	38
450	52	.0450.052.0	257	109.7	112.7	16	42
450	91	.0450.091.0	335	120.1	125.1	16	42
450	143	.0450.143.0	439	134	142	16	42
500	48	.0500.048.0	245	145.1	148.1	16	46
500	90	.0500.090.0	336	163.5	169.5	16	46
500	135	.0500.135.0	423	179.6	187.6	16	46

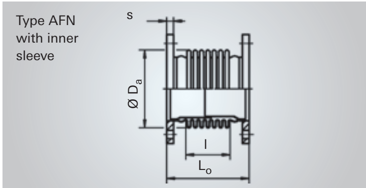
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
376	63	945.7	10	2	845	221.8	38431
375	171.2	943	26	13	426	111.5	2616
376	345	945.7	45	45	327	86	497
408	63	1128.2	9	2	920	288.2	49917
409	171.2	1131.1	25	13	416	130.6	3064
412	312	1140.1	41	37	334	105.6	746
467	104	1475.9	13	4	946	387.9	24657
467	182	1475.9	23	12	541	221.6	4601
467	286	1475.9	36	30	344	141	1186
520	104	1851.3	13	4	954	490.5	31179
520	182	1851.3	22	12	545	280.3	5818
520	286	1851.3	35	29	347	178.4	1499
579	84	2294.5	11	3	996	634.9	61867
580	174.6	2298.7	20	10	660	421.3	9501
580	261.9	2298.7	30	23	440	280.9	2815

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 25... PN 25





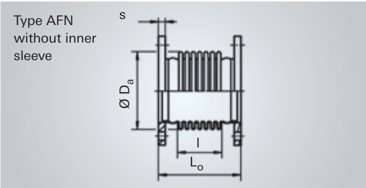
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Flange[2)]	
		AFN 25...		without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
50	12	.0050.012.0	128	5.8	5.8	40	20
50	27	.0050.027.0	187	6.3	7.3	40	20
65	17	.0065.017.0	134	7.3	7.3	40	22
65	40	.0065.040.0	222	8.8	9.8	40	22
80	23	.0080.023.0	152	9.4	9.4	40	24
80	42	.0080.042.0	222	10.6	11.6	40	24
100	23	.0100.023.0	146	13.1	14.1	40	26
100	48	.0100.048.0	220	14.7	15.7	40	26
125	26	.0125.026.0	169	18.6	18.6	40	28
125	52	.0125.052.0	233	20	21	40	28
150	29	.0150.029.0	173	23.3	24.3	40	30
150	48	.0150.048.0	228	25.4	26.4	40	30
200	26	.0200.026.0	185	32.7	33.7	25	32
200	44	.0200.044.0	239	34.9	35.9	25	32
200	71	.0200.071.0	311	39.4	40.4	25	32
250	24	.0250.024.0	189	45.9	46.9	25	35
250	45	.0250.045.0	249	49.2	51.2	25	35
250	72	.0250.072.0	329	53.7	55.7	25	35
300	27	.0300.027.0	201	60.3	62.3	25	38
300	46	.0300.046.0	267	64.1	66.1	25	38
300	76	.0300.076.0	337	73.9	77.9	25	38

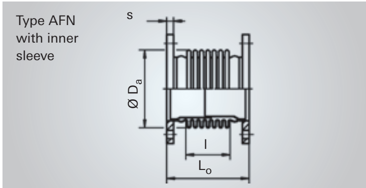
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
90	40	46.6	19	2	405	5.2	2249
91	99	47.2	42	12	221	2.9	203
111	44	71.6	22	3	273	5.4	1932
113	132	73.1	54	21	175	3.6	140
125	60	92.5	26	4	267	6.9	1312
125	130	92.5	45	17	222	5.7	232
152	52	141	20	3	310	12.2	3090
153	126	142.1	43	16	198	7.8	339
177	64	191.1	21	4	350	18.6	3116
175	128	188.7	39	14	206	10.8	454
207	64	270.3	19	4	376	28.2	4737
207	119	270.3	30	10	314	23.6	1143
261	72	443	13	3	855	105.3	13961
261	126	443	22	8	489	60.2	2605
263	198	446.8	35	20	353	43.7	767
323	60	685.8	10	2	1089	207.4	39604
320	120	678.9	18	6	649	122.4	5845
319	200	676.6	29	17	414	77.8	1338
376	66	945.7	9	2	1076	282.6	44600
370	132	929.4	16	6	755	195	7693
376	201.6	945.7	26	15	545	143.3	2424

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE AFN 25... PN 25





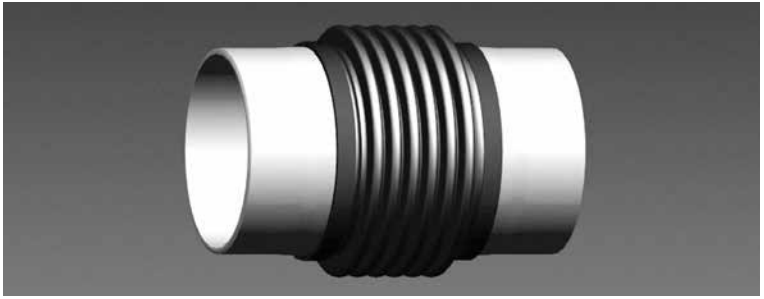
Nominal diameter	Nominal axial movement absorption[1]	Type AFN 25...	Overall length	Weight approx.		Flange[2]	
				without inner sleeve	with inner sleeve	drilling as per EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	G	PN	s
–	mm	–	mm	kg	kg	-	mm
350	30	.0350.030.0	215	92.8	94.8	25	42
350	50	.0350.050.0	263	97.6	100.6	25	42
350	75	.0350.075.0	335	104.4	109.4	25	42
400	32	.0400.032.0	265	130.7	133.7	25	48
400	56	.0400.056.0	340	140	144	25	48
400	96	.0400.096.0	489	162.1	169.1	25	48

Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
413	72	1143.1	9	2	1373	436	57832
413	120	1143.1	16	5	824	261.6	12492
411	192	1137.1	23	13	571	180.4	3364
466	100	1472.5	9	3	1934	791.1	54390
466	175	1472.5	15	8	1105	452	10149
469	324	1482.8	27	25	700	288.4	1889

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

06

AXIAL EXPANSION JOINTS WITH WELD ENDS TYPE ARN



Type designation
The type designation consists of 2 parts
1. Type series. defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type ARN: HYDRA axial expansion joint with weld ends

Standard version/materials:
Multi-ply bellows made of 1.4541
Weld ends up to DN 300: P235GH (1.0345)
Weld ends from DN 350: P265GH (1.0425)
Operating temperature: up to 400 °C
Operating temperature „Low pressure (Exhaust)“: up to 550 °C

Type designation (example)

ARN	10	·	0150	·	064	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal (2δ = ±32 = 64 mm)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________________
- Piping - nominal diameter DN ____________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ____________________
- Max./min. allowable temperature [°C] ____________________
- Test pressure PT [bar] ____________________

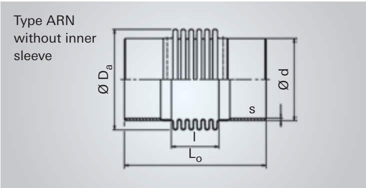
Optional:
- Category ____________________

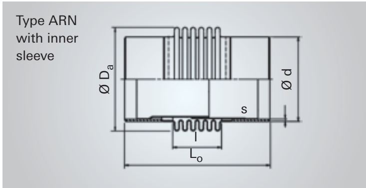
Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

Operating condition „Low pressure (Exhaust)“
Expansion joints for low pressure (exhaust-gas) are designed for unpressurized applications (PS < 0.5 bar gauge pressure).
The Pressure Equipment Directive (PED) does not apply to this operating condition.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH WELD ENDS

TYPE ARN 01... PN 1





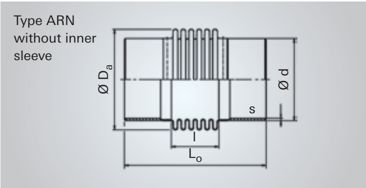
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length		Weight approx.		Weld end	
		ARN 01...	standard type	exhaust gas	without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	L_o	G	G	d	s
–	mm	–	mm	mm	kg	kg	-	mm
50	24	.0050.024.0	214	214	0.9	1.1	60.3	2.9
50	56	.0050.056.0	286	286	1.2	1.5	60.3	2.9
50	80	.0050.080.0	340	340	1.3	1.7	60.3	2.9
65	28	.0065.028.0	214	214	1.2	1.4	76.1	2.9
65	64	.0065.064.0	286	286	1.5	1.9	76.1	2.9
65	92	.0065.092.0	340	340	1.7	2.3	76.1	2.9
80	37	.0080.037.0	230	230	1.6	1.9	88.9	3.2
80	74	.0080.074.0	300	300	1.9	2.5	88.9	3.2
80	106	.0080.106.0	360	360	2.2	2.8	88.9	3.2
100	40	.0100.040.0	226	226	2.2	2.6	114.3	3.6
100	86	.0100.086.0	303	303	2.6	3.3	114.3	3.6
100	119	.0100.119.0	358	358	3	3.9	114.3	3.6
125	63	.0125.063.0	267	251	3.1	3.6	139.7	4
125	126	.0125.126.0	358	342	3.7	4.7	139.7	4
125	175	.0125.175.0	436	420	4.2	5.1	139.7	4
150	63	.0150.063.0	267	251	3.8	4.4	168.3	4
150	126	.0150.126.0	358	342	4.5	5.2	168.3	4
150	180	.0150.180.0	436	420	5.2	6.2	168.3	4
200	70	.0200.070.0	285	265	5.4	6.8	219.1	4.5
200	140	.0200.140.0	390	370	6.5	7.5	219.1	4.5
200	200	.0200.200.0	480	460	7.4	9.4	219.1	4.5

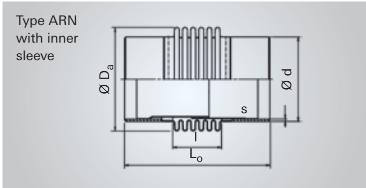
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	38	6	93	1.2	278
88.5	126	45.7	88	32	40	0.5	22
88.5	180	45.7	126	66	28	0.4	8
107	54	68.7	37	6	85	1.6	381
107	126	68.7	87	32	36	0.7	30
107	180	68.7	125	65	25	0.5	10
121	70	89.1	44	9	67	1.7	234
121	140	89.1	89	36	34	0.8	29
121	200	89.1	127	74	24	0.6	10
148	66	136.8	38	7	73	2.8	438
148	143	136.8	81	34	34	1.3	43
148	198	136.8	113	65	24	0.9	16
174	91	187.5	54	14	41	2.2	179
174	182	187.5	108	57	21	1.1	22
171	260	183.9	137	103	18	0.9	10
203	91	264.5	46	12	48	3.6	295
203	182	264.5	93	49	24	1.8	37
203	260	264.5	132	100	17	1.2	13
255	105	431.9	41	12	53	6.4	399
255	210	431.9	82	50	27	3.2	50
254	300	430.1	112	98	20	2.4	18

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH WELD ENDS

TYPE ARN 01... PN 1



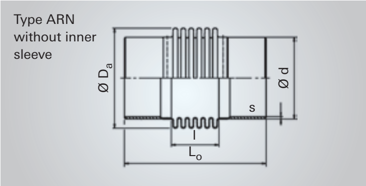


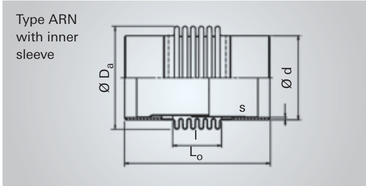
Nominal diameter	Nominal axial movement absorption[1]	Type ARN 01...	Overall length		Weight approx.		Weld end		Bellows			Nominal movement absorption[1]		Spring rate		
			standard type	exhaust gas	without inner sleeve	with inner sleeve	outside diameter	wall thickness	outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
DN	$2\delta_N$	–	L_o	L_o	G	G	d	s	D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
–	mm	–	mm	mm	kg	kg	-	mm	mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
250	72	.0250.072.0	282	262	7.2	8.2	273	5	312	102	660.5	33	10	62	11.4	753
250	144	.0250.144.0	384	364	8.5	10.5	273	5	312	204	660.5	66	39	31	5.7	94
250	216	.0250.216.0	486	466	9.6	12.6	273	5	311	306	658.2	95	84	22	4	30
300	70	.0300.070.0	279	255	9.2	11.2	323.9	5.6	365	95	915.9	27	7	73	18.5	1410
300	154	.0300.154.0	393	369	10.8	14.8	323.9	5.6	365	209	915.9	59	36	33	8.4	132
300	210	.0300.210.0	469	445	11.9	16.9	323.9	5.6	365	285	915.9	80	66	24	6.2	52
350	75	.0350.075.0	284	260	8	11	355.6	4	400	100	1104.5	27	8	66	20.2	1389
350	150	.0350.150.0	384	360	9.5	13.5	355.6	4	400	200	1104.5	55	32	33	10.1	174
350	210	.0350.210.0	464	440	10.8	15.8	355.6	4	400	280	1104.5	76	62	24	7.2	63
400	65	.0400.065.0	289	265	10.9	12.9	406.4	4	458	105	1445.5	18	6	212	85	5299
400	117	.0400.117.0	373	349	13.7	17.7	406.4	4	458	189	1445.5	33	18	118	47.2	909
400	195	.0400.195.0	499	475	17.8	23.8	406.4	4	458	315	1445.5	55	50	71	28.3	196
450	56	.0450.056.0	272	248	11.8	13.8	457	4	513	88	1824.7	15	4	243	123.4	10953
450	140	.0450.140.0	404	380	16.7	21.7	457	4	513	220	1824.7	37	23	97	49.3	701
450	196	.0450.196.0	492	468	20	26	457	4	513	308	1824.7	52	46	70	35.2	255
500	68	.0500.068.0	320	292	15.4	18.4	508	4	569	92	2252.2	15	4	215	134.4	10915
500	136	.0500.136.0	412	384	19.4	25.4	508	4	569	184	2252.2	31	16	107	67.2	1364
500	221	.0500.221.0	527	499	24.3	31.3	508	4	569	299	2252.2	50	43	66	41.3	318
600	76	.0600.076.0	332	304	18.9	21.9	610	4	674	104	3201.9	15	4	215	190.9	12134
600	152	.0600.152.0	436	408	23.9	30.9	610	4	674	208	3201.9	29	18	107	95.4	1517
600	228	.0600.228.0	540	512	28.9	37.9	610	4	674	312	3201.9	44	40	72	63.6	449

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH WELD ENDS

TYPE ARN 01... PN 1





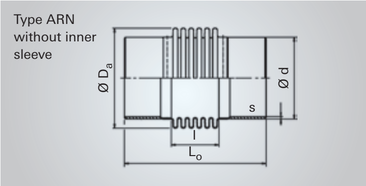
Nominal diameter	Nominal axial movement absorption1)	Type	Overall length		Weight approx.		Weld end	
		ARN 01...	standard type	exhaust gas	without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	L_o	G	G	d	s
–	mm	–	mm	mm	kg	kg	-	mm
700	80	.0700.080.0	340	312	22.4	25.4	711	4
700	140	.0700.140.0	424	396	27.2	34.2	711	4
700	220	.0700.220.0	536	508	33.5	43.5	711	4
800	84	.0800.084.0	348	316	25.9	31.9	813	4
800	147	.0800.147.0	435	403	31.4	40.4	813	4
800	231	.0800.231.0	551	519	38.7	50.7	813	4
900	84	.0900.084.0	352	320	29.4	36.4	914	4
900	168	.0900.168.0	472	440	37.9	48.9	914	4
900	231	.0900.231.0	562	530	44.2	57.2	914	4
1000	72	.1000.072.0	332	296	30.6	35.6	1016	4
1000	144	.1000.144.0	428	392	37.8	49.8	1016	4
1000	240	.1000.240.0	556	520	47.5	62.5	1016	4
1200	72	.1200.072.0	329	329	48.2	55.2	1220	6
1200	144	.1200.144.0	422	422	57.3	75.3	1220	6
1200	240	.1200.240.0	546	546	69.4	93.4	1220	6
1400	48	.1400.048.0	304	304	53.8	61.8	1420	6
1400	108	.1400.108.0	434	434	65.9	85.9	1420	6
1400	180	.1400.180.0	590	590	80.4	107.4	1420	6
1600	48	.1600.048.0	304	304	61.4	70.4	1620	6
1600	108	.1600.108.0	434	434	75.2	98.2	1620	6
1600	180	.1600.180.0	590	590	91.8	121.8	1620	6

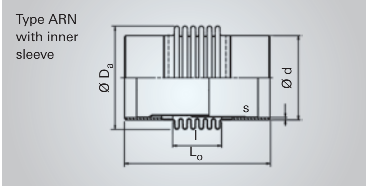
Bellows			Nominal movement absorption1)		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	14	5	203	244	13376
780	196	4324.1	25	14	116	139.4	2496
780	308	4324.1	39	35	74	88.7	643
882	116	5588	13	4	220	342.3	17488
882	203	5588	23	13	126	195.6	3263
882	319	5588	35	33	80	124.5	841
992	120	7133.1	12	4	238	471	22487
992	240	7133.1	24	16	119	235.5	2811
992	330	7133.1	32	31	86	171.3	1081
1095	96	8750	8	2	335	814.7	60780
1095	192	8750	17	9	168	407.4	7598
1095	320	8750	28	26	101	244.4	1641
1295	93	12330.8	8	2	331	1132.9	90056
1295	186	12330.8	15	8	165	566.4	11257
1295	310	12330.8	25	23	99	339.9	2432
1472	104	16376.6	4	1	932	4240.3	269545
1472	234	16376.6	9	6	414	1884.6	23664
1472	390	16376.6	15	17	249	1130.7	5111
1672	104	21227.2	3	1	1056	6229.2	395974
1672	234	21227.2	8	5	470	2768.5	34763
1672	390	21227.2	13	15	282	1661.1	7509

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS FOR LOW PRESSURE WITH WELD ENDS

TYPE ARN 01... PN 1





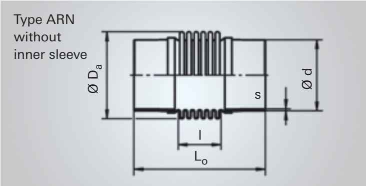
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length		Weight approx.		Weld end	
		ARN 01...	standard type	exhaust gas	without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	L_o	G	G	d	s
–	mm	–	mm	mm	kg	kg	-	mm
1800	48	.1800.048.0	304	304	69	80	1820	6
1800	108	.1800.108.0	434	434	84.5	110.5	1820	6
1800	180	.1800.180.0	590	590	103.1	137.1	1820	6
2000	48	.2000.048.0	304	304	76.6	88.6	2020	6
2000	108	.2000.108.0	434	434	93.8	122.8	2020	6
2000	180	.2000.180.0	590	590	114.5	152.5	2020	6
2200	48	.2200.048.0	304	304	84.2	97.2	2220	6
2200	108	.2200.108.0	434	434	103.1	136.1	2220	6
2200	180	.2200.180.0	590	590	125.9	167.9	2220	6
2400	48	.2400.048.0	304	304	91.8	106.8	2420	6
2400	108	.2400.108.0	434	434	112.4	148.4	2420	6
2400	180	.2400.180.0	590	590	137.2	183.2	2420	6
2600	48	.2600.048.0	304	304	99.4	114.4	2620	6
2600	108	.2600.108.0	434	434	121.8	160.8	2620	6
2600	180	.2600.180.0	590	590	148.6	198.6	2620	6
2800	48	.2800.048.0	304	304	107	124	2820	6
2800	108	.2800.108.0	434	434	131.1	173.1	2820	6
2800	180	.2800.180.0	590	590	159.9	213.9	2820	6
3000	48	.3000.048.0	304	304	114.6	131.6	3020	6
3000	108	.3000.108.0	434	434	140.4	185.4	3020	6
3000	180	.3000.180.0	590	590	171.3	228.3	3020	6

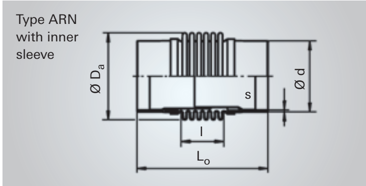
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
1872	104	26706.2	3	1	1180	8751.7	556323
1872	234	26706.2	7	5	524	3889.6	48840
1872	390	26706.2	12	13	315	2333.8	10550
2072	104	32813.4	3	1	1302	11866.5	754329
2072	234	32813.4	6	4	579	5274	66224
2072	390	32813.4	10	12	347	3164.4	14304
2272	104	39549	3	1	1424	15641.4	994288
2272	234	39549	6	4	633	6951.7	87290
2272	390	39549	9	11	380	4171	18855
2472	104	46912.9	2	1	1545	20139	1280190
2472	234	46912.9	5	4	687	8950.7	112390
2472	390	46912.9	9	10	412	5370.4	24276
2672	104	54905.1	2	1	1667	25422	1616018
2672	234	54905.1	5	3	741	11298.6	141873
2672	390	54905.1	8	9	444	6779.2	30644
2872	104	63525.6	2	1	1788	31552.9	2005749
2872	234	63525.6	4	3	795	14023.5	176088
2872	390	63525.6	7	8	477	8414.1	38035
3072	104	72774.5	2	1	1909	38594.4	2453359
3072	234	72774.5	4	3	849	17153.1	215384
3072	390	72774.5	7	8	509	10291.8	46523

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 02... PN 2.5





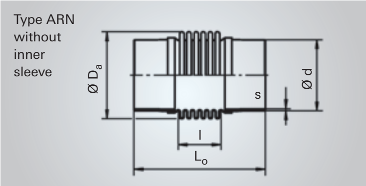
Nominal diameter	Nominal axial movement absorption[1]	Type ARN 02...	Overall length	Weight approx.		Weld end	
				without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	24	.0050.024.0	214	0.9	1.1	60.3	2.9
50	44	.0050.044.0	259	1.1	1.3	60.3	2.9
50	70	.0050.070.0	331	1.6	2	60.3	2.9
65	28	.0065.028.0	214	1.2	1.4	76.1	2.9
65	60	.0065.060.0	277	1.5	1.8	76.1	2.9
65	87	.0065.087.0	350	2.1	2.7	76.1	2.9
80	27	.0080.027.0	210	1.5	1.8	88.9	3.2
80	64	.0080.064.0	280	1.8	2.2	88.9	3.2
80	92	.0080.092.0	358	2.5	3.2	88.9	3.2
100	46	.0100.046.0	237	2.3	2.7	114.3	3.6
100	86	.0100.086.0	303	2.6	3.4	114.3	3.6
100	122	.0100.122.0	420	5.3	7.3	114.3	3.6
125	45	.0125.045.0	241	2.9	3.4	139.7	4
125	90	.0125.090.0	306	3.4	4.4	139.7	4
125	140	.0125.140.0	456	6.9	7.9	139.7	4
150	54	.0150.054.0	254	3.6	4.3	168.3	4
150	99	.0150.099.0	319	4.2	5.1	168.3	4
150	160	.0150.160.0	476	8.7	10.7	168.3	4
200	70	.0200.070.0	285	5.4	7.4	219.1	4.5
200	130	.0200.130.0	388	7.5	9.5	219.1	4.5
200	190	.0200.190.0	503	12.2	15.2	219.1	4.5

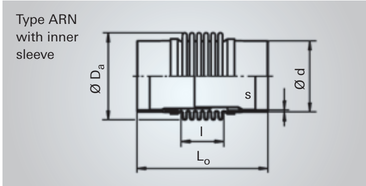
Bellows			Nominal movement absorption[1]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	37	6	93	1.2	278
88.5	99	45.7	68	20	51	0.6	45
88.5	171	45.7	109	54	49	0.6	15
107	54	68.7	37	6	85	1.6	381
107	117	68.7	80	27	39	0.7	37
108	190	69.4	116	64	40	0.8	15
121	50	89.1	31	4	94	2.3	641
121	120	89.1	74	26	39	1	46
121	198	89.1	105	60	43	1.1	19
148	77	136.8	43	10	63	2.4	276
148	143	136.8	79	33	34	1.3	43
150	260	138.9	114	86	57	2.2	22
174	65	187.5	37	7	58	3	491
174	130	187.5	74	28	29	1.5	61
172	280	185.1	118	96	53	2.7	24
203	78	264.5	38	9	56	4.1	469
203	143	264.5	70	29	31	2.3	76
203	300	264.5	113	98	51	3.8	29
255	105	431.9	39	12	53	6.4	399
256	208	433.7	74	45	43	5.1	81
257	323	435.6	104	98	51	6.2	41

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 02... PN 2.5





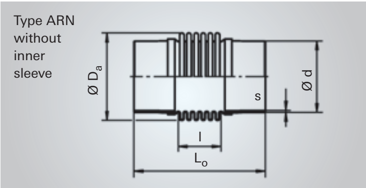
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Weld end	
		ARN 02...		without inner sleeve	with inner sleeve	outside diameter	wall t hickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
250	72	.0250.072.0	282	7.2	9.2	273	5
250	144	.0250.144.0	384	10	12	273	5
250	204	.0250.204.0	486	15.8	19.8	273	5
300	70	.0300.070.0	279	9.2	11.2	323.9	5.6
300	126	.0300.126.0	355	10.2	14.2	323.9	5.6
300	210	.0300.210.0	464	18.5	23.5	323.9	5.6
350	75	.0350.075.0	284	7.9	10.9	355.6	4
350	150	.0350.150.0	384	11.4	16.4	355.6	4
350	210	.0350.210.0	478	18.1	24.1	355.6	4
400	65	.0400.065.0	289	10.9	13.9	406.4	4
400	117	.0400.117.0	373	13.7	18.7	406.4	4
400	195	.0400.195.0	499	17.8	25.8	406.4	4
450	56	.0450.056.0	272	11.8	15.8	457	4
450	140	.0450.140.0	404	16.7	23.7	457	4
450	196	.0450.196.0	492	20	28	457	4
500	68	.0500.068.0	320	15.4	19.4	508	4
500	136	.0500.136.0	412	19.4	27.4	508	4
500	221	.0500.221.0	527	24.3	35.3	508	4
600	76	.0600.076.0	332	18.9	24.9	610	4
600	150	.0600.150.0	436	23.9	33.9	610	4
600	224	.0600.224.0	540	28.8	42.8	610	4

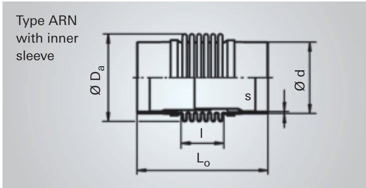
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
312	102	660.5	31	9	62	11.4	753
315	204	667.4	68	40	40	7.5	123
316	306	669.7	94	84	50	9.2	68
365	95	915.9	25	7	73	18.5	1410
363	171	910.6	43	21	46	11.6	273
371	280	932.1	80	65	52	13.5	119
399	100	1101.5	25	7	70	21.4	1469
402	200	1110.4	54	31	46	14.2	245
402	294	1110.4	73	62	60	18.6	148
458	105	1445.5	18	5	212	85	5299
458	189	1445.5	32	17	118	47.2	909
458	315	1445.5	53	48	71	28.3	196
513	88	1824.7	14	4	243	123.4	10953
513	220	1824.7	35	23	97	49.3	701
513	308	1824.7	49	44	70	35.2	255
569	92	2252.2	15	4	215	134.4	10915
569	184	2252.2	29	16	107	67.2	1364
569	299	2252.2	48	41	66	41.3	318
674	104	3201.9	14	4	215	190.9	12134
674	208	3201.9	28	17	107	95.4	1517
673	312	3196.9	41	37	74	66.1	467

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 02... PN 2.5





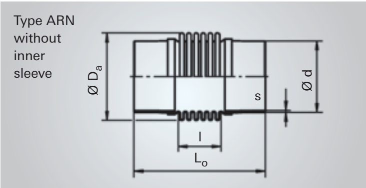
Nominal diameter	Nominal axial movement absorption[1)]	Type	Overall length	Weight approx.		Weld end	
		ARN 02...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
700	80	.0700.080.0	340	22.4	28.4	711	4
700	135	.0700.135.0	424	26.7	37.7	711	4
700	215	.0700.215.0	536	32.7	47.7	711	4
800	84	.0800.084.0	348	25.9	35.9	813	4
800	147	.0800.147.0	435	38.6	52.6	813	4
800	231	.0800.231.0	562	61.6	79.6	813	4
900	84	.0900.084.0	352	29.4	41.4	914	4
900	168	.0900.168.0	480	47.5	64.5	914	4
900	231	.0900.231.0	562	57.3	78.3	914	4
1000	72	.1000.072.0	332	30.6	39.6	1016	4
1000	144	.1000.144.0	434	46.1	63.1	1016	4
1000	240	.1000.240.0	566	60.7	83.7	1016	4
1200	72	.1200.072.0	332	53.8	68.8	1220	6
1200	144	.1200.144.0	428	66.8	92.8	1220	6
1200	230	.1200.230.0	556	84	121	1220	6
1400	48	.1400.048.0	304	53.8	68.8	1420	6
1400	108	.1400.108.0	434	65.9	95.9	1420	6
1400	180	.1400.180.0	590	80.4	123.4	1420	6
1600	47	.1600.047.0	304	61.4	77.4	1620	6
1600	106	.1600.106.0	434	75.2	109.2	1620	6
1600	178	.1600.178.0	590	91.8	141.8	1620	6

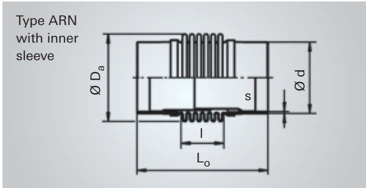
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	13	4	203	244	13376
776	196	4300.8	22	12	135	161.5	2891
776	308	4300.8	34	30	86	102.8	745
882	116	5588	12	4	220	342.3	17488
883	203	5594.7	22	13	189	293.8	4902
886	330	5614.6	36	34	149	233	1471
992	120	7133.1	11	4	238	471	22487
994	248	7148	23	17	172	341.6	3819
994	330	7148	32	30	125	248.5	1569
1096	96	8758.3	8	2	324	787.5	58748
1096	198	8758.3	16	9	251	611.7	10729
1096	330	8758.3	27	26	151	367	2317
1295	96	12330.8	7	2	511	1752	130705
1293	192	12311.1	14	8	274	935.5	17448
1292	320	12301.3	22	21	170	580.4	3897
1472	104	16376.6	4	1	932	4240.3	269545
1472	234	16376.6	9	6	414	1884.6	23664
1472	390	16376.6	14	16	249	1130.7	5111
1672	104	21227.2	3	1	1056	6229.2	395974
1672	234	21227.2	8	5	470	2768.5	34763
1672	390	21227.2	13	14	282	1661.1	7509

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 02... PN 2.5





Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 02...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
1800	45	.1800.045.0	304	69	87	1820	6
1800	105	.1800.105.0	434	84.5	123.5	1820	6
1800	175	.1800.175.0	590	103.1	159.1	1820	6
2000	45	.2000.045.0	304	76.6	97.6	2020	6
2000	100	.2000.100.0	434	93.8	136.8	2020	6
2000	175	.2000.175.0	588	132.1	194.1	2020	6

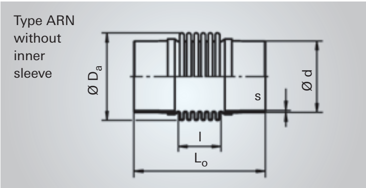
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
1872	104	26706.2	3	1	1180	8751.7	556323
1872	234	26706.2	7	5	524	3889.6	48840
1872	390	26706.2	11	13	315	2333.8	10550
2072	104	32813.4	3	1	1302	11866.5	754329
2072	234	32813.4	6	4	579	5274	66224
2094.8	388	33180.5	10	11	514	4738.8	21642

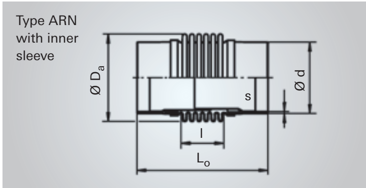
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

06

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 06... PN 6





Nominal diameter	Nominal axial movement absorption[1]	Type ARN 06...	Overall length	Weight approx.		Weld end	
				without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	23	.0050.023.0	214	0.9	1.1	60.3	2.9
50	52	.0050.052.0	286	1.4	1.7	60.3	2.9
65	28	.0065.028.0	214	1.2	1.4	76.1	2.9
65	46	.0065.046.0	250	1.4	1.7	76.1	2.9
65	72	.0065.072.0	358	3.3	3.9	76.1	2.9
80	27	.0080.027.0	210	1.5	1.8	88.9	3.2
80	48	.0080.048.0	250	1.7	2	88.9	3.2
80	77	.0080.077.0	364	3.8	4.5	88.9	3.2
100	33	.0100.033.0	215	2.1	2.5	114.3	3.6
100	59	.0100.059.0	268	2.7	3.2	114.3	3.6
100	93	.0100.093.0	368	5.2	6.2	114.3	3.6
125	32	.0125.032.0	228	2.8	3.3	139.7	4
125	58	.0125.058.0	270	3.4	4.1	139.7	4
125	98	.0125.098.0	386	6.3	7.3	139.7	4
150	40	.0150.040.0	246	3.8	4.5	168.3	4
150	88	.0150.088.0	341	6.2	8.2	168.3	4
150	124	.0150.124.0	448	11.1	13.1	168.3	4
200	40	.0200.040.0	244	5.4	6.4	219.1	4.5
200	90	.0200.090.0	333	8.2	10.2	219.1	4.5
200	140	.0200.140.0	432	14.3	17.3	219.1	4.5

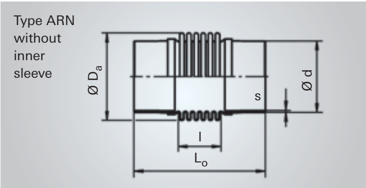
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	36	6	93	1.2	278
88.5	126	45.7	79	29	67	0.8	37
107	54	68.7	35	5	85	1.6	381
107	90	68.7	58	15	51	1	82
110	198	70.9	95	54	91	1.8	31
121	50	89.1	29	4	94	2.3	641
121	90	89.1	53	14	52	1.3	110
123	204	90.8	87	51	97	2.4	40
149	55	137.9	30	5	80	3.1	695
149	108	137.9	52	16	71	2.7	161
151	208	140	87	52	85	3.3	53
172	52	185.1	25	4	85	4.4	1108
172	94.5	185.1	44	12	78	4	307
173	210	186.3	79	48	89	4.6	72
202	70	263	28	6	117	8.6	1201
203	165	264.5	60	29	93	6.9	173
205	272	267.4	85	67	104	7.7	72
256	64	433.7	21	4	138	16.7	2797
257	153	435.6	47	21	108	13	383
260	252	441.2	72	52	110	13.5	146

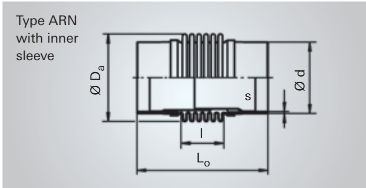
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 06... PN 6

06





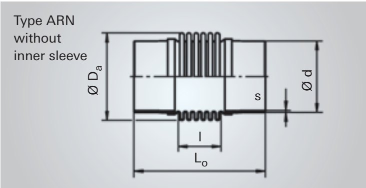
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 06...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
250	48	.0250.048.0	252	8.5	9.5	273	5
250	96	.0250.096.0	324	10.7	12.7	273	5
250	144	.0250.144.0	420	17.8	20.8	273	5
300	60	.0300.060.0	264	11.2	14.2	323.9	5.6
300	115	.0300.115.0	352	15.5	19.5	323.9	5.6
300	165	.0300.165.0	426	22.1	27.1	323.9	5.6
350	60	.0350.060.0	268	10	12	355.6	4
350	115	.0350.115.0	352	12.9	17.9	355.6	4
350	165	.0350.165.0	437	21.9	26.9	355.6	4
400	52	.0400.052.0	272	12.1	15.1	406.4	4
400	117	.0400.117.0	382	17.4	23.4	406.4	4
400	169	.0400.169.0	483	26.6	33.6	406.4	4
450	56	.0450.056.0	276	13.8	16.8	457	4
450	108	.0450.108.0	368	18.6	24.6	457	4
450	182	.0450.182.0	496	30.8	39.8	457	4
500	66	.0500.066.0	328	20.4	24.4	508	4
500	149	.0500.149.0	453	30.5	38.5	508	4
500	215	.0500.215.0	579	53	65	508	4
600	76	.0600.076.0	340	25.1	31.1	610	4
600	124	.0600.124.0	424	32.2	42.2	610	4
600	216	.0600.216.0	576	62.2	76.2	610	4

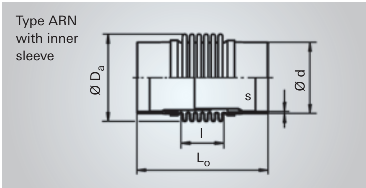
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
316	72	669.7	21	4	211	39.2	5200
316	144	669.7	42	18	105	19.6	650
319	240	676.6	63	44	110	20.7	247
371	80	932.1	22	5	183	47.4	5091
372	168	934.8	44	21	109	28.4	692
374	242	940.2	60	42	104	27.3	320
402	84	1110.4	20	5	212	65.3	6360
399	168	1101.5	36	17	127	38.7	943
405	253	1119.2	54	40	120	37.3	401
461	88	1455.6	14	4	361	145.9	12951
461	198	1455.6	32	18	160	64.8	1137
462	299	1459	46	40	148	60.2	463
515	92	1832.2	14	4	349	177.8	14443
513	184	1824.7	26	14	192	97.1	1971
515	312	1832.2	44	40	150	76.6	541
572	100	2264.8	15	4	414	260.3	17894
572	225	2264.8	33	21	184	115.7	1571
574	351	2273.3	47	48	192	121.4	677
677	112	3217	14	4	414	370.2	20288
674	196	3201.9	22	13	267	237.5	4251
678	348	3222	40	41	216	193.7	1100

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 06... PN 6





06

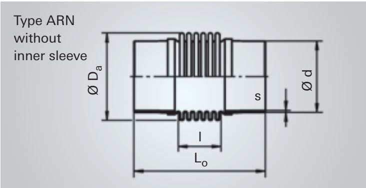
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 06...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
700	76	.0700.076.0	340	29.7	36.7	711	4
700	135	.0700.135.0	425	44.4	55.4	711	4
700	220	.0700.220.0	558	70.9	86.9	711	4
800	84	.0800.084.0	364	44.1	54.1	813	4
800	168	.0800.168.0	496	67	83	813	4
800	231	.0800.231.0	595	84.2	104.2	813	4
900	84	.0900.084.0	364	49.9	61.9	914	4
900	168	.0900.168.0	496	75.9	93.9	914	4
900	231	.0900.231.0	595	95.4	117.4	914	4
1000	66	.1000.066.0	341	49.3	59.3	1016	4
1000	132	.1000.132.0	446	71.7	88.7	1016	4
1000	220	.1000.220.0	586	101.6	125.6	1016	4
1200	69	.1200.069.0	341	70.5	85.5	1220	6
1200	130	.1200.130.0	446	96.6	124.6	1220	6
1200	220	.1200.220.0	586	131.1	169.1	1220	6

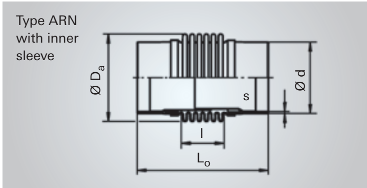
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
780	112	4324.1	12	4	439	527.3	28904
778	197.4	4312.5	21	12	354	424	7481
783	330	4341.6	35	34	232	279.4	1764
887	132	5621.2	12	5	642	1002.4	39554
887	264	5621.2	25	19	321	501.2	4944
887	363	5621.2	34	36	233	364.5	1902
996	132	7163	11	4	715	1422.4	56127
996	264	7163	21	16	357	711.2	7016
996	363	7163	29	31	260	517.2	2699
1100	105	8791.5	8	2	974	2377.8	148289
1100	210	8791.5	15	9	487	1188.9	18536
1100	350	8791.5	26	26	292	713.4	4004
1296	105	12340.7	7	2	1092	3743.5	233458
1294	210	12321	13	8	585	2001.8	31210
1293	350	12311.1	21	21	363	1242.8	6976

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 10... PN 10





Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 10...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	22	.0050.022.0	214	0.9	1.1	60.3	2.9
50	46	.0050.046.0	300	1.8	2.1	60.3	2.9
65	22	.0065.022.0	205	1.2	1.4	76.1	2.9
65	37	.0065.037.0	240	1.5	1.8	76.1	2.9
65	60	.0065.060.0	325	2.9	3.3	76.1	2.9
80	20	.0080.020.0	204	1.6	1.8	88.9	3.2
80	41	.0080.041.0	248	1.9	2.2	88.9	3.2
80	63	.0080.063.0	328	3.4	3.9	88.9	3.2
100	26	.0100.026.0	208	2.2	2.5	114.3	3.6
100	48	.0100.048.0	256	2.6	3.1	114.3	3.6
100	80	.0100.080.0	370	6.1	7.1	114.3	3.6
125	30	.0125.030.0	232	3	3.5	139.7	4
125	53	.0125.053.0	274	4.2	4.9	139.7	4
125	85	.0125.085.0	384	7.4	8.4	139.7	4
150	32	.0150.032.0	236	4.2	4.8	168.3	4
150	64	.0150.064.0	296	5.4	6.4	168.3	4
150	95	.0150.095.0	384	9.3	11.3	168.3	4
200	40	.0200.040.0	248	6.2	7.2	219.1	4.5
200	76	.0200.076.0	316	7.7	8.7	219.1	4.5
200	110	.0200.110.0	378	12.2	14.2	219.1	4.5
250	44	.0250.044.0	252	8.4	9.4	273	5
250	84	.0250.084.0	320	13.1	15.1	273	5
250	130	.0250.130.0	484	22.1	25.1	273	5

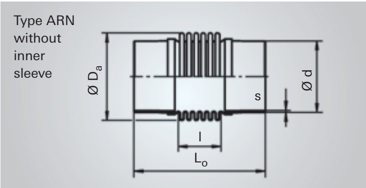
06

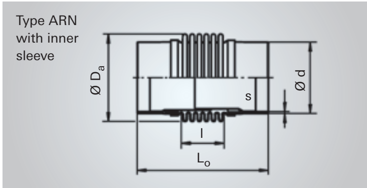
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	34	5	93	1.2	278
90	140	46.6	71	29	116	1.5	52
108	45	69.4	29	4	91	1.8	596
108	80	69.4	46	11	94	1.8	196
110	165	70.9	77	37	109	2.1	54
121	44	89.1	22	3	192	4.8	1687
122	88	89.9	46	12	86	2.2	192
123	168	90.8	70	34	118	3	72
151	48	140	24	3	134	5.2	1559
149	96	137.9	44	12	80	3.1	230
152	210	141	72	44	131	5.1	80
171	56	183.9	23	4	148	7.5	1655
173	98	186.3	40	11	138	7.1	511
174	208	187.5	65	39	138	7.2	115
203	60	264.5	21	4	257	18.9	3603
203	120	264.5	42	15	128	9.4	450
205	208	267.4	63	38	136	10.1	160
257	68	435.6	20	4	242	29.3	4361
255.5	136	432.8	38	15	135	16.3	604
260	198	441.2	55	31	140	17.2	301
313	72	662.8	18	4	257	47.2	6265
319	140	676.6	35	14	189	35.5	1246
319	304	676.6	52	46	201	37.8	281

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 10... PN 10





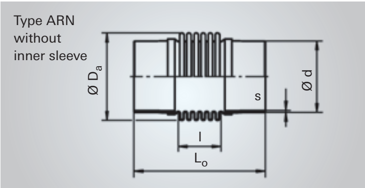
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 10...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
300	45	.0300.045.0	247	11	13	323.9	5.6
300	86	.0300.086.0	316	15.7	18.7	323.9	5.6
300	137	.0300.137.0	514	31.5	36.5	323.9	5.6
350	56	.0350.056.0	272	10.8	12.8	355.6	4
350	95	.0350.095.0	341	16.2	20.2	355.6	4
350	160	.0350.160.0	568	46.7	53.7	355.6	4
400	48	.0400.048.0	280	17.4	20.4	406.4	4
400	120	.0400.120.0	424	30.4	36.4	406.4	4
400	168	.0400.168.0	548	50.9	58.9	406.4	4
450	56	.0450.056.0	284	20	24	457	4
450	112	.0450.112.0	384	30.3	36.3	457	4
450	168	.0450.168.0	484	40.6	48.6	457	4
500	66	.0500.066.0	336	25.5	30.5	508	4
500	110	.0500.110.0	417	34.3	42.3	508	4
500	192	.0500.192.0	564	63.7	74.7	508	4
600	72	.0600.072.0	344	31.3	36.3	610	4
600	140	.0600.140.0	462	58.5	69.5	610	4
600	216	.0600.216.0	588	80.2	94.2	610	4
700	76	.0700.076.0	356	48.7	55.7	711	5
700	152	.0700.152.0	484	74.7	88.7	711	5
700	209	.0700.209.0	580	94.1	110.1	711	5

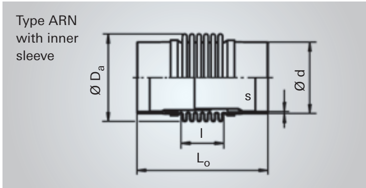
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
372	63	934.8	15	3	292	75.7	13122
372	132	934.8	30	11	215	55.8	2202
374	330	940.2	49	46	240	62.7	396
401	88	1107.4	18	4	283	87	7721
402	156.8	1110.4	30	14	225	69.3	1939
412	384	1140.1	52	58	271	85.8	400
464	96	1465.7	14	4	730	297.3	22180
464	240	1465.7	34	24	292	118.9	1420
467	364	1475.9	48	50	270	110.8	575
518	100	1843.6	13	4	706	361.3	24844
518	200	1843.6	27	16	353	180.7	3105
518	300	1843.6	40	35	235	120.4	920
575	108	2277.5	14	4	599	379	22339
573	189	2269.1	24	13	372	234.7	4518
576	336	2281.7	41	40	282	178.7	1088
679	116	3227.1	13	4	624	559.4	28583
680	234.4	3232.1	26	17	438	393	4919
681	360	3237.1	39	41	280	252.2	1338
785	128	4353.3	12	5	857	1035.8	43466
785	256	4353.3	25	18	428	517.9	5433
785	352	4353.3	34	35	311	376.6	2090

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 16... PN 16





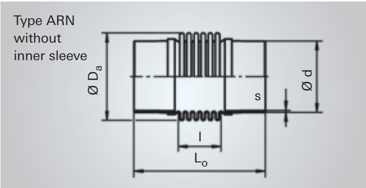
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 16...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	20	.0050.020.0	214	1	1.2	60.3	2.9
50	40	.0050.040.0	303	2	2.3	60.3	2.9
65	26	.0065.026.0	220	1.4	1.6	76.1	2.9
65	48	.0065.048.0	292	2.5	2.9	76.1	2.9
80	23	.0080.023.0	220	1.9	2.1	88.9	3.2
80	50	.0080.050.0	292	2.9	3.4	88.9	3.2
100	31	.0100.031.0	225	2.8	3.1	114.3	3.6
100	58	.0100.058.0	314	5	6	114.3	3.6
125	21	.0125.021.0	218	3.3	3.8	139.7	4
125	42	.0125.042.0	263	4.3	5	139.7	4
125	65	.0125.065.0	336	6.3	7.3	139.7	4
150	24	.0150.024.0	221	4	4.6	168.3	4
150	44	.0150.044.0	269	5.2	6.2	168.3	4
150	73	.0150.073.0	336	7.9	9.9	168.3	4
200	30	.0200.030.0	234	6.9	7.9	219.1	4.5
200	57	.0200.057.0	288	8.9	9.9	219.1	4.5
200	97	.0200.097.0	450	17.9	19.9	219.1	4.5
250	32	.0250.032.0	256	9.5	10.5	273	5
250	60	.0250.060.0	332	12.4	14.4	273	5
250	103	.0250.103.0	440	22	25	273	5

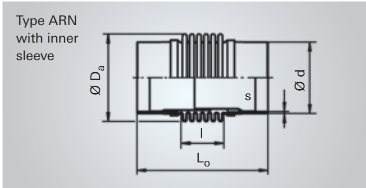
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	32	5	155	2	464
91	143	47.2	62	26	153	2	67
108	60	69.4	32	6	126	2.4	464
110	132	70.9	60	23	136	2.7	105
122	60	89.9	25	4	278	6.9	1325
123	132	90.8	54	20	150	3.8	149
153	65	142.1	29	6	174	6.9	1118
152	154	141	52	23	178	7	202
173	42	186.3	16	2	322	16.6	6489
174	87	187.5	33	8	192	10	906
174	160	187.5	49	23	180	9.4	252
204	45	265.9	15	2	316	23.4	7933
204	93	265.9	30	8	206	15.2	1212
205	160	267.4	47	22	176	13.1	351
261	54	443	15	2	479	59	13906
260	108	441.2	28	9	257	31.5	1857
262	270	444.9	48	37	276	34.1	322
319	76	676.6	13	3	603	113.3	13491
317	152	672	24	11	340	63.5	1890
320	260	678.9	40	30	300	56.5	575

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 16... PN 16





Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 16...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
300	40	.0300.040.0	268	13.9	15.9	323.9	5.6
300	75	.0300.075.0	355	21.1	24.1	323.9	5.6
300	120	.0300.120.0	529	40	45	323.9	5.6
350	40	.0350.040.0	268	13.1	15.1	355.6	4
350	88	.0350.088.0	377	23.3	27.3	355.6	4
350	130	.0350.130.0	496	39.5	46.5	355.6	4
400	48	.0400.048.0	288	22.7	25.7	406.4	5
400	96	.0400.096.0	392	34.7	40.7	406.4	5
400	132	.0400.132.0	470	43.6	51.6	406.4	5
450	52	.0450.052.0	288	26.1	30.1	457	5
450	104	.0450.104.0	392	39.9	45.9	457	5
450	143	.0450.143.0	470	50.4	58.4	457	5
500	48	.0500.048.0	312	29.2	34.2	508	5
500	90	.0500.090.0	403	49.4	57.4	508	5
500	135	.0500.135.0	490	65.5	76.5	508	5

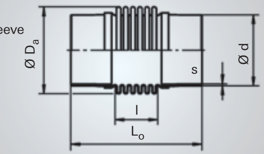
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
376	84	945.7	14	3	633	166.4	16213
375	171.2	943	26	13	426	111.5	2616
376	345	945.7	45	45	327	86	497
408	84	1128.2	13	3	690	216.1	21059
409	192.6	1131.1	28	16	370	116.1	2152
412	312	1140.1	41	37	334	105.6	746
467	104	1475.9	13	4	946	387.9	24657
467	208	1475.9	26	16	473	193.9	3082
467	286	1475.9	36	30	344	141	1186
520	104	1851.3	13	4	954	490.5	31179
520	208	1851.3	25	15	477	245.2	3897
520	286	1851.3	35	29	347	178.4	1499
579	84	2294.5	11	3	996	634.9	61867
580	174.6	2298.7	20	10	660	421.3	9501
580	261.9	2298.7	30	23	440	280.9	2815

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

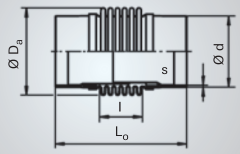
AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 25... PN 25

Type ARN without inner sleeve



Type ARN with inner sleeve



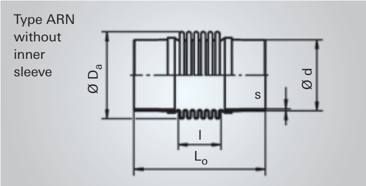
Nominal diameter	Nominal axial movement absorption[1]	Type ARN 25...	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Weld end outside diameter	Weld end wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	15	.0050.015.0	205	1	1.2	60.3	2.9
50	30	.0050.030.0	270	1.7	1.9	60.3	2.9
65	21	.0065.021.0	215	1.6	1.8	76.1	2.9
65	40	.0065.040.0	292	3	3.4	76.1	2.9
80	23	.0080.023.0	220	2.1	2.4	88.9	3.2
80	42	.0080.042.0	290	3.4	3.8	88.9	3.2
100	23	.0100.023.0	212	2.7	3	114.3	3.6
100	48	.0100.048.0	286	4.5	4.9	114.3	3.6
125	26	.0125.026.0	240	4.3	4.8	139.7	4
125	52	.0125.052.0	304	5.7	6.7	139.7	4
150	29	.0150.029.0	240	5.2	6.3	168.3	4
150	48	.0150.048.0	295	7.6	8.6	168.3	4
200	26	.0200.026.0	252	7.7	7.7	219.1	4.5
200	52	.0200.052.0	324	10.5	12.5	219.1	4.5
200	71	.0200.071.0	378	14.6	16.6	219.1	4.5
250	24	.0250.024.0	240	10.5	11.5	273	5
250	45	.0250.045.0	300	13.8	15.8	273	5
250	72	.0250.072.0	380	18.3	20.3	273	5
300	27	.0300.027.0	250	13.6	15.6	323.9	5.6
300	46	.0300.046.0	316	17.4	20.4	323.9	5.6
300	76	.0300.076.0	386	27.7	32.7	323.9	5.6

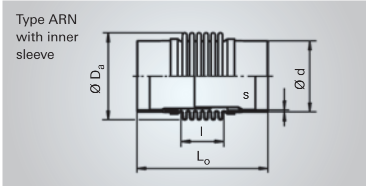
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] angular	Nominal movement absorption[1)] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88	45	45.4	24	3	199	2.5	851
91	110	47.2	46	15	199	2.6	148
111	55	71.6	27	4	219	4.4	989
113	132	73.1	54	21	175	3.6	140
125	60	92.5	26	4	267	6.9	1312
125	130	92.5	45	17	222	5.7	232
152	52	141	20	3	310	12.2	3090
153	126	142.1	43	16	198	7.8	339
177	64	191.1	21	4	350	18.6	3116
175	128	188.7	39	14	206	10.8	454
207	64	270.3	19	4	376	28.2	4737
207	119	270.3	30	10	314	23.6	1143
261	72	443	13	3	855	105.3	13961
261	144	443	25	11	428	52.6	1745
263	198	446.8	35	20	353	43.7	767
323	60	685.8	10	2	1089	207.4	39604
320	120	678.9	18	6	649	122.4	5845
319	200	676.6	29	17	414	77.8	1338
376	66	945.7	9	2	1076	282.6	44600
370	132	929.4	16	6	755	195	7693
376	201.6	945.7	26	15	545	143.3	2424

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 25... PN 25





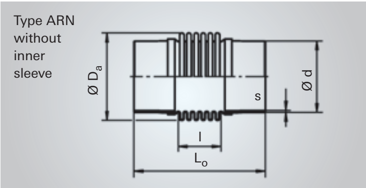
Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 25...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
350	30	.0350.030.0	256	18.2	20.2	355.6	6
350	65	.0350.065.0	352	27.5	31.5	355.6	6
350	100	.0350.100.0	438	43.8	48.8	355.6	6
400	40	.0400.040.0	309	27.9	30.9	406.4	6
400	80	.0400.080.0	434	43.4	49.4	406.4	6
400	112	.0400.112.0	562	64.8	72.8	406.4	6

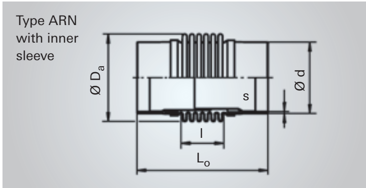
Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
413	72	1143.1	9	2	1373	436	57832
411	168	1137.1	21	10	653	206.1	5021
418	254	1158.1	33	24	458	147.4	1571
466	125	1472.5	11	4	1547	632.9	27847
466	250	1472.5	22	16	774	316.4	3481
469	378	1482.8	32	35	600	247.2	1189

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

AXIAL EXPANSION JOINTS WITH WELD ENDS

TYPE ARN 40... PN 40



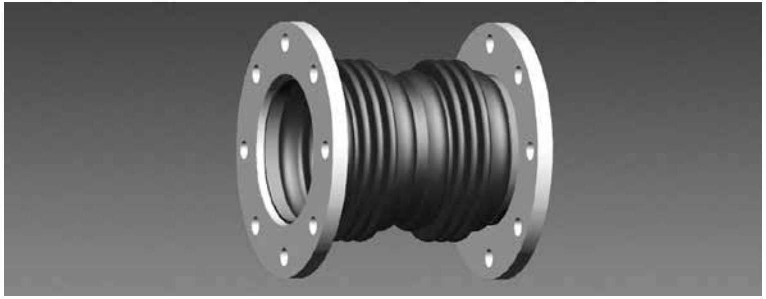


Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.		Weld end	
		ARN 40...		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	L_o	G	G	d	s
–	mm	–	mm	kg	kg	-	mm
50	11	.0050.011.0	200	1.1	1.2	60.3	2.9
50	23	.0050.023.0	248	1.5	1.7	60.3	2.9
65	18	.0065.018.0	220	2	2.2	76.1	2.9
65	32	.0065.032.0	268	2.7	3	76.1	2.9
80	17	.0080.017.0	212	2.3	2.6	88.9	3.2
80	31	.0080.031.0	264	3	3.4	88.9	3.2
100	16	.0100.016.0	225	3	3.4	114.3	3.6
100	36	.0100.036.0	329	4.6	4.9	114.3	3.6
125	24	.0125.024.0	272	5	5.3	139.7	4
125	44	.0125.044.0	363	7.8	8.8	139.7	4
150	25	.0150.025.0	261	6.5	7.5	168.3	4
150	52	.0150.052.0	427	13.9	14.9	168.3	4
200	22	.0200.022.0	260	9.9	9.9	219.1	4.5
200	44	.0200.044.0	340	14.5	16.5	219.1	4.5
200	61	.0200.061.0	400	18.2	19.2	219.1	4.5
250	21	.0250.021.0	243	13.4	14.4	273	6.3
250	49	.0250.049.0	338	23.5	25.5	273	6.3
250	70	.0250.070.0	405	29.8	32.8	273	6.3
300	24	.0300.024.0	276	20.1	22.1	323.9	7.1
300	54	.0300.054.0	391	30.8	34.8	323.9	7.1
300	77	.0300.077.0	534	47.6	53.6	323.9	7.1

Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
90	40	46.6	18	2	405	5.2	2249
91	88	47.2	35	9	248	3.3	289
113	60	73.1	23	4	384	7.8	1492
113	108	73.1	42	13	214	4.3	256
128	52	95	19	3	409	10.8	2746
125	104	92.5	34	10	278	7.1	454
150	65	138.9	14	3	792	30.6	4973
147	169	135.8	32	16	408	15.4	371
174	96	187.5	18	5	692	36	2689
175	187	188.7	33	18	467	24.5	481
209	85	273.2	16	4	805	61.1	5811
208	247	271.7	34	24	537	40.5	457
263	80	446.8	11	2	1530	189.9	20402
263	160	446.8	21	10	765	95	2550
264	220	448.6	30	19	520	64.8	921
324	63	688.1	9	2	1579	301.9	52297
326	157.5	692.8	19	9	877	168.8	4677
326	225	692.8	27	18	614	118.1	1604
378	92	951.1	8	2	2135	564	45812
377	207	948.4	18	11	1001	263.6	4230
378	350	951.1	28	28	775	204.7	1149

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

UNIVERSAL EXPANSION JOINTS WITH FLANGES TYPE UBN, UFN



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type UBN: HYDRA Universal expansion joint with loose flanges
Type UFN: HYDRA Universal expansion joint with plain fixed flanges

Standard design/Materials
Multi-ply bellows made of 1.4541
Flange made of S235JRG2 (1.0038) or P250GH (1.0460)
Operating temperature: up to 300 °C / 450 °C
Operating temperature „Low pressure (Exhaust)": up to 550 °C

Type designation (example)

UBN	06	·	0150	·	096	·	0
Type	Nominal pressure (PN6)		Nominal diameter (DN150)		Movement absorption, nominal (2δ = ±48 = 96 mm)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________
- Piping - nominal diameter DN ____________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ____________
- Max./min. allowable temperature [°C] ____________
- Test pressure PT [bar] ____________

Optional:
- Category ____________

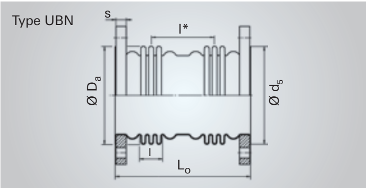
Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

Operating condition „Low pressure (Exhaust)"
Expansion joints for low pressure (exhaust-gas) are designed for unpressurized applications (PS < 0.5 bar gauge pressure).
The Pressure Equipment Directive (PED) does not apply to this operating condition.

06

UNIVERSAL EXPANSION JOINTS FOR LOW PRESSURE WITH LOOSE FLANGES

TYPE UBN 01... PN 1



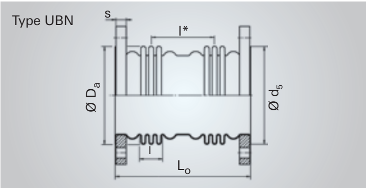
Nominal diameter	Nominal axial movement absorp-tion[1)]	Type UBN 01...	Overall length	Weight approx.	Centre-to-centre distance of bellows	Flange[2)]		
						drilling EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	L_o	G	l*	PN	d_5	s
–	mm	–	mm	kg	mm	-	mm	mm
50	56	.0050.056.0	392	3.6	257	6	90	16
65	83	.0065.083.0	432	4.7	279	6	107	16
80	95	.0080.095.0	446	7.1	280	6	122	18
100	119	.0100.119.0	466	8.2	291	6	147	18
125	144	.0125.144.0	480	10.9	286	6	178	20
150	144	.0150.144.0	493	12.3	299	6	202	20
200	160	.0200.160.0	499	17.5	285	6	258	22
250	168	.0250.168.0	499	22.3	272	6	312	24
300	196	.0300.196.0	510	29.4	269	6	365	24
350	180	.0350.180.0	534	39.9	302	6	410	26
400	156	.0400.156.0	519	51.9	266	6	465	28
450	140	.0450.140.0	523	62.5	282	6	520	30
500	136	.0500.136.0	533	67.1	310	6	570	30

Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	63	45.7	88	162	40	1	2
107	81	68.7	112	217	28	1.1	2
121	90	89.1	114	218	26	1.3	2
148	99	136.8	113	221	24	1.8	2
174	104	187.5	124	236	18	1.9	3
203	104	264.5	106	213	21	3.1	4
255	120	431.9	93	173	23	5.6	7
312	119	660.5	77	134	27	9.8	14
365	133	915.9	75	127	26	13.2	19
400	120	1104.5	65	129	27	16.8	20
458	126	1445.5	44	74	88	70.8	107
513	110	1824.7	37	68	97	98.7	135
569	92	2252.2	31	66	107	134.4	156

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

UNIVERSAL EXPANSION JOINTS WITH LOOSE FLANGES

TYPE UBN 06... PN 6



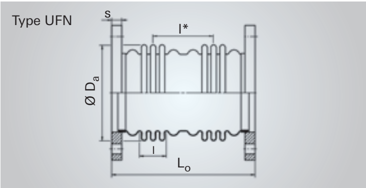
Nominal diameter	Nominal axial movement absorption[1)]	Type UBN 06...	Overall length	Weight approx.	Centre-to-centre distance of bellows	Flange[2)] drilling EN 1092	Flange[2)] rim diameter	Flange[2)] thickness
DN	$2\delta_N$	–	L_o	G	l*	PN	d_5	s
–	mm	–	mm	kg	mm	-	mm	mm
50	44	.0050.044.0	343	3.7	216	6	90	16
65	55	.0065.055.0	343	4.7	210	6	107	16
80	61	.0080.061.0	367	7.2	224	6	122	18
100	73	.0100.073.0	388	9.6	232	6	147	18
125	84	.0125.084.0	416	13	240	6	178	20
150	96	.0150.096.0	433	15	251	6	202	20
200	100	.0200.100.0	474	21.1	293	6	258	22
250	120	.0250.120.0	414	26.7	214	6	312	24
300	100	.0300.100.0	434	31.6	230	6	365	24
350	105	.0350.105.0	444	42.6	231	6	410	26
400	130	.0400.130.0	465	55.8	227	6	465	28
450	135	.0450.135.0	489	68.1	242	6	520	30
500	132	.0500.132.0	499	79.7	266	6	570	30

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] angular	Nominal movement absorption[1)] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	68	104	78	2	5
108	60	69.4	71	104	63	2.4	6
121	66	89.1	68	105	64	3.2	7
150	78	138.9	67	104	95	7.3	15
172	84	185.1	69	110	88	9	17
203	90	264.5	66	110	86	12.6	22
257	85	435.6	53	107	97	23.5	30
316	90	669.7	53	73	84	31.4	74
371	95	932.1	34	51	111	57.7	118
404	100	1116.3	33	48	115	71.4	144
461	110	1455.6	35	50	144	116.7	241
514	115	1828.5	33	51	146	148.6	270
572	100	2264.8	29	51	207	260.3	403

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

UNIVERSAL EXPANSION JOINTS FOR LOW PRESSURE WITH PLAIN FIXED FLANGES

TYPE UFN 01... PN 1



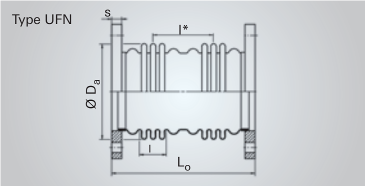
Nominal diameter	Nominal axial movement absorption[1]	Type UFN 01...	Overall length	Weight approx.	Centre-to-centre distance of bellows	Flange[2] drilling EN 1092	Flange[2] thickness
DN	$2\delta_N$	–	L_o	G	l*	PN	s
–	mm	–	mm	kg	mm	-	mm
50	56	.0050.056.0	404	3.6	257	6	16
65	83	.0065.083.0	444	4.7	279	6	16
80	95	.0080.095.0	456	7.1	280	6	18
100	119	.0100.119.0	476	8.2	291	6	18
125	144	.0125.144.0	488	11	286	6	20
150	144	.0150.144.0	501	12.4	299	6	20
200	160	.0200.160.0	512	17.6	292	6	22
250	168	.0250.168.0	524	22.5	293	6	24
300	196	.0300.196.0	514	29.5	269	6	24
350	180	.0350.180.0	536	39.9	302	6	26
400	156	.0400.156.0	517	51.5	266	6	28
450	140	.0450.140.0	521	62	282	6	30
500	136	.0500.136.0	531	66.6	310	6	30

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] angular	Nominal movement absorption[1] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	63	45.7	88	162	40	1	2
107	81	68.7	112	217	28	1.1	2
121	90	89.1	114	218	26	1.3	2
148	99	136.8	113	221	24	1.8	2
174	104	187.5	124	236	18	1.9	3
203	104	264.5	106	213	21	3.1	4
255	120	431.9	93	178	23	5.6	7
312	119	660.5	77	147	27	9.8	12
365	133	915.9	75	127	26	13.2	19
400	120	1104.5	65	129	27	16.8	20
458	126	1445.5	44	74	88	70.8	107
513	110	1824.7	37	68	97	98.7	135
569	92	2252.2	31	66	107	134.4	156

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

UNIVERSAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES

TYPE UFN 06... PN 6



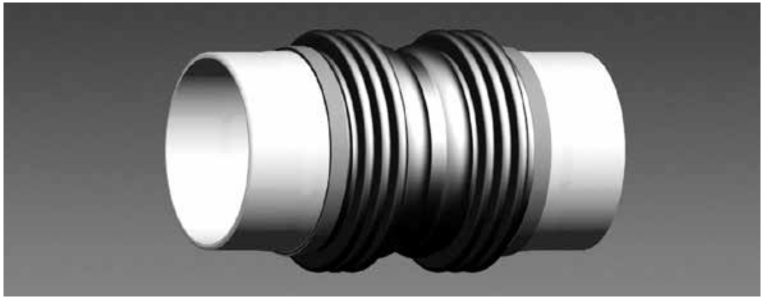
Nominal dia-meter	Nominal axial movement absorption[1)]	Type UFN 06...	Overall length	Weight approx.	Centre-to-centre bellows distance	Flange[2)]	
						drilling EN 1092	thickness
DN	$2\delta_N$	–	L_o	G	l*	PN	s
–	mm	–	mm	kg	mm	-	mm
50	44	.0050.044.0	354	3.7	216	6	16
65	55	.0065.055.0	354	4.7	210	6	16
80	61	.0080.061.0	376	7.2	224	6	18
100	73	.0100.073.0	396	9.5	232	6	18
125	84	.0125.084.0	422	12.8	240	6	20
150	96	.0150.096.0	439	14.8	251	6	20
200	100	.0200.100.0	478	20.9	293	6	22
250	120	.0250.120.0	416	26.4	214	6	24
300	100	.0300.100.0	437	31.5	230	6	24
350	105	.0350.105.0	445	42.4	231	6	26
400	130	.0400.130.0	462	55	227	6	28
450	135	.0450.135.0	486	67	242	6	30
500	132	.0500.132.0	495	77.1	266	6	30

06

Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	68	104	78	2	5
108	60	69.4	71	104	63	2.4	6
121	66	89.1	68	105	64	3.2	7
150	78	138.9	67	104	95	7.3	15
172	84	185.1	69	110	88	9	17
203	90	264.5	66	110	86	12.6	22
257	85	435.6	53	107	97	23.5	30
316	90	669.7	53	73	84	31.4	74
371	95	932.1	34	51	111	57.7	118
404	100	1116.3	33	48	115	71.4	144
461	110	1455.6	35	50	144	116.7	241
514	115	1828.5	33	51	146	148.6	270
572	100	2264.8	29	51	207	260.3	403

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

UNIVERSAL EXPANSION JOINTS WITH WELD ENDS TYPE URN



Type designation

The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example

Type URN: HYDRA Universal-expansion joint with weld ends

Standard version/materials:

Multi-ply bellow made of 1.4541
Weld ends up to DN 300: P235GH (1.0345)
Weld ends from DN 350: P265GH (1.0425)
Operating temperature: up to 400 °C
Operating temperature „Low pressure (Exhaust)“: up to 550 °C

Type designation (example)

URN	06	·	0150	·	096	·	0
Type	Nominal pressure (PN6)		Nominal diameter (DN150)		Movement absorption, nominal (2δ = ±48 = 96 mm)		Internal sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"

Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ______
- Piping - nominal diameter DN ______

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ______
- Max./min. allowable temperature [°C] ______
- Test pressure PT [bar] ______

Optional:
- Category ______

Note

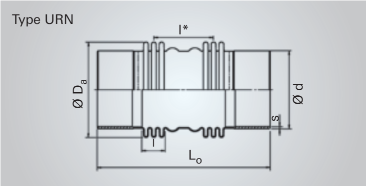
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

Operating condition „Low pressure (Exhaust)“

Expansion joints for low pressure (exhaust-gas) are designed for unpressurized applications (PS < 0.5 bar gauge pressure).
The Pressure Equipment Directive (PED) does not apply to this operating condition.

UNIVERSAL EXPANSION JOINTS FOR LOW PRESSURE WITH WELD ENDS

TYPE URN 01... PN 1



Nominal diameter	Axial Movement absorption Nominal[1]	Type URN 01...	Overall length standard type	Overall length exhaust gas	Weight approx.	Centre-to-centre distance of bellows	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	L_o	L_o	G	l*	d	s
–	mm	–	mm	mm	kg	mm	-	mm
50	56	.0050.056.0	480	480	1.4	257	60.3	2.9
65	83	.0065.083.0	520	520	2	279	76.1	2.9
80	95	.0080.095.0	530	530	2.4	280	88.9	3.2
100	119	.0100.119.0	550	550	3.4	291	114.3	3.6
125	144	.0125.144.0	566	550	4.4	286	139.7	4
150	144	.0150.144.0	579	563	5.4	299	168.3	4
200	160	.0200.160.0	592	572	7.5	292	219.1	4.5
250	168	.0250.168.0	592	572	9.7	293	273	5
300	196	.0300.196.0	586	562	12.4	269	323.9	5.6
350	180	.0350.180.0	606	582	11.4	302	355.6	4
400	156	.0400.156.0	576	552	17.4	266	406.4	4
450	140	.0450.140.0	576	552	19	282	457	4
500	136	.0500.136.0	630	602	22.7	310	508	4

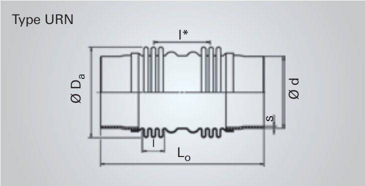
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] angular	Nominal movement absorption[1] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	63	45.7	88	162	40	1	2
107	81	68.7	112	217	28	1.1	2
121	90	89.1	114	218	26	1.3	2
148	99	136.8	113	221	24	1.8	2
174	104	187.5	124	236	18	1.9	3
203	104	264.5	106	213	21	3.1	4
255	120	431.9	93	178	23	5.6	7
312	119	660.5	77	147	27	9.8	12
365	133	915.9	75	127	26	13.2	19
400	120	1104.5	65	129	27	16.8	20
458	126	1445.5	44	74	88	70.8	107
513	110	1824.7	37	68	97	98.7	135
569	92	2252.2	31	66	107	134.4	156

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

06

UNIVERSAL EXPANSION JOINTS WITH WELD ENDS

TYPE URN 06... PN 6

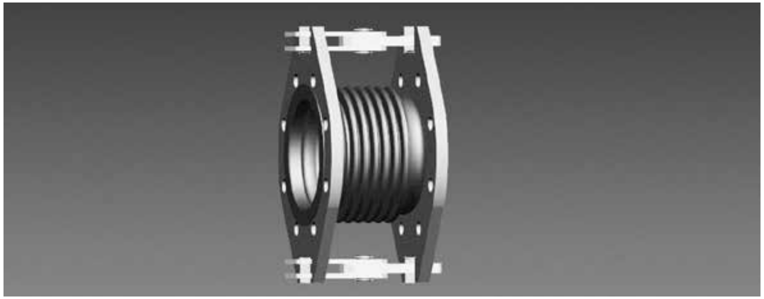


Nominal diameter	Nominal axial movement absorption[1]	Type URN 06...	Overall length	Weight approx.	Centre-to-centre distance of bellows	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	L_o	G	l*	d	s
–	mm	–	mm	kg	mm	-	mm
50	44	.0050.044.0	430	1.6	216	60.3	2.9
65	55	.0065.055.0	430	2	210	76.1	2.9
80	61	.0080.061.0	450	2.5	224	88.9	3.2
100	73	.0100.073.0	470	4.7	232	114.3	3.6
125	84	.0125.084.0	500	6.1	240	139.7	4
150	96	.0150.096.0	517	7.7	251	168.3	4
200	100	.0200.100.0	558	10.6	293	219.1	4.5
250	120	.0250.120.0	484	13.3	214	273	5
300	100	.0300.100.0	509	14.2	230	323.9	5.6
350	105	.0350.105.0	515	13.6	231	355.6	4
400	130	.0400.130.0	521	20.5	227	406.4	4
450	135	.0450.135.0	541	23.7	242	457	4
500	132	.0500.132.0	594	33.5	266	508	4

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] angular	Nominal movement absorption[1] lateral	Spring rate axial	Spring rate angular	Spring rate lateral
D_a	l	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
88.5	54	45.7	68	104	78	2	5
108	60	69.4	71	104	63	2.4	6
121	66	89.1	68	105	64	3.2	7
150	78	138.9	67	104	95	7.3	15
172	84	185.1	69	110	88	9	17
203	90	264.5	66	110	86	12.6	22
257	85	435.6	53	107	97	23.5	30
316	90	669.7	53	73	84	31.4	74
371	95	932.1	34	51	111	57.7	118
404	100	1116.3	33	48	115	71.4	144
461	110	1455.6	35	50	144	116.7	241
514	115	1828.5	33	51	146	148.6	270
572	100	2264.8	29	51	207	260.3	403

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES TYPE WBN, WBK



Type designation

The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example

Type WBN:
HYDRA single hinge angular expansion joint with loose flanges
Type WBK:
HYDRA gimbal hinge angular expansion joint with loose flanges

Standard version/materials:

Multi-ply bellows made of 1.4541
Flange made of P265GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

WBN	10	· 0150	· 360	· 0
Type	Nominal pressure (PN10)	Nominal diameter (DN150)	Movement absorption, nominal ($2\alpha = \pm 18 = 36°$)	Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"

Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________________
- Piping - nominal diameter DN ____________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar]____________________
- Max./min. allowable temperature [°C] ____________________
- Test pressure PT [bar] ____________________

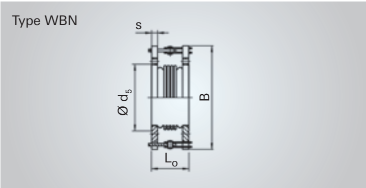
Optional:
- Category ____________________

Note

Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 06 ... PN 6



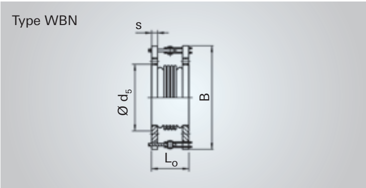
Nominal diameter	Nominal angular movement absorption	Typ WBN 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	33	.0050.330.0	124	7.2
50	41	.0050.410.0	142	7.4
65	27	.0065.270.0	115	8.4
65	39	.0065.390.0	142	8.8
80	27	.0080.270.0	123	11.2
80	38	.0080.380.0	153	11.6
100	27	.0100.270.0	128	12
100	38	.0100.380.0	161	12.4
125	30	.0125.300.0	158	15.7
125	39	.0125.390.0	186	16.2
150	23	.0150.230.0	158	16.6
150	36	.0150.360.0	214	17.7
200	23	.0200.230.0	171	22.5
200	34	.0200.340.0	228	25.1
250	18	.0250.180.0	178	28.9
250	32	.0250.320.0	250	31.7
300	19	.0300.190.0	186	38.2
300	34	.0300.340.0	275	43.1

Max. width approx.	Flange[2]			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
244	6	90	16	0.4	1.2	0
244	6	90	16	0.4	0.9	0
279	6	107	16	0.6	1.9	0
279	6	107	16	0.6	1.2	0.1
304	6	122	18	0.8	2.3	0.1
304	6	122	18	0.8	1.5	0.2
319	6	147	18	1.3	3.3	0.2
319	6	147	18	1.3	2.3	0.3
349	6	178	20	1.8	6	0.3
349	6	178	20	1.8	4.3	0.5
364	6	202	20	2.6	8.6	0.5
364	6	202	20	2.6	4.8	0.9
419	6	258	22	4.3	13.3	1
419	6	258	22	4.3	14.7	1.7
469	6	312	24	6.6	39.2	1.3
469	6	312	24	6.6	19.6	2.7
559	6	365	24	9.3	47.4	2.1
559	6	365	24	9.2	33.6	4.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 06 ... PN 6



06

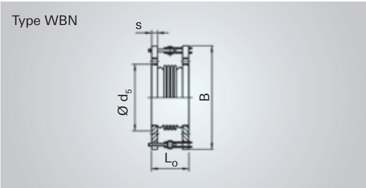
Nominal diameter	Nominal angular movement absorption	Typ WBN 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
350	18	.0350.180.0	194	61.2
350	34	.0350.340.0	309	69.6
400	13	.0400.130.0	211	67.9
400	27	.0400.270.0	343	77.1
450	13	.0450.130.0	215	76.5
450	24	.0450.240.0	330	85.1
500	14	.0500.140.0	224	85.5
500	26	.0500.260.0	349	98.3
600	13	.0600.130.0	254	155.4
600	25	.0600.250.0	394	173.9
700	14	.0700.140.0	282	177.6
700	25	.0700.250.0	444	220.9
800	11	.0800.110.0	296	242.9
800	23	.0800.230.0	494	286.6

Max. width approx.	Flange[2)]			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
654	6	410	26	19.9	65.3	2.7
654	6	410	26	20	34.6	6.3
674	6	465	28	26.2	145.9	3.7
674	6	465	28	26.2	58.3	9.2
734	6	520	28	32.9	185.7	4.8
734	6	520	28	32.8	86.3	10.9
794	6	570	28	40.7	260.3	6.5
794	6	570	28	40.7	115.7	14.7
964	6	670	37	77.2	370.2	10.4
964	6	670	37	76.7	192.2	23.3
1064	6	775	37	103.2	490.6	17.4
1064	6	775	37	104.1	307.4	37.7
1184	6	880	43	134.9	1002.4	21.5
1184	6	880	43	134.9	401	53.7

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 10 ... PN 10



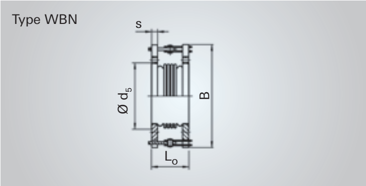
Nominal diameter	Nominal angular movement absorption	Typ WBN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	31	.0050.310.0	130	10
50	37	.0050.370.0	148	10.2
65	26	.0065.260.0	123	11.4
65	37	.0065.370.0	159	12
80	25	.0080.250.0	133	12.7
80	36	.0080.360.0	166	13.2
100	26	.0100.260.0	142	15.3
100	36	.0100.360.0	174	16.4
125	25	.0125.250.0	162	18
125	34	.0125.340.0	205	19.5
150	23	.0150.230.0	172	22.9
150	36	.0150.360.0	232	24.4
200	22	.0200.220.0	181	29.2
200	32	.0200.320.0	233	31.6
250	18	.0250.180.0	182	46.6
250	30	.0250.300.0	263	51.5
300	23	.0300.230.0	226	60.1
300	29	.0300.290.0	270	63

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	10	92	19	0.4	1.2	0
269	10	92	19	0.4	0.9	0
289	10	107	20	0.6	1.9	0
289	10	107	20	0.6	1.8	0.1
304	10	122	20	0.8	3.8	0.1
304	10	122	20	0.8	2.4	0.2
329	10	147	22	1.3	4.9	0.2
329	10	147	22	1.3	6.3	0.3
349	10	178	22	1.8	6	0.3
349	10	178	22	1.8	6.8	0.6
379	10	208	24	2.6	15.1	0.5
379	10	208	24	2.6	8.4	1
444	10	258	24	4.3	23.5	1
444	10	258	24	4.3	16.8	1.7
544	10	320	26	11.9	47.2	1.3
544	10	320	26	11.9	29.9	2.9
594	10	370	28	16.9	60	2.9
594	10	370	28	16.7	53.6	4.1

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 10 ... PN 10



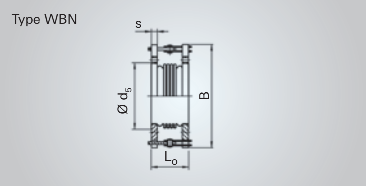
Nominal diameter	Nominal angular movement absorption	Typ WBN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
350	17	.0350.170.0	203	68.8
350	26	.0350.260.0	277	76.2
400	12	.0400.120.0	230	92.5
400	26	.0400.260.0	374	108.8
450	13	.0450.130.0	244	118.8
450	25	.0450.250.0	369	134.4
500	14	.0500.140.0	252	150.3
500	25	.0500.250.0	387	172.1
600	12	.0600.120.0	272	197.1
600	23	.0600.230.0	417	221.7

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
654	10	410	28	19.9	87	2.8
654	10	410	28	20	65.5	5.1
704	10	465	32	26.3	297.3	4
704	10	465	32	26.3	118.9	10.2
794	10	520	37	33.1	361.3	5.3
794	10	520	37	33.1	160.6	12
864	10	570	37	54.5	394.4	7.1
864	10	570	37	54.5	175.3	16
974	10	670	43	77.3	581.2	10.8
974	10	670	43	76.8	302.5	24.2

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 16 ... PN 16



06

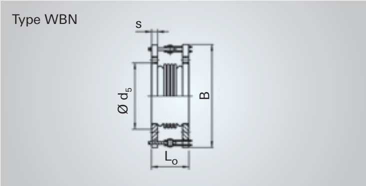
Nominal diameter	Nominal angular movement absorption	Typ WBN 16...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	25	.0050.250.0	122	10
50	34	.0050.340.0	149	10.4
65	25	.0065.250.0	129	11.6
65	34	.0065.340.0	168	12.5
80	23	.0080.230.0	139	13.1
80	32	.0080.320.0	175	13.7
100	24	.0100.240.0	148	15.8
100	33	.0100.330.0	187	16.6
125	24	.0125.240.0	163	19
125	33	.0125.330.0	214	20.5
150	22	.0150.220.0	172	23.4
150	31	.0150.310.0	226	25.2
200	22	.0200.220.0	192	43.4
200	31	.0200.310.0	246	46.4
250	14	.0250.140.0	212	54.5
250	23	.0250.230.0	289	61.5
300	15	.0300.150.0	239	77.7
300	22	.0300.220.0	323	84.4
350	12	.0350.120.0	218	98.6
350	19	.0350.190.0	302	105.6

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	16	92	19	0.4	2.2	0
269	16	92	19	0.4	1.4	0
289	16	107	20	0.6	2.9	0.1
289	16	107	20	0.7	3.3	0.1
304	16	122	20	0.8	6.9	0.1
304	16	122	20	0.8	4.3	0.2
329	16	147	22	1.3	8.8	0.2
329	16	147	22	1.3	5.5	0.4
359	16	178	22	1.8	10.8	0.3
359	16	178	22	1.8	8.1	0.6
389	16	208	24	2.6	17.6	0.5
389	16	208	24	2.6	12.3	0.9
494	16	258	26	7.9	37.8	1.1
494	16	258	26	7.8	27.1	1.8
544	16	320	29	12.1	95.9	1.8
544	16	320	29	12.1	67.2	3.3
594	16	375	37	16.9	147.3	2.8
594	16	375	37	16.8	86.2	5.1
694	16	410	37	20.3	216.1	2.7
694	16	410	37	20	132.8	5.4

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

SINGLE HINGE VERSION TYPE WBN 25 ... PN 25



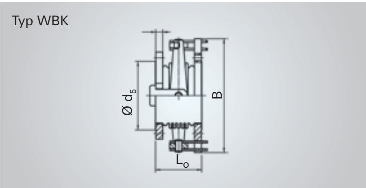
Nominal diameter	Nominal angular movement absorption	Typ WBN 25...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	22	.0050.220.0	130	10.7
50	30	.0050.300.0	160	11.1
65	23	.0065.230.0	139	12.9
65	30	.0065.300.0	172	13.4
80	22	.0080.220.0	148	15.4
80	28	.0080.280.0	172	15.8
100	22	.0100.220.0	153	18.5
100	27	.0100.270.0	179	19
125	22	.0125.220.0	183	24.3
125	29	.0125.290.0	231	25.7
150	20	.0150.200.0	187	41.4
150	27	.0150.270.0	235	43.6
200	14	.0200.140.0	204	53.5
200	22	.0200.220.0	277	59.4
250	14	.0250.140.0	235	74.4
250	20	.0250.200.0	295	79.1
300	14	.0300.140.0	264	125.3
300	19	.0300.190.0	345	131.2
350	11	.0350.110.0	277	167.5
350	18	.0350.180.0	325	174.1

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	25	92	20	0.4	4.2	0
269	25	92	20	0.4	2.6	0.1
289	25	107	22	0.7	5.3	0.1
289	25	107	22	0.7	3.3	0.1
304	25	122	24	0.9	8.3	0.1
304	25	122	24	0.9	5.9	0.2
334	25	147	24	1.3	10.6	0.2
334	25	147	24	1.3	9.9	0.3
359	25	178	26	1.8	18.7	0.4
359	25	178	26	1.8	11.7	0.6
454	25	208	28	4.7	28.3	0.6
454	25	208	28	4.7	20.7	0.9
494	25	258	32	7.9	84.2	1.1
494	25	258	32	8	56.9	2
559	25	320	37	12.2	146.9	1.9
559	25	320	37	12.1	97.3	3.1
664	25	375	43	22.6	257.9	3.1
664	25	375	43	22.3	130	5.3
744	25	410	47	27.3	274.6	3.9
744	25	410	47	27.2	216.7	5.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

GIMBAL HINGE VERSION TYPE WBK 06 ... PN 6

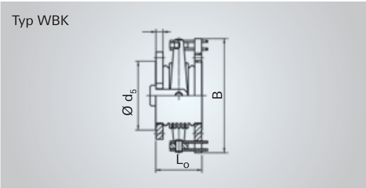


06

Nominal diameter	Nominal angular movement absorption	Typ WBK 06...	Overall length	Weight approx.	Max. width approx.	Flange[2]			Spring rate		
						drilling DIN 1092	rim diameter	thickness			
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	33	.0050.330.0	124	11.3	244	6	90	16	0.4	1.2	0
50	41	.0050.410.0	142	11.5	244	6	90	16	0.4	0.9	0
65	27	.0065.270.0	115	13.2	279	6	107	16	0.6	1.9	0
65	39	.0065.390.0	142	13.5	279	6	107	16	0.6	1.2	0.1
80	27	.0080.270.0	123	16.4	304	6	122	18	0.8	2.3	0.1
80	38	.0080.380.0	153	16.8	304	6	122	18	0.8	1.5	0.2
100	27	.0100.270.0	128	17.5	319	6	147	18	1.3	3.3	0.2
100	38	.0100.380.0	161	17.9	319	6	147	18	1.3	2.3	0.3
125	30	.0125.300.0	158	21.9	349	6	178	20	1.8	6	0.3
125	39	.0125.390.0	186	22.3	349	6	178	20	1.8	4.3	0.5
150	23	.0150.230.0	158	23	364	6	202	20	2.6	8.6	0.5
150	36	.0150.360.0	214	24.1	364	6	202	20	2.6	4.8	0.9
200	23	.0200.230.0	171	32.1	419	6	258	22	4.3	13.3	1
200	34	.0200.340.0	228	34.8	419	6	258	22	4.3	14.7	1.7
250	18	.0250.180.0	178	40.4	469	6	312	24	6.6	39.2	1.3
250	32	.0250.320.0	250	43.2	469	6	312	24	6.6	19.6	2.7
300	34	.0300.340.0	275	60.7	559	6	365	24	9.2	33.6	4.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES GIMBAL HINGE VERSION TYPE WBK 06 ... PN 6

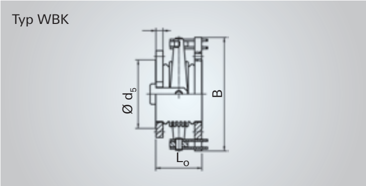


Nominal diameter	Nominal angular movement absorption	Typ WBK 06...	Overall length	Weight approx.	Max. width approx.	Flange[2)] drilling DIN 1092	Flange[2)] rim diameter	Flange[2)] thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
350	34	.0350.340.0	309	100.5	654	6	410	26	20	34.6	6.3
400	27	.0400.270.0	343	113.6	674	6	465	28	26.2	58.3	9.2
450	24	.0450.240.0	330	131.5	734	6	520	28	32.8	86.3	10.9
500	26	.0500.260.0	349	157.8	794	6	570	28	40.7	115.7	14.7
600	25	.0600.250.0	394	287.9	964	6	670	37	76.7	192.2	23.3
700	25	.0700.250.0	444	376.1	1064	6	775	37	104.1	307.4	37.7
800	23	.0800.230.0	494	492.3	1184	6	880	43	134.9	401	53.7

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

GIMBAL HINGE VERSION TYPE WBK 10 ... PN 10



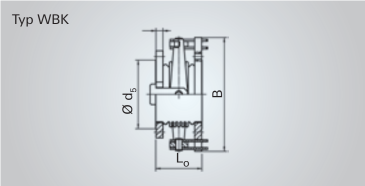
Nominal diameter	Nominal angular movement absorption	Typ WBK 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	31	.0050.310.0	130	14.6
50	37	.0050.370.0	148	14.8
65	26	.0065.260.0	123	16.4
65	37	.0065.370.0	159	17
80	25	.0080.250.0	133	18
80	36	.0080.360.0	166	18.4
100	26	.0100.260.0	142	21
100	36	.0100.360.0	174	22.1
125	25	.0125.250.0	162	24.1
125	34	.0125.340.0	205	25.6
150	23	.0150.230.0	172	31.5
150	36	.0150.360.0	232	33.1
200	22	.0200.220.0	181	40
200	32	.0200.320.0	233	42.4
250	18	.0250.180.0	182	69.7
250	30	.0250.300.0	263	74.6
300	29	.0300.290.0	270	93.6
350	26	.0350.260.0	277	115.9
400	26	.0400.260.0	374	159.6
450	25	.0450.250.0	369	190.2
500	25	.0500.250.0	387	276.5
600	23	.0600.230.0	417	369.7

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	10	92	19	0.4	1.2	0
269	10	92	19	0.4	0.9	0
289	10	107	20	0.6	1.9	0
289	10	107	20	0.6	1.8	0.1
304	10	122	20	0.8	3.8	0.1
304	10	122	20	0.8	2.4	0.2
329	10	147	22	1.3	4.9	0.2
329	10	147	22	1.3	6.3	0.3
349	10	178	22	1.8	6	0.3
349	10	178	22	1.8	6.8	0.6
379	10	208	24	2.6	15.1	0.5
379	10	208	24	2.6	8.4	1
444	10	258	24	4.3	23.5	1
444	10	258	24	4.3	16.8	1.7
544	10	320	26	11.9	47.2	1.3
544	10	320	26	11.9	29.9	2.9
594	10	370	28	16.7	53.6	4.1
654	10	410	28	20	65.5	5.1
704	10	465	32	26.3	118.9	10.2
794	10	520	37	33.1	160.6	12
864	10	570	37	54.5	175.3	16
974	10	670	43	76.8	302.5	24.2

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

GIMBAL HINGE VERSION TYPE WBK 16 ... PN 16

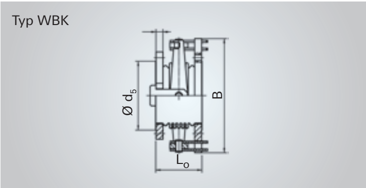


Nominal diameter	Nominal angular movement absorption	Typ WBK 16...	Overall length	Weight approx.	Max. width approx.	Flange 2)			Spring rate		
						drilling DIN 1092	rim diameter	thickness			
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	25	.0050.250.0	122	14.6	269	16	92	19	0.4	2.2	0
50	34	.0050.340.0	149	14.9	269	16	92	19	0.4	1.4	0
65	25	.0065.250.0	129	16.6	289	16	107	20	0.6	2.9	0.1
65	34	.0065.340.0	168	17.4	289	16	107	20	0.7	3.3	0.1
80	23	.0080.230.0	139	18.4	304	16	122	20	0.8	6.9	0.1
80	32	.0080.320.0	175	19	304	16	122	20	0.8	4.3	0.2
100	24	.0100.240.0	148	22.1	329	16	147	22	1.3	8.8	0.2
100	33	.0100.330.0	187	22.9	329	16	147	22	1.3	5.5	0.4
125	24	.0125.240.0	163	27.2	359	16	178	22	1.8	10.8	0.3
125	33	.0125.330.0	214	28.7	359	16	178	22	1.8	8.1	0.6
150	22	.0150.220.0	172	34.3	389	16	208	24	2.6	17.6	0.5
150	31	.0150.310.0	226	36.2	389	16	208	24	2.6	12.3	0.9
200	22	.0200.220.0	192	63	494	16	258	26	7.9	37.8	1.1
200	31	.0200.310.0	246	66.1	494	16	258	26	7.8	27.1	1.8
250	14	.0250.140.0	212	83.6	544	16	320	29	12.1	95.9	1.8
250	23	.0250.230.0	289	90.5	544	16	320	29	12.1	67.2	3.3
300	22	.0300.220.0	323	122.9	594	16	375	37	16.8	86.2	5.1
350	19	.0350.190.0	302	160.3	694	16	410	37	20	132.8	5.4

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH LOOSE FLANGES

GIMBAL HINGE VERSION TYPE WBK 25 ... PN 25

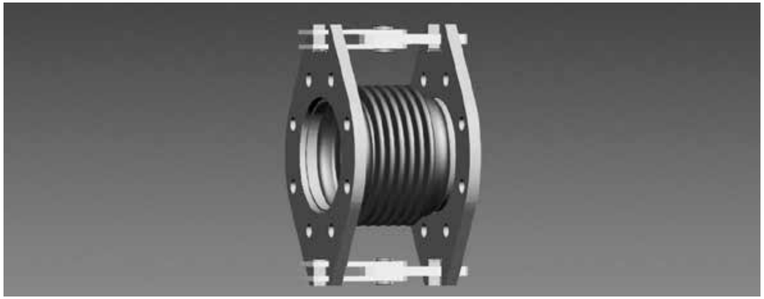


06

Nominal diameter	Nominal angular movement absorption	Typ WBK 25...	Overall length	Weight approx.	Max. width approx.	Flange[2)] drilling DIN 1092	Flange[2)] rim diameter	Flange[2)] thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	22	.0050.220.0	130	15.3	269	25	92	20	0.4	4.2	0
50	30	.0050.300.0	160	15.7	269	25	92	20	0.4	2.6	0.1
65	23	.0065.230.0	139	17.8	289	25	107	22	0.7	5.3	0.1
65	30	.0065.300.0	172	18.4	289	25	107	22	0.7	3.3	0.1
80	22	.0080.220.0	148	21.1	304	25	122	24	0.9	8.3	0.1
80	28	.0080.280.0	172	21.6	304	25	122	24	0.9	5.9	0.2
100	22	.0100.220.0	153	26.6	334	25	147	24	1.3	10.6	0.2
100	27	.0100.270.0	179	27.1	334	25	147	24	1.3	9.9	0.3
125	22	.0125.220.0	183	34.4	359	25	178	26	1.8	18.7	0.4
125	29	.0125.290.0	231	35.8	359	25	178	26	1.8	11.7	0.6
150	20	.0150.200.0	187	59.4	454	25	208	28	4.7	28.3	0.6
150	27	.0150.270.0	235	61.6	454	25	208	28	4.7	20.7	0.9
200	14	.0200.140.0	204	77.6	494	25	258	32	7.9	84.2	1.1
200	22	.0200.220.0	277	83.4	494	25	258	32	8	56.9	2
250	20	.0250.200.0	295	116.4	559	25	320	37	12.1	97.3	3.1
300	19	.0300.190.0	345	199	664	25	375	43	22.3	130	5.3
350	18	.0350.180.0	349	269.1	744	25	410	47	27.2	189.7	6.3

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES TYPE WFN, WFK



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type WFN:
HYDRA single hinge angular expansion joint with plain fixed flanges
Type WFK:
HYDRA gimbal hinge angular expansion joint with plain fixed flanges

Standard version/materials:
Multi-ply bellows made of 1.4541
Flange made of P265GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

WFN	10	·	0150	·	360	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal ($2\alpha = \pm 18 = 36°$)		Inner sleeve (0 = without., 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ______________________
- Piping - nominal diameter DN ______________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

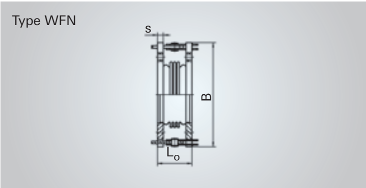
Design data:
- Max. allowable pressure [bar]______________________
- Max./min. allowable temperature [°C] ______________________
- Test pressure PT [bar] ______________________

Optional:
- Category ______________________

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 06 ... PN 6



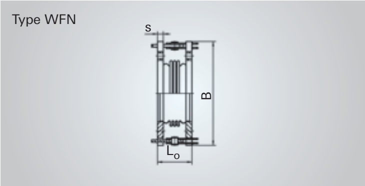
06

Nominal diameter	Nominal angular movement absorption	Typ WFN 06...	Overall length	Weight approx.	Max. width approx.	Flange 2) drilling DIN 1092	Flange 2) rim diameter	Flange 2) thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	33	.0050.330.0	124	7.2	244	6	90	16	0.4	1.2	0
50	41	.0050.410.0	142	7.4	244	6	90	16	0.4	0.9	0
65	27	.0065.270.0	115	8.4	279	6	107	16	0.6	1.9	0
65	39	.0065.390.0	142	8.8	279	6	107	16	0.6	1.2	0.1
80	27	.0080.270.0	123	11.2	304	6	122	18	0.8	2.3	0.1
80	38	.0080.380.0	153	11.6	304	6	122	18	0.8	1.5	0.2
100	27	.0100.270.0	128	12	319	6	147	18	1.3	3.3	0.2
100	38	.0100.380.0	161	12.4	319	6	147	18	1.3	2.3	0.3
125	30	.0125.300.0	158	15.7	349	6	178	20	1.8	6	0.3
125	39	.0125.390.0	186	16.2	349	6	178	20	1.8	4.3	0.5
150	23	.0150.230.0	158	16.6	364	6	202	20	2.6	8.6	0.5
150	36	.0150.360.0	214	17.7	364	6	202	20	2.6	4.8	0.9
200	23	.0200.230.0	171	22.5	419	6	258	22	4.3	13.3	1
200	34	.0200.340.0	228	25.1	419	6	258	22	4.3	14.7	1.7
250	18	.0250.180.0	178	28.9	469	6	312	24	6.6	39.2	1.3
250	32	.0250.320.0	250	31.7	469	6	312	24	6.6	19.6	2.7
300	19	.0300.190.0	186	38.2	559	6	365	24	9.3	47.4	2.1
300	34	.0300.340.0	275	43.1	559	6	365	24	9.2	33.6	4.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 06 ... PN 6



06

Nominal diameter	Nominal angular movement absorption	Typ WFN 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
350	18	.0350.180.0	194	61.2
350	34	.0350.340.0	309	69.6
400	13	.0400.130.0	211	67.9
400	27	.0400.270.0	343	77.1
450	13	.0450.130.0	215	76.5
450	24	.0450.240.0	330	85.1
500	14	.0500.140.0	224	85.5
500	26	.0500.260.0	349	98.3
600	13	.0600.130.0	254	155.4
600	25	.0600.250.0	394	173.9
700	14	.0700.140.0	282	177.6
700	25	.0700.250.0	444	220.9
800	11	.0800.110.0	296	242.9
800	23	.0800.230.0	494	286.6

06

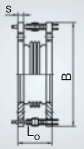
Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
654	6	410	26	19.9	65.3	2.7
654	6	410	26	20	34.6	6.3
674	6	465	28	26.2	145.9	3.7
674	6	465	28	26.2	58.3	9.2
734	6	520	28	32.9	185.7	4.8
734	6	520	28	32.8	86.3	10.9
794	6	570	28	40.7	260.3	6.5
794	6	570	28	40.7	115.7	14.7
964	6	670	37	77.2	370.2	10.4
964	6	670	37	76.7	192.2	23.3
1064	6	775	37	103.2	490.6	17.4
1064	6	775	37	104.1	307.4	37.7
1184	6	880	43	134.9	1002.4	21.5
1184	6	880	43	134.9	401	53.7

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 10 ... PN 10

Type WFN



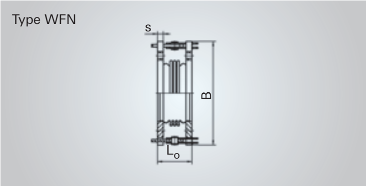
Nominal diameter	Nominal angular movement absorption	Typ WFN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	31	.0050.310.0	130	10
50	37	.0050.370.0	148	10.2
65	26	.0065.260.0	123	11.4
65	37	.0065.370.0	159	12
80	25	.0080.250.0	133	12.7
80	36	.0080.360.0	166	13.2
100	26	.0100.260.0	142	15.3
100	36	.0100.360.0	174	16.4
125	25	.0125.250.0	162	18
125	34	.0125.340.0	205	19.5
150	23	.0150.230.0	172	22.9
150	36	.0150.360.0	232	24.4
200	22	.0200.220.0	181	29.2
200	32	.0200.320.0	233	31.6
250	18	.0250.180.0	182	46.6
250	30	.0250.300.0	263	51.5
300	23	.0300.230.0	226	60.1
300	29	.0300.290.0	270	63

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	10	92	19	0.4	1.2	0
269	10	92	19	0.4	0.9	0
289	10	107	20	0.6	1.9	0
289	10	107	20	0.6	1.8	0.1
304	10	122	20	0.8	3.8	0.1
304	10	122	20	0.8	2.4	0.2
329	10	147	22	1.3	4.9	0.2
329	10	147	22	1.3	6.3	0.3
349	10	178	22	1.8	6	0.3
349	10	178	22	1.8	6.8	0.6
379	10	208	24	2.6	15.1	0.5
379	10	208	24	2.6	8.4	1
444	10	258	24	4.3	23.5	1
444	10	258	24	4.3	16.8	1.7
544	10	320	26	11.9	47.2	1.3
544	10	320	26	11.9	29.9	2.9
594	10	370	28	16.9	60	2.9
594	10	370	28	16.7	53.6	4.1

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 10 ... PN 10



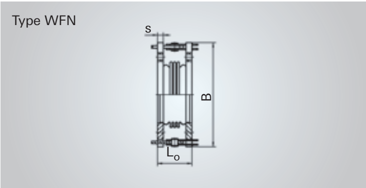
Nominal diameter	Nominal angular movement absorption	Typ WFN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
350	17	.0350.170.0	203	68.8
350	26	.0350.260.0	277	76.2
400	12	.0400.120.0	230	92.5
400	26	.0400.260.0	374	108.8
450	13	.0450.130.0	244	118.8
450	25	.0450.250.0	369	134.4
500	14	.0500.140.0	252	150.3
500	25	.0500.250.0	387	172.1
600	12	.0600.120.0	272	197.1
600	23	.0600.230.0	417	221.7

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
654	10	410	28	19.9	87	2.8
654	10	410	28	20	65.5	5.1
704	10	465	32	26.3	297.3	4
704	10	465	32	26.3	118.9	10.2
794	10	520	37	33.1	361.3	5.3
794	10	520	37	33.1	160.6	12
864	10	570	37	54.5	394.4	7.1
864	10	570	37	54.5	175.3	16
974	10	670	43	77.3	581.2	10.8
974	10	670	43	76.8	302.5	24.2

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 16 ... PN 16



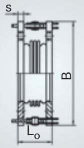
Nominal diameter	Nominal angular movement absorption	Typ WFN 16...	Overall length	Weight approx.	Max. width approx.	Flange 2) drilling DIN 1092	Flange 2) rim diameter	Flange 2) thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	25	.0050.250.0	122	10	269	16	92	19	0.4	2.2	0
50	34	.0050.340.0	149	10.4	269	16	92	19	0.4	1.4	0
65	25	.0065.250.0	129	11.6	289	16	107	20	0.6	2.9	0.1
65	34	.0065.340.0	168	12.5	289	16	107	20	0.7	3.3	0.1
80	23	.0080.230.0	139	13.1	304	16	122	20	0.8	6.9	0.1
80	32	.0080.320.0	175	13.7	304	16	122	20	0.8	4.3	0.2
100	24	.0100.240.0	148	15.8	329	16	147	22	1.3	8.8	0.2
100	33	.0100.330.0	187	16.6	329	16	147	22	1.3	5.5	0.4
125	24	.0125.240.0	163	19	359	16	178	22	1.8	10.8	0.3
125	33	.0125.330.0	214	20.5	359	16	178	22	1.8	8.1	0.6
150	22	.0150.220.0	172	23.4	389	16	208	24	2.6	17.6	0.5
150	31	.0150.310.0	226	25.2	389	16	208	24	2.6	12.3	0.9
200	22	.0200.220.0	192	43.4	494	16	258	26	7.9	37.8	1.1
200	31	.0200.310.0	246	46.4	494	16	258	26	7.8	27.1	1.8
250	14	.0250.140.0	212	54.5	544	16	320	29	12.1	95.9	1.8
250	23	.0250.230.0	289	61.5	544	16	320	29	12.1	67.2	3.3
300	15	.0300.150.0	239	77.7	594	16	375	37	16.9	147.3	2.8
300	22	.0300.220.0	323	84.4	594	16	375	37	16.8	86.2	5.1
350	12	.0350.120.0	218	98.6	694	16	410	37	20.3	216.1	2.7
350	19	.0350.190.0	302	105.6	694	16	410	37	20	132.8	5.4

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

SINGLE HINGE VERSION TYPE WFN 25 ... PN 25

Type WFN



06

Nominal diameter	Nominal angular movement absorption	Typ WFN 25...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	22	.0050.220.0	130	10.7
50	30	.0050.300.0	160	11.1
65	23	.0065.230.0	139	12.9
65	30	.0065.300.0	172	13.4
80	22	.0080.220.0	148	15.4
80	28	.0080.280.0	172	15.8
100	22	.0100.220.0	153	18.5
100	27	.0100.270.0	179	19
125	22	.0125.220.0	183	24.3
125	29	.0125.290.0	231	25.7
150	20	.0150.200.0	187	41.4
150	27	.0150.270.0	235	43.6
200	14	.0200.140.0	204	53.5
200	22	.0200.220.0	277	59.4
250	14	.0250.140.0	235	74.4
250	20	.0250.200.0	295	79.1
300	14	.0300.140.0	264	125.3
300	19	.0300.190.0	345	131.2
350	11	.0350.110.0	277	167.5
350	18	.0350.180.0	325	174.1

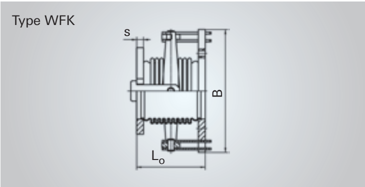
06

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
269	25	92	20	0.4	4.2	0
269	25	92	20	0.4	2.6	0.1
289	25	107	22	0.7	5.3	0.1
289	25	107	22	0.7	3.3	0.1
304	25	122	24	0.9	8.3	0.1
304	25	122	24	0.9	5.9	0.2
334	25	147	24	1.3	10.6	0.2
334	25	147	24	1.3	9.9	0.3
359	25	178	26	1.8	18.7	0.4
359	25	178	26	1.8	11.7	0.6
454	25	208	28	4.7	28.3	0.6
454	25	208	28	4.7	20.7	0.9
494	25	258	32	7.9	84.2	1.1
494	25	258	32	8	56.9	2
559	25	320	37	12.2	146.9	1.9
559	25	320	37	12.1	97.3	3.1
664	25	375	43	22.6	257.9	3.1
664	25	375	43	22.3	130	5.3
744	25	410	47	27.3	274.6	3.9
744	25	410	47	27.2	216.7	5.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

GIMBAL HINGE VERSION TYPE WFK 06 ... PN 6

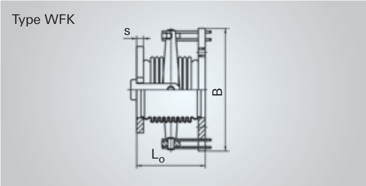


Nominal diameter	Nominal angular movement absorption	Typ WFK 06...	Overall length	Weight approx.	Max. width approx.	Flange [2]			Spring rate		
						drilling DIN 1092	rim diameter	thickness			
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	33	.0050.330.0	138	11.4	244	6	16	0.4	1.2	0	0
50	41	.0050.410.0	156	11.6	244	6	16	0.4	0.9	0	0
65	27	.0065.270.0	129	13.3	279	6	16	0.6	1.9	0	0
65	39	.0065.390.0	156	13.7	279	6	16	0.6	1.2	0.1	0.1
80	27	.0080.270.0	136	16.5	304	6	18	0.8	2.3	0.1	0.1
80	38	.0080.380.0	166	16.9	304	6	18	0.8	1.5	0.2	0.2
100	27	.0100.270.0	141	17.6	319	6	18	1.3	3.3	0.2	0.2
100	38	.0100.380.0	174	18	319	6	18	1.3	2.3	0.3	0.3
125	30	.0125.300.0	168	21.8	349	6	20	1.8	6	0.3	0.3
125	39	.0125.390.0	196	22.3	349	6	20	1.8	4.3	0.5	0.5
150	23	.0150.230.0	168	23	364	6	20	2.6	8.6	0.5	0.5
150	36	.0150.360.0	224	24.1	364	6	20	2.6	4.8	0.9	0.9
200	23	.0200.230.0	180	32	419	6	22	4.3	13.3	1	1
200	34	.0200.340.0	236	34.5	419	6	22	4.3	14.7	1.7	1.7
250	18	.0250.180.0	184	39.9	469	6	24	6.6	39.2	1.3	1.3
250	32	.0250.320.0	256	42.7	469	6	24	6.6	19.6	2.7	2.7
300	34	.0300.340.0	280	60	559	6	24	9.2	33.6	4.5	4.5

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

GIMBAL HINGE VERSION TYPE WFK 06 ... PN 6

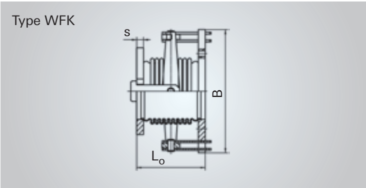


Nominal diameter	Nominal angular movement absorption	Typ WFK 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
350	34	.0350.340.0	312	99.4
400	27	.0400.270.0	340	112.3
450	24	.0450.240.0	327	130
500	26	.0500.260.0	345	155.5
600	25	.0600.250.0	390	284.4
700	25	.0700.250.0	438	369.9
800	23	.0800.230.0	488	484.2

Max. width approx.	Flange 2)			Spring rate		
	drilling DIN 1092	rim diameter	thickness			
B	PN	d_5	s	c_r	c_α	c_p
mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
654	6	26	20	34.6	6.3	6.3
674	6	28	26.2	58.3	9.2	9.2
734	6	28	32.8	86.3	10.9	10.9
794	6	28	40.7	115.7	14.7	14.7
964	6	37	76.7	192.2	23.3	23.3
1064	6	37	104.1	307.4	37.7	37.7
1184	6	43	134.9	401	53.7	53.7

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES GIMBAL HINGE VERSION TYPE WFK 10 ... PN 10



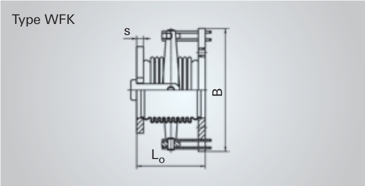
06

Nominal diameter	Nominal angular movement absorption	Typ WFK 10...	Overall length	Weight approx.	Max. width approx.	Flange[2)] drilling DIN 1092	rim diameter	thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	31	.0050.310.0	141	14.7	269	10	19	0.4	1.2	0	0
50	37	.0050.370.0	159	14.9	269	10	19	0.4	0.9	0	0
65	26	.0065.260.0	133	16.5	289	10	20	0.6	1.9	0	0
65	37	.0065.370.0	168	17	289	10	20	0.6	1.8	0.1	0.1
80	25	.0080.250.0	143	18	304	10	20	0.8	3.8	0.1	0.1
80	36	.0080.360.0	176	18.5	304	10	20	0.8	2.4	0.2	0.2
100	26	.0100.260.0	150	21	329	10	22	1.3	4.9	0.2	0.2
100	36	.0100.360.0	181	22	329	10	22	1.3	6.3	0.3	0.3
125	25	.0125.250.0	170	24	349	10	22	1.8	6	0.3	0.3
125	34	.0125.340.0	212	25.4	349	10	22	1.8	6.8	0.6	0.6
150	23	.0150.230.0	177	31.3	379	10	24	2.6	15.1	0.5	0.5
150	36	.0150.360.0	237	32.8	379	10	24	2.6	8.4	1	1
200	22	.0200.220.0	187	39.7	444	10	24	4.3	23.5	1	1
200	32	.0200.320.0	238	42	444	10	24	4.3	16.8	1.7	1.7
250	18	.0250.180.0	186	69.1	544	10	26	11.9	47.2	1.3	1.3
250	30	.0250.300.0	266	73.9	544	10	26	11.9	29.9	2.9	2.9
300	29	.0300.290.0	265	92.1	594	10	28	16.7	53.6	4.1	4.1
350	26	.0350.260.0	272	114.1	654	10	28	20	65.5	5.1	5.1
400	26	.0400.260.0	368	156.6	704	10	32	26.3	118.9	10.2	10.2
450	25	.0450.250.0	363	186.3	794	10	37	33.1	160.6	12	12
500	25	.0500.250.0	381	272.2	864	10	37	54.5	175.3	16	16
600	23	.0600.230.0	411	363.9	974	10	43	76.8	302.5	24.2	24.2

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES

GIMBAL HINGE VERSION TYPE WFK 16 ... PN 16

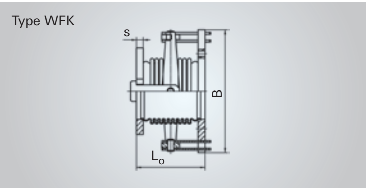


06

Nominal diameter	Nominal angular movement absorption	Typ WFK 16...	Overall length	Weight approx.	Max. width approx.	Flange 2)			Spring rate		
						drilling DIN 1092	rim diameter	thickness			
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	25	.0050.250.0	132	14.7	269	16	19	0.4	2.2	0	0
50	34	.0050.340.0	159	15	269	16	19	0.4	1.4	0	0
65	25	.0065.250.0	138	16.6	289	16	20	0.6	2.9	0.1	0.1
65	34	.0065.340.0	176	17.4	289	16	20	0.7	3.3	0.1	0.1
80	23	.0080.230.0	148	18.4	304	16	20	0.8	6.9	0.1	0.1
80	32	.0080.320.0	184	19	304	16	20	0.8	4.3	0.2	0.2
100	24	.0100.240.0	155	22	329	16	22	1.3	8.8	0.2	0.2
100	33	.0100.330.0	194	22.8	329	16	22	1.3	5.5	0.4	0.4
125	24	.0125.240.0	170	27	359	16	22	1.8	10.8	0.3	0.3
125	33	.0125.330.0	220	28.5	359	16	22	1.8	8.1	0.6	0.6
150	22	.0150.220.0	177	34.1	389	16	24	2.6	17.6	0.5	0.5
150	31	.0150.310.0	230	35.8	389	16	24	2.6	12.3	0.9	0.9
200	22	.0200.220.0	194	62.4	494	16	26	7.9	37.8	1.1	1.1
200	31	.0200.310.0	248	65.4	494	16	26	7.8	27.1	1.8	1.8
250	14	.0250.140.0	208	82.5	544	16	29	12.1	95.9	1.8	1.8
250	23	.0250.230.0	284	89.2	544	16	29	12.1	67.2	3.3	3.3
300	22	.0300.220.0	318	120.8	594	16	37	16.8	86.2	5.1	5.1
350	19	.0350.190.0	297	157.9	694	16	37	20	132.8	5.4	5.4

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

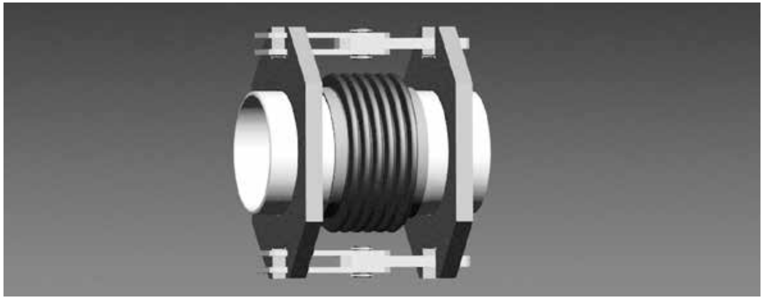
ANGULAR EXPANSION JOINTS WITH PLAIN FIXED FLANGES GIMBAL HINGE VERSION TYPE WFK 25 ... PN 25



Nominal diameter	Nominal angular movement absorption	Typ WFK 25...	Overall length	Weight approx.	Max. width approx.	Flange 2)			Spring rate		
						drilling DIN 1092	rim diameter	thickness			
DN	$2\alpha_N$	–	L_o	G	B	PN	d_5	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	-	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
22	.0050.220.0	138	15.3	15.3	269	25	20	0.4	4.2	0	0
30	.0050.300.0	168	15.8	15.7	269	25	20	0.4	2.6	0.1	0.1
23	.0065.230.0	145	17.8	17.8	289	25	22	0.7	5.3	0.1	0.1
30	.0065.300.0	178	18.3	18.4	289	25	22	0.7	3.3	0.1	0.1
22	.0080.220.0	152	21	21.1	304	25	24	0.9	8.3	0.1	0.1
28	.0080.280.0	176	21.5	21.6	304	25	24	0.9	5.9	0.2	0.2
22	.0100.220.0	157	26.4	26.6	334	25	24	1.3	10.6	0.2	0.2
27	.0100.270.0	183	26.9	27.1	334	25	24	1.3	9.9	0.3	0.3
22	.0125.220.0	184	33.9	34.4	359	25	26	1.8	18.7	0.4	0.4
29	.0125.290.0	232	35.3	35.8	359	25	26	1.8	11.7	0.6	0.6
20	.0150.200.0	182	58.7	59.4	454	25	28	4.7	28.3	0.6	0.6
27	.0150.270.0	230	60.9	61.6	454	25	28	4.7	20.7	0.9	0.9
14	.0200.140.0	217	77.6	77.6	494	25	32	7.9	70.2	1.3	1.1
22	.0200.220.0	271	82.2	83.4	494	25	32	8	56.9	2	2
20	.0250.200.0	289	114.4		559	25	37	12.1	97.3	3.1	3.1
19	.0300.190.0	339	196.1	116.4	664	25	43	22.3	130	5.3	5.3
18	.0350.180.0	341	264.4	269.1	744	25	47	27.2	189.7	6.3	6.3

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

ANGULAR EXPANSION JOINTS WITH WELD ENDS TYPE WRN, WRK



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type WRN: HYDRA single hinge angular expansion joint with weld ends
Type WRK: HYDRA gimbal hinge angular expansion joint with weld ends

Standard version/materials:
Multi-ply bellow made of 1.4541
Weld ends up to DN 300: P 235 GH (1.0345)
Weld ends from DN 350: P 265 GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

WRN	10	·	0150	·	240	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal ($2\alpha = \pm12 = 24°$)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________
- Piping - nominal diameter DN ____________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ____________
- Max./min. allowable temperature [°C] ____________
- Test pressure PT [bar] ____________

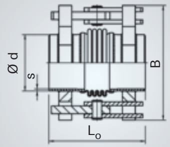
Optional:
- Category ____________

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 02 ... PN 2.5

Type WRN

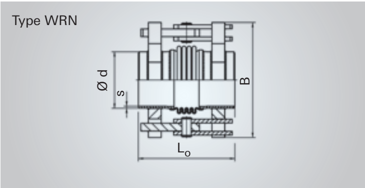


06

Nominal diameter	Nominal angular movement absorption	Typ WRN 02...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	18	.0050.180.0	217	5.2	195	60.3	2.9	0.4	2.5	0
50	29	.0050.290.0	235	5.3	195	60.3	2.9	0.4	1.5	0
50	40	.0050.400.0	253	5.5	195	60.3	2.9	0.4	1.1	0
65	17	.0065.170.0	217	6.1	215	76.1	3.2	0.6	3.2	0
65	28	.0065.280.0	235	6.2	215	76.1	3.2	0.6	1.9	0
65	38	.0065.380.0	253	6.5	215	76.1	3.2	0.6	1.4	0.1
80	17	.0080.170.0	220	7	230	88.9	4	0.8	3.9	0
80	28	.0080.280.0	240	7.3	230	88.9	4	0.8	2.3	0.1
80	38	.0080.380.0	260	7.5	230	88.9	4	0.8	1.7	0.1
100	17	.0100.170.0	223	8.6	260	114.3	4.5	1.3	5.5	0.1
100	28	.0100.280.0	245	8.9	260	114.3	4.5	1.3	3.3	0.2
100	38	.0100.380.0	267	9.2	260	114.3	4.5	1.3	2.4	0.3
125	20	.0125.200.0	245	10.9	285	139.7	6.3	1.8	5	0.2
125	32	.0125.320.0	271	11.3	285	139.7	6.3	1.8	3	0.3
125	38	.0125.380.0	284	11.5	285	139.7	6.3	1.8	2.5	0.4
150	17	.0150.170.0	245	12.3	320	168.3	5.6	2.6	8.3	0.2
150	27	.0150.270.0	271	12.7	320	168.3	5.6	2.6	5	0.4
150	36	.0150.360.0	297	13.2	320	168.3	5.6	2.6	3.6	0.6
200	14	.0200.140.0	255	18.1	380	219.1	8	4.3	14.9	0.5
200	27	.0200.270.0	300	18.9	380	219.1	8	4.3	7.5	1.1
200	35	.0200.350.0	330	19.5	380	219.1	8	4.3	5.6	1.5
250	14	.0250.140.0	261	23.6	445	273	8.8	6.6	22.8	0.9
250	26	.0250.260.0	312	24.7	445	273	8.8	6.6	11.4	1.9
250	36	.0250.360.0	363	25.7	445	273	8.8	6.6	7.6	2.9

ANGULAR EXPANSION JOINTS WITH WELD ENDS

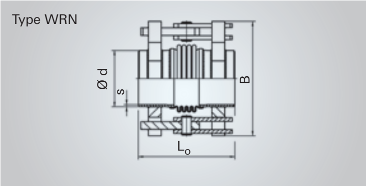
SINGLE HINGE VERSION TYPE WRN 02 ... PN 2.5



Nominal diameter	Nominal angular movement absorption	Typ WRN 02...	Overall length	Weight approx.	Max. width approx.	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
300	14	.0300.140.0	271	29.9	500	323.9	10	9.1	30.8	1.5
300	26	.0300.260.0	328	31.1	500	323.9	10	9.1	15.4	3
300	32	.0300.320.0	404	34.5	500	323.9	10	9.2	11	5.1
350	13	.0350.130.0	284	28.6	546	355.6	6	11	33.7	1.9
350	25	.0350.250.0	344	29.9	546	355.6	6	10.9	20	3.8
350	38	.0350.380.0	424	33.7	546	355.6	6	11	15	6.4
400	10	.0400.100.0	287	51.2	596	406.4	15	14.4	141.6	2.6
400	20	.0400.200.0	350	53.7	596	406.4	15	14.4	70.8	5.2
400	28	.0400.280.0	413	56.2	596	406.4	15	14.4	47.2	7.9
450	10	.0450.100.0	300	60	656	457	15	18.2	164.5	3.4
450	19	.0450.190.0	366	63	656	457	15	18.2	82.2	6.9
450	26	.0450.260.0	432	65.9	656	457	15	18.2	54.8	10.4
500	11	.0500.110.0	327	63.7	716	508	12	22.5	179.2	4.5
500	20	.0500.200.0	396	67.2	716	508	12	22.5	89.6	9
500	28	.0500.280.0	488	71.9	716	508	12	22.5	53.7	15
600	10	.0600.100.0	346	98	816	610	15	32	254.5	7.2
600	16	.0600.160.0	398	100.9	816	610	15	32	152.7	12
600	21	.0600.210.0	476	105.3	816	610	15	32	95.4	19.3
700	9	.0700.090.0	392	138.1	970	711	15	77.8	325.4	10.5
700	17	.0700.170.0	476	144.5	970	711	15	77.5	181.5	20.9
700	25	.0700.250.0	616	155	970	711	15	77.4	102.8	38.4
800	8.4	.0800.084.0	429	182.9	1080	813	15	100.5	456.3	14
800	18	.0800.180.0	545	191.8	1080	813	15	99.8	248.4	32.6
800	26	.0800.260.0	661	213.6	1080	813	15	100.7	187	51.7

ANGULAR EXPANSION JOINTS WITH WELD ENDS

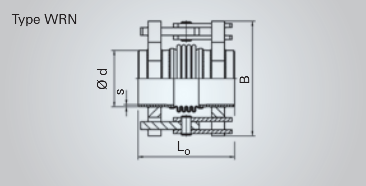
SINGLE HINGE VERSION TYPE WRN 02 ... PN 2.5



Nominal diameter	Nominal angular movement absorption	Typ WRN 02...	Overall length	Weight approx.	Max. width approx.	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
900	7.4	.0900.074.0	452	217.5	1200	914	15	128.3	628	18.6
900	14	.0900.140.0	542	225	1200	914	15	127.5	397.2	36.9
900	20	.0900.200.0	692	238.2	1200	914	15	127.5	216.7	67.7
1000	7.8	.1000.078.0	502	280	1310	1016	15	157.4	814.7	24.3
1000	14	.1000.140.0	598	288.2	1310	1016	15	156.1	564.1	48.3
1000	17	.1000.170.0	670	306.7	1310	1016	15	157.6	458.8	67
1200	6.6	.1200.066.0	522	426.9	1544	1220	20	295.9	1752	34.3
1200	12	.1200.120.0	618	445.2	1544	1220	20	295.9	876	68.6
1200	18	.1200.180.0	746	468.5	1544	1220	20	295.4	561.3	114.2
1400	4	.1400.040.0	526	490.9	1744	1420	15	399.2	5689.1	56.1
1400	7.8	.1400.078.0	643	510.7	1744	1420	15	399.2	2844.6	112.3
1400	12	.1400.120.0	812	563.5	1744	1420	15	399.6	2541	194.1
1600	3.6	.1600.036.0	556	648.3	1994	1620	15	645.6	8325.1	72.6
1600	6.8	.1600.068.0	673	673.9	1994	1620	15	645.6	4162.6	145.3
1600	11	.1600.110.0	828	709.1	1994	1620	15	645.6	2497.5	242.1
1800	3.2	.1800.032.0	556	715.1	2184	1820	15	811.1	11666.5	91.2
1800	6	.1800.060.0	673	742.8	2184	1820	15	811.1	5833.3	182.5
1800	9.6	.1800.096.0	828	780.7	2184	1820	15	811.1	3500	304.2
2000	2.8	.2000.028.0	576	926.1	2404	2020	15	995.4	15795.9	112
2000	5.6	.2000.056.0	693	955.8	2404	2020	15	995.4	7898	224
2000	8.6	.2000.086.0	848	996.5	2404	2020	15	995.4	4738.8	373.3

ANGULAR EXPANSION JOINTS WITH WELD ENDS

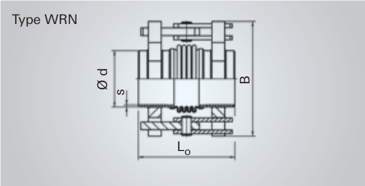
SINGLE HINGE VERSION TYPE WRN 06 ... PN 6



Nominal diameter	Nominal angular movement absorption	Typ WRN 06...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	18	.0050.180.0	217	5.2	195	60.3	2.9	0.4	2.5	0
50	28	.0050.280.0	235	5.3	195	60.3	2.9	0.4	1.5	0
50	37	.0050.370.0	253	5.5	195	60.3	2.9	0.4	1.1	0
65	17	.0065.170.0	217	6	215	76.1	2.9	0.6	3.2	0
65	27	.0065.270.0	235	6.1	215	76.1	2.9	0.6	1.9	0
65	39	.0065.390.0	262	6.5	215	76.1	2.9	0.6	1.2	0.1
80	17	.0080.170.0	220	6.7	230	88.9	3.2	0.8	3.9	0
80	27	.0080.270.0	240	7	230	88.9	3.2	0.8	2.3	0.1
80	38	.0080.380.0	270	7.3	230	88.9	3.2	0.8	1.5	0.2
100	17	.0100.170.0	223	8.1	260	114.3	3.6	1.3	5.5	0.1
100	27	.0100.270.0	245	8.4	260	114.3	3.6	1.3	3.3	0.2
100	38	.0100.380.0	278	8.9	260	114.3	3.6	1.3	2.3	0.3
125	19	.0125.190.0	245	9.5	285	139.7	4	1.8	5	0.2
125	30	.0125.300.0	276	10.2	285	139.7	4	1.8	6	0.3
125	39	.0125.390.0	304	10.7	285	139.7	4	1.8	4.3	0.5
150	15	.0150.150.0	248	11.4	320	168.3	4	2.6	14.3	0.3
150	27	.0150.270.0	290	12.2	320	168.3	4	2.6	7.1	0.6
150	36	.0150.360.0	332	13	320	168.3	4	2.6	4.8	0.9
200	14	.0200.140.0	268	18.7	380	219.1	4.5	4.3	22.2	0.6
200	29	.0200.290.0	332	20	380	219.1	4.5	4.2	11.7	1.3
200	40	.0200.400.0	390	23.1	380	219.1	4.5	4.3	11.7	2.1
250	14	.0250.140.0	274	25.2	445	273	5	6.6	52.3	1
250	22	.0250.220.0	310	26.6	445	273	5	6.6	31.4	1.7
250	32	.0250.320.0	364	28.7	445	273	5	6.6	19.6	2.7

ANGULAR EXPANSION JOINTS WITH WELD ENDS

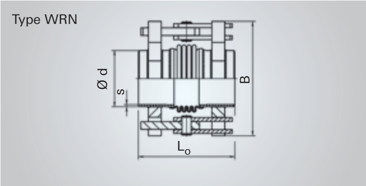
SINGLE HINGE VERSION TYPE WRN 06 ... PN 6



Nominal diameter	Nominal angular movement absorption	Typ WRN 06...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
300	14	.0300.140.0	294	36.7	495	323.9	5.6	9.3	63.2	1.6
300	22	.0300.220.0	334	38.5	495	323.9	5.6	9.3	37.9	2.7
300	34	.0300.340.0	402	42.3	495	323.9	5.6	9.2	33.6	4.5
350	13	.0350.130.0	317	50.8	580	355.6	8	19.9	87	2
350	25	.0350.250.0	380	54.4	580	355.6	8	19.8	48.7	4
350	34	.0350.340.0	452	60.2	580	355.6	8	20	34.6	6.3
400	10	.0400.100.0	330	66	640	406.4	8	26.2	194.5	2.7
400	19	.0400.190.0	396	70.7	640	406.4	8	26.2	97.2	5.5
400	27	.0400.270.0	484	76.7	640	406.4	8	26.2	58.3	9.2
450	9.8	.0450.098.0	343	75.7	700	457	8	32.9	247.6	3.6
450	18	.0450.180.0	412	81	700	457	8	32.9	123.8	7.3
450	24	.0450.240.0	481	86.1	700	457	8	32.8	86.3	10.9
500	10	.0500.100.0	383	98.2	750	508	8	40.7	347	4.9
500	17	.0500.170.0	433	103.4	750	508	8	40.7	208.2	8.2
500	26	.0500.260.0	533	113.7	750	508	8	40.7	115.7	14.7
600	10	.0600.100.0	412	146.7	904	610	8	77.2	493.5	7.8
600	16	.0600.160.0	468	154.8	904	610	8	77.2	296.1	13
600	25	.0600.250.0	580	169.3	904	610	8	76.7	192.2	23.3
700	9	.0700.090.0	452	197.6	1014	711	8	103.7	703.1	10.5
700	17	.0700.170.0	536	209.7	1014	711	8	102.7	464.1	20.8
700	24	.0700.240.0	638	241.4	1014	711	8	104.1	341.5	33.9
800	8.4	.0800.084.0	491	253.4	1124	813	10	134.9	1336.5	16.1
800	16	.0800.160.0	590	275.3	1124	813	10	134.9	668.3	32.2
800	23	.0800.230.0	722	304.4	1124	813	10	134.9	401	53.7

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 06 ... PN 6

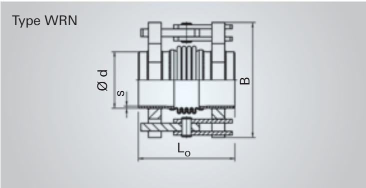


Nominal diameter	Nominal angular movement absorption	Typ WRN 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
900	7.4	.0900.074.0	561	402.5
900	14	.0900.140.0	660	430.3
900	20	.0900.200.0	792	466.9
1000	7	.1000.070.0	601	458.4
1000	13	.1000.130.0	706	489.8
1000	19	.1000.190.0	846	531.2
1200	6.2	.1200.062.0	621	583.2
1200	12	.1200.120.0	726	618.3
1200	17	.1200.170.0	866	664.3
1400	3.8	.1400.038.0	631	842.8
1400	7.6	.1400.076.0	751	879.9
1400	11	.1400.110.0	912	929.3
1600	3.2	.1600.032.0	711	1222.5
1600	6.2	.1600.062.0	811	1254.6
1600	9.4	.1600.094.0	972	1318.2
1800	2.8	.1800.028.0	711	1362
1800	5.6	.1800.056.0	778	1389.8
1800	8.6	.1800.086.0	944	1468.9
2000	2.8	.2000.028.0	861	2136.4
2000	5	.2000.050.0	860	2093.6
2000	7.8	.2000.078.0	973	2161.4

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
1284	914	10	214.8	1896.5	20.5
1284	914	10	214.8	948.3	41.1
1284	914	10	214.8	569	68.5
1394	1016	10	263.7	2377.8	26.7
1394	1016	10	263.7	1188.9	53.5
1394	1016	10	263.7	713.4	89.2
1594	1220	10	370.2	3743.5	37.5
1594	1220	10	369.6	2001.8	75
1594	1220	10	369.3	1242.8	124.9
1840	1420	15	666	8470	58.2
1840	1420	15	666	4235	116.4
1840	1420	15	666	2541	194.1
2086	1620	15	1077	12388.1	75.3
2086	1620	15	1077	6194.1	150.6
2086	1620	15	1077	3716.4	251.1
2286	1820	15	1353.9	22948.2	98
2286	1820	15	1353.9	13768.9	163.3
2286	1820	15	1352.8	8021.6	293.7
2596	2020	15	2076.6	40358.5	124.2
2596	2020	15	2076.6	18629.4	200.4
2596	2020	15	2076.6	11643.3	320.6

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 10 ... PN 10

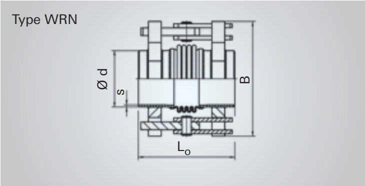


Nominal diameter	Nominal angular movement absorption	Typ WRN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	17	.0050.170.0	217	5.2
50	27	.0050.270.0	235	5.3
50	37	.0050.370.0	262	5.6
65	16	.0065.160.0	217	6
65	29	.0065.290.0	244	6.2
65	37	.0065.370.0	270	6.7
80	16	.0080.160.0	223	6.8
80	25	.0080.250.0	245	7.1
80	36	.0080.360.0	278	7.6
100	17	.0100.170.0	226	8.3
100	26	.0100.260.0	250	8.7
100	36	.0100.360.0	281	9.7
125	16	.0125.160.0	258	11.9
125	25	.0125.250.0	286	12.4
125	32	.0125.320.0	314	12.8
150	15	.0150.150.0	261	14.5
150	27	.0150.270.0	306	15.7
150	36	.0150.360.0	351	16.9
200	14	.0200.140.0	281	23
200	26	.0200.260.0	332	24.6
200	34	.0200.340.0	383	27.1

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
195	60.3	2.9	0.4	2.5	0
195	60.3	2.9	0.4	1.5	0
195	60.3	2.9	0.4	0.9	0
215	76.1	2.9	0.6	3.2	0
215	76.1	2.9	0.6	2	0.1
215	76.1	2.9	0.6	1.8	0.1
230	88.9	3.2	0.8	6.3	0
230	88.9	3.2	0.8	3.8	0.1
230	88.9	3.2	0.8	2.4	0.2
260	114.3	3.6	1.3	8.2	0.1
260	114.3	3.6	1.3	4.9	0.2
260	114.3	3.6	1.3	6.3	0.3
285	139.7	4	1.8	10.1	0.2
285	139.7	4	1.8	6	0.3
285	139.7	4	1.8	5.3	0.5
320	168.3	4	2.6	25.2	0.3
320	168.3	4	2.6	12.6	0.6
320	168.3	4	2.6	8.4	1
380	219.1	4.5	4.3	39.1	0.6
380	219.1	4.5	4.3	19.6	1.2
380	219.1	4.5	4.3	15.9	1.9

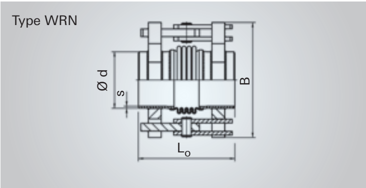
ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 10 ... PN 10



Nominal diameter	Nominal angular movement absorption	Typ WRN 10...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	14	.0250.140.0	304	39.8	480	273	5	12	52.3	1
250	21	.0250.210.0	340	41.5	480	273	5	11.8	46.1	1.7
250	30	.0250.300.0	402	45.5	480	273	5	11.9	29.9	2.9
300	15	.0300.150.0	327	55.8	540	323.9	5.6	16.8	75.7	1.7
300	23	.0300.230.0	374	60.4	540	323.9	5.6	16.9	60	2.9
300	29	.0300.290.0	418	63.4	540	323.9	5.6	16.7	53.6	4.1
350	13	.0350.130.0	330	57.7	580	355.6	8	20	103.7	2.1
350	21	.0350.210.0	379	62.8	580	355.6	8	20.1	82	3.7
350	26	.0350.260.0	425	66.1	580	355.6	8	20	65.5	5.1
400	9.4	.0400.094.0	346	77.8	640	406.4	8	26.3	396.4	3
400	18	.0400.180.0	418	85.9	640	406.4	8	26.3	198.2	6.1
400	26	.0400.260.0	514	96.6	640	406.4	8	26.3	118.9	10.2
450	9.6	.0450.096.0	379	111.9	720	457	8	33.1	481.8	4
450	16	.0450.160.0	429	118.2	720	457	8	33.1	289.1	6.6
450	23	.0450.230.0	504	127.4	720	457	8	33.1	180.7	10.6
500	10	.0500.100.0	429	157.8	794	508	10	54.5	525.9	5.3
500	16	.0500.160.0	483	166.5	794	508	10	54.6	303.2	8.9
500	24	.0500.240.0	564	179	794	508	10	54.4	205.4	14.2
600	9.4	.0600.094.0	435	188.7	904	610	10	77.3	774.9	8.1
600	15	.0600.150.0	493	199.3	904	610	10	77.3	464.9	13.5
600	23	.0600.230.0	609	218.9	904	610	10	76.8	302.5	24.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS



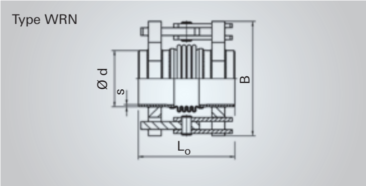
Nominal diameter	Nominal angular movement absorption	Typ WRN 10...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
700	8.6	.0700.086.0	514	323.7
700	16	.0700.160.0	610	351.3
700	22	.0700.220.0	706	379
800	8.4	.0800.084.0	544	370.9
800	15	.0800.150.0	646	400.6
800	22	.0800.220.0	782	442.8
900	7.4	.0900.074.0	584	487.2
900	14	.0900.140.0	686	520.9
900	20	.0900.200.0	822	564.6
1000	5.8	.1000.058.0	674	750.4
1000	11	.1000.110.0	782	798.3
1000	16	.1000.160.0	926	862.4
1200	6	.1200.060.0	717	978.5
1200	11	.1200.110.0	828	1030.7
1200	15	.1200.150.0	939	1083
1400	3.8	.1400.038.0	861	1589.9
1400	7	.1400.070.0	861	1569.7
1400	10	.1400.100.0	1027	1669.9

SINGLE HINGE VERSION TYPE WRN 10 ... PN 10

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
1064	711	12	130.5	1381	12.1
1064	711	12	130.5	690.5	24.2
1064	711	12	130.5	460.3	36.3
1164	813	12	169	1793.7	16.6
1164	813	12	168	1073.7	33.1
1164	813	12	168.6	577.5	55.4
1294	914	12	215.3	2543	21.2
1294	914	12	214.6	1413.9	42.3
1294	914	12	214.4	879.6	70.4
1450	1016	15	354.6	5006.8	27.7
1450	1016	15	354.6	2503.4	55.5
1450	1016	15	354.6	1502	92.5
1686	1220	15	617	5353.6	39.7
1686	1220	15	614	3306.5	79
1686	1220	15	613.1	2373.6	118.4
1986	1420	15	1042.7	13976.5	62.4
1986	1420	15	1042.7	8385.9	104
1986	1420	15	1042.7	4658.8	187.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 16 ... PN 16

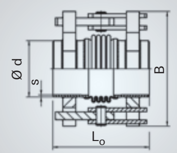


Nominal diameter	Nominal angular movement absorption	Typ WRN 16...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	16	.0050.160.0	217	5.2	195	60.3	2.9	0.4	3.7	0
50	25	.0050.250.0	235	5.4	195	60.3	2.9	0.4	2.2	0
50	34	.0050.340.0	262	5.7	195	60.3	2.9	0.4	1.4	0
65	16	.0065.160.0	220	6.1	215	76.1	2.9	0.6	4.9	0
65	25	.0065.250.0	240	6.3	215	76.1	2.9	0.6	2.9	0.1
65	34	.0065.340.0	278	7.2	215	76.1	2.9	0.7	3.3	0.1
80	14	.0080.140.0	236	8.6	230	88.9	3.2	0.8	11.6	0
80	23	.0080.230.0	260	9	230	88.9	3.2	0.8	6.9	0.1
80	32	.0080.320.0	296	9.7	230	88.9	3.2	0.8	4.3	0.2
100	15	.0100.150.0	239	10.6	260	114.3	3.6	1.3	14.7	0.1
100	24	.0100.240.0	265	11.1	260	114.3	3.6	1.3	8.8	0.2
100	33	.0100.330.0	304	11.9	260	114.3	3.6	1.3	5.5	0.4
125	15	.0125.150.0	258	12.3	285	139.7	4	1.8	18	0.2
125	24	.0125.240.0	286	13	285	139.7	4	1.8	10.8	0.3
125	33	.0125.330.0	336	14.4	285	139.7	4	1.8	8.1	0.6
150	14	.0150.140.0	271	17.2	320	168.3	4	2.6	25.2	0.3
150	22	.0150.220.0	301	17.9	320	168.3	4	2.6	17.6	0.5
150	31	.0150.310.0	354	19.7	320	168.3	4	2.6	12.3	0.9
200	14	.0200.140.0	314	37.9	420	219.1	4.5	7.9	63	0.6
200	22	.0200.220.0	350	40.1	420	219.1	4.5	7.9	37.8	1.1
200	31	.0200.310.0	404	43	420	219.1	4.5	7.8	27.1	1.8

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 16 ... PN 16

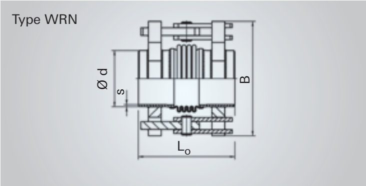
Type WRN



Nominal diameter	Nominal angular movement absorption	Typ WRN 16...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	9	.0250.090.0	317	46.4	480	273	5	12.1	159.9	1.1
250	16	.0250.160.0	374	49.8	480	273	5	12.1	79.9	2.2
250	23	.0250.230.0	431	55.4	480	273	5	12.1	67.2	3.3
300	9.6	.0300.096.0	337	64.1	540	323.9	5.6	16.9	245.5	1.7
300	15	.0300.150.0	379	67.5	540	323.9	5.6	16.9	147.3	2.8
300	22	.0300.220.0	463	74.2	540	323.9	5.6	16.8	86.2	5.1
350	8.8	.0350.088.0	357	82	600	355.6	8	20.3	288.2	2
350	14	.0350.140.0	399	85.6	600	355.6	8	20.1	191.3	3.4
350	20	.0350.200.0	483	92.3	600	355.6	8	20	124.6	6.1
400	9.4	.0400.094.0	392	120.6	684	406.4	8	35.4	517.2	3.3
400	15	.0400.150.0	444	128.9	684	406.4	8	35.4	310.3	5.5
400	23	.0400.230.0	548	146.1	684	406.4	8	35.4	172.4	10
450	9	.0450.090.0	402	136.5	744	457	8	44.4	654	4.1
450	14	.0450.140.0	454	145.8	744	457	8	44.4	392.4	6.9
450	22	.0450.220.0	558	164.9	744	457	8	44.4	218	12.5
500	10	.0500.100.0	452	184.7	794	508	10	54.7	714.8	5.5
500	16	.0500.160.0	508	195.6	794	508	10	54.6	446.7	9.2
500	22	.0500.220.0	578	216.4	794	508	10	55	375.7	13.9
600	6.2	.0600.062.0	488	282.9	944	610	12	96.9	2052.2	8.4
600	12	.0600.120.0	578	306.6	944	610	12	96.9	1026.1	16.8
600	16	.0600.160.0	668	330.5	944	610	12	96.9	684.1	25.3

06

ANGULAR EXPANSION JOINTS WITH WELD ENDS SINGLE HINGE VERSION TYPE WRN 16 ... PN 16

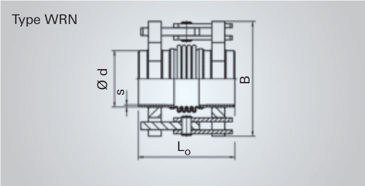


06

Nominal diameter	Nominal angular movement absorption	Typ WRN 16...	Overall length	Weight approx.	Max. width approx.	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
700	6.2	.0700.062.0	531	362.7	1064	711	12	130.9	2524.3	11.7
700	12	.0700.120.0	624	390.4	1064	711	12	130.7	1307.4	23.5
700	16	.0700.160.0	717	418.4	1064	711	12	130.5	903.2	35.2
800	6	.0800.060.0	608	575.1	1220	813	15	225.6	3409.1	15.7
800	11	.0800.110.0	704	608.4	1220	813	15	224.3	2031	31.2
800	15	.0800.150.0	800	641.9	1220	813	15	223.5	1512.4	46.6
900	6	.0900.060.0	720	870.4	1386	914	15	361.9	4706.7	21.4
900	11	.0900.110.0	796	907.6	1386	914	15	359.6	2866	42.5
900	16	.0900.160.0	932	973.6	1386	914	15	358.9	1842.2	70.7
1000	5.8	.1000.058.0	744	970.9	1496	1016	15	444.5	6654.9	29.3
1000	9	.1000.090.0	820	1016.7	1496	1016	15	444.5	3993	48.9
1000	14	.1000.140.0	972	1102.7	1496	1016	15	443.3	2436.3	87.9

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 25 ... PN 25

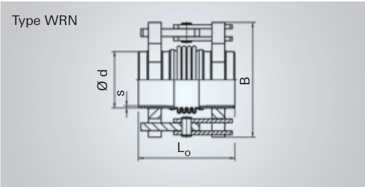


Nominal diameter	Nominal angular movement absorption	Typ WRN 25...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	14	.0050.140.0	230	6.4
50	22	.0050.220.0	250	6.7
50	30	.0050.300.0	280	7.2
65	15	.0065.150.0	233	7.6
65	23	.0065.230.0	255	7.9
65	29	.0065.290.0	277	8.3
80	14	.0080.140.0	236	8.7
80	22	.0080.220.0	260	9.2
80	28	.0080.280.0	284	9.6
100	14	.0100.140.0	249	12.7
100	22	.0100.220.0	275	13.2
100	27	.0100.270.0	301	13.8
125	14	.0125.140.0	274	15.1
125	22	.0125.220.0	306	16.1
125	27	.0125.270.0	338	17
150	13	.0150.130.0	314	33.2
150	20	.0150.200.0	346	34.9
150	27	.0150.270.0	394	37
200	9	.0200.090.0	324	42.3
200	16	.0200.160.0	378	45.8
200	22	.0200.220.0	432	50.5
250	9	.0250.090.0	330	53.5
250	14	.0250.140.0	370	56.8
250	20	.0250.200.0	430	61.5

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
195	60.3	2.9	0.4	7	0
195	60.3	2.9	0.4	4.2	0
195	60.3	2.9	0.4	2.6	0.1
215	76.1	2.9	0.7	8.8	0
215	76.1	2.9	0.7	5.3	0.1
215	76.1	2.9	0.7	3.8	0.1
230	88.9	3.2	0.9	13.8	0
230	88.9	3.2	0.9	8.3	0.1
230	88.9	3.2	0.9	5.9	0.2
260	114.3	3.6	1.3	17.6	0.1
260	114.3	3.6	1.3	10.6	0.2
260	114.3	3.6	1.3	9.9	0.3
285	139.7	4	1.8	31.2	0.2
285	139.7	4	1.8	18.7	0.4
285	139.7	4	1.8	13.4	0.6
360	168.3	4	4.8	43.6	0.3
360	168.3	4	4.7	28.3	0.6
360	168.3	4	4.7	20.7	0.9
420	219.1	4.5	7.9	140.4	0.6
420	219.1	4.5	7.9	70.2	1.3
420	219.1	4.5	8	56.9	2
480	273	5	12.2	244.9	1.1
480	273	5	12.2	146.9	1.9
480	273	5	12.1	97.3	3.1

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 25 ... PN 25

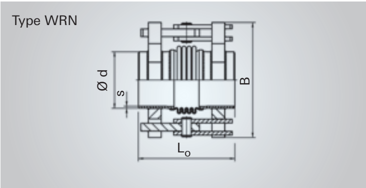


Nominal diameter	Nominal angular movement absorption	Typ WRN 25...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
300	8.6	.0300.086.0	380	101.2
300	14	.0300.140.0	424	106
300	18	.0300.180.0	490	113.2
350	8.8	.0350.088.0	406	125.6
350	14	.0350.140.0	454	132.3
350	20	.0350.200.0	550	146.1
400	6.2	.0400.062.0	409	144.4
400	12	.0400.120.0	484	157
400	16	.0400.160.0	559	170
450	6.2	.0450.062.0	490	233.1
450	12	.0450.120.0	550	246.8
450	16	.0450.160.0	628	264.1
500	6.2	.0500.062.0	516	277.9
500	10	.0500.100.0	576	294.5
500	16	.0500.160.0	696	327.7
600	6.2	.0600.062.0	600	463.8
600	10	.0600.100.0	636	477.9
600	15	.0600.150.0	764	523.5
700	6	.0700.060.0	721	698.2
700	9.4	.0700.094.0	721	699.6
700	14	.0700.140.0	853	757.4

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
584	323.9	5.6	22.5	313.3	1.7
584	323.9	5.6	22.5	198.3	2.9
584	323.9	5.6	22.3	146.2	4.7
624	355.6	10	27.3	457.7	2.3
624	355.6	10	27.3	274.6	3.9
624	355.6	10	27.2	168.6	7.1
684	406.4	10	35.3	1054.8	3.2
684	406.4	10	35.3	527.4	6.4
684	406.4	10	35.3	351.6	9.6
784	457	10	55.4	1335.9	4.1
784	457	10	55.4	668	8.3
784	457	10	55.4	445.3	12.5
844	508	12	68.7	1943.4	5.9
844	508	12	68.7	1166	9.9
844	508	12	68.7	647.8	17.9
1000	610	15	130.2	2542.1	9
1000	610	15	130.2	1525.3	15.1
1000	610	15	130.2	847.4	27.2
1156	711	15	218.5	3611.3	12.5
1156	711	15	218.5	2166.8	20.9
1156	711	15	217.3	1393.9	37.4

ANGULAR EXPANSION JOINTS WITH WELD ENDS

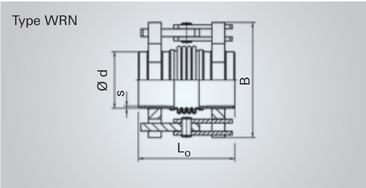
SINGLE HINGE VERSION TYPE WRN 40 ... PN 40



Nominal diameter	Nominal angular movement absorption	Typ WRN 40...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	14	.0050.140.0	233	6.5	195	60.3	2.9	0.4	8.7	0
50	21	.0050.210.0	255	6.8	195	60.3	2.9	0.4	5.2	0
50	25	.0050.250.0	277	7.2	195	60.3	2.9	0.4	3.7	0.1
65	12	.0065.120.0	236	7.9	215	76.1	2.9	0.7	15.9	0
65	19	.0065.190.0	260	8.4	215	76.1	2.9	0.7	9.6	0.1
65	26	.0065.260.0	296	9.2	215	76.1	2.9	0.7	6	0.1
80	13	.0080.130.0	249	10.4	225	88.9	3.2	0.9	19	0.1
80	20	.0080.200.0	275	10.9	225	88.9	3.2	0.9	11.4	0.1
80	24	.0080.240.0	301	11.6	225	88.9	3.2	0.9	8.2	0.2
100	7.8	.0100.078.0	249	12.5	260	114.3	3.6	1.3	44.8	0.1
100	12	.0100.120.0	275	12.9	260	114.3	3.6	1.3	26.9	0.2
100	17	.0100.170.0	327	14.5	260	114.3	3.6	1.3	22.2	0.4
125	8.6	.0125.086.0	304	26.5	330	139.7	4	3.3	72.1	0.2
125	13	.0125.130.0	336	28.2	330	139.7	4	3.3	43.3	0.4
125	17	.0125.170.0	368	29.6	330	139.7	4	3.3	30.9	0.6
150	8.6	.0150.086.0	314	33.3	360	168.3	4	4.8	95.6	0.3
150	13	.0150.130.0	346	35.1	360	168.3	4	4.8	57.3	0.6
150	17	.0150.170.0	378	36.5	360	168.3	4	4.7	51	0.8
200	7.8	.0200.078.0	350	52.9	420	219.1	4.5	8	253.2	0.7
200	12	.0200.120.0	390	56.1	420	219.1	4.5	8	151.9	1.2
200	17	.0200.170.0	450	60.9	420	219.1	4.5	8	95	2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 40 ... PN 40

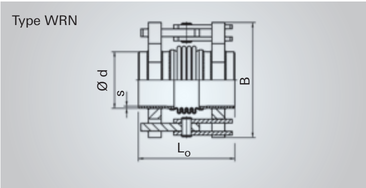


Nominal diameter	Nominal angular movement absorption	Typ WRN 40...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
250	7.8	.0250.078.0	373	89.7
250	12	.0250.120.0	415	94.8
250	17	.0250.170.0	478	102.1
300	5.8	.0300.058.0	403	123
300	9.2	.0300.092.0	449	129.6
300	14	.0300.140.0	541	142.5
350	6	.0350.060.0	480	188.4
350	9.6	.0350.096.0	504	193.1
350	14	.0350.140.0	600	210.4
400	6	.0400.060.0	481	210.3
400	9.6	.0400.096.0	519	219.4
400	14	.0400.140.0	627	241.5
450	5.8	.0450.058.0	511	260.5
450	9.4	.0450.094.0	567	275.2
450	13	.0450.130.0	654	295.7
500	4.4	.0500.044.0	621	408.9
500	7	.0500.070.0	633	413.7
500	11	.0500.110.0	749	449.2

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
524	273	6.3	16.4	337.7	1.2
524	273	6.3	16.4	202.6	2
524	273	6.3	16.2	155.8	3.2
584	323.9	7.1	22.6	832.6	1.8
584	323.9	7.1	22.6	499.5	3.1
584	323.9	7.1	22.6	277.5	5.6
674	355.6	10	34.2	883.5	2.3
674	355.6	10	34.2	530.1	3.9
674	355.6	10	33.9	341.6	7
724	406.4	10	44.4	1153.5	3.4
724	406.4	10	44.4	692.1	5.8
724	406.4	10	44	460.8	10.3
784	457	10	55.8	1716.5	4.6
784	457	10	55.8	1029.9	7.8
784	457	10	55.6	701.9	12.4
890	508	12	91.4	3288.6	5.7
890	508	12	91.4	1973.2	9.6
890	508	12	91.2	1140.4	17.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 63 ... PN 63



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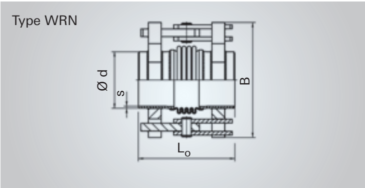
Nominal diameter	Nominal angular movement absorption	Typ WRN 63...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	9	.0050.090.0	242	7.5	195	60.3	2.9	0.4	17.8	0
50	13	.0050.130.0	262	7.8	195	60.3	2.9	0.4	10.7	0
50	16	.0050.160.0	284	8.1	195	60.3	2.9	0.4	7.6	0
65	8.6	.0065.086.0	246	9.2	215	76.1	3.2	0.7	27.9	0
65	13	.0065.130.0	270	9.6	215	76.1	3.2	0.7	16.7	0.1
65	17	.0065.170.0	306	10.4	215	76.1	3.2	0.7	10.5	0.1
80	8.2	.0080.082.0	256	12.1	225	88.9	4	0.9	36.3	0
80	13	.0080.130.0	280	12.6	225	88.9	4	0.9	21.8	0.1
80	16	.0080.160.0	304	13	225	88.9	4	0.8	18	0.2
100	6.6	.0100.066.0	292	25.8	300	114.3	4.5	2.4	85.2	0.1
100	10	.0100.100.0	320	27	300	114.3	4.5	2.4	51.1	0.2
100	14	.0100.140.0	362	28.6	300	114.3	4.5	2.4	32	0.4
125	8.4	.0125.084.0	317	31.7	330	139.7	6.3	3.3	89.7	0.2
125	11	.0125.110.0	334	32.4	330	139.7	6.3	3.3	67.3	0.3
125	16	.0125.160.0	385	34.7	330	139.7	6.3	3.3	45	0.6
150	7	.0150.070.0	347	43.2	360	168.3	5.6	4.8	175.6	0.4
150	11	.0150.110.0	385	45.4	360	168.3	5.6	4.8	105.4	0.7
150	14	.0150.140.0	423	47.9	360	168.3	5.6	4.8	75.3	1
200	5.2	.0200.052.0	393	88.7	464	219.1	8	10.6	513.6	0.8
200	10	.0200.100.0	456	95.6	464	219.1	8	10.6	256.8	1.6
200	13	.0200.130.0	519	101.9	464	219.1	8	10.6	171.2	2.4

ANGULAR EXPANSION JOINTS WITH WELD ENDS

SINGLE HINGE VERSION TYPE WRN 63 ... PN 63



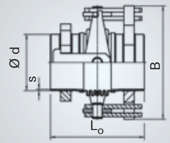
Nominal diameter	Nominal angular movement absorption	Typ WRN 63...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
250	5	.0250.050.0	419	130.8
250	8	.0250.080.0	465	136.6
250	12	.0250.120.0	557	149.1
300	5.2	.0300.052.0	481	194.2
300	8.2	.0300.082.0	509	199.7
300	11	.0300.110.0	600	218.5
350	5.2	.0350.052.0	549	242.3
350	9.6	.0350.096.0	636	263
350	13	.0350.130.0	723	282.9
400	3.8	.0400.038.0	611	355.4
400	7.2	.0400.072.0	656	366.4
400	10	.0400.100.0	763	400

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
554	273	8.8	16.4	785.4	1.3
554	273	8.8	16.4	471.3	2.2
554	273	8.8	16.4	261.8	4.1
624	323.9	10	28.5	955.2	2
624	323.9	10	28.3	636.1	3.4
624	323.9	10	28.5	442.6	5.7
674	355.6	12	34.8	1439.4	2.9
674	355.6	12	34.8	719.7	5.8
674	355.6	12	34.8	479.8	8.7
780	406.4	15	59.1	2381.4	3.4
780	406.4	15	58.6	1427.4	6.8
780	406.4	15	59.4	956.3	11.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 02 ... PN 2.5

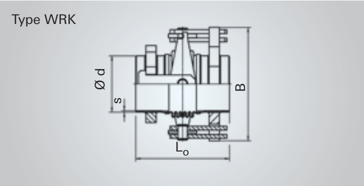
Type WRK



Nominal diameter	Nominal angular movement absorption	Typ WRK 02...	Overall length	Weight approx.	Max. width approx.	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	18	.0050.180.0	217	8.2	195	60.3	2.9	0.4	2.5	0
50	29	.0050.290.0	235	8.4	195	60.3	2.9	0.4	1.5	0
50	40	.0050.400.0	253	8.6	195	60.3	2.9	0.4	1.1	0
65	17	.0065.170.0	217	9.5	215	76.1	3.2	0.6	3.2	0
65	28	.0065.280.0	235	9.7	215	76.1	3.2	0.6	1.9	0
65	38	.0065.380.0	253	9.9	215	76.1	3.2	0.6	1.4	0.1
80	17	.0080.170.0	220	10.8	230	88.9	4	0.8	3.9	0
80	28	.0080.280.0	240	11	230	88.9	4	0.8	2.3	0.1
80	38	.0080.380.0	260	11.3	230	88.9	4	0.8	1.7	0.1
100	17	.0100.170.0	223	12.9	260	114.3	4.5	1.3	5.5	0.1
100	28	.0100.280.0	245	13.2	260	114.3	4.5	1.3	3.3	0.2
100	38	.0100.380.0	267	13.5	260	114.3	4.5	1.3	2.4	0.3
125	20	.0125.200.0	245	15.7	285	139.7	6.3	1.8	5	0.2
125	32	.0125.320.0	271	16.1	285	139.7	6.3	1.8	3	0.3
125	38	.0125.380.0	284	16.3	285	139.7	6.3	1.8	2.5	0.4
150	17	.0150.170.0	245	17.7	320	168.3	5.6	2.6	8.3	0.2
150	27	.0150.270.0	271	18.2	320	168.3	5.6	2.6	5	0.4
150	36	.0150.360.0	297	18.6	320	168.3	5.6	2.6	3.6	0.6
200	14	.0200.140.0	255	24.6	380	219.1	8	4.3	14.9	0.5
200	27	.0200.270.0	300	25.5	380	219.1	8	4.3	7.5	1.1
200	35	.0200.350.0	330	26	380	219.1	8	4.3	5.6	1.5

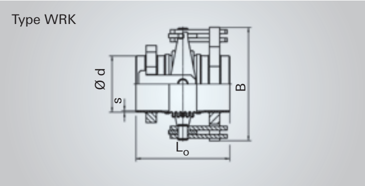
ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 02 ... PN 2.5



Nominal diameter	Nominal angular movement absorption	Typ WRK 02...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	14	.0250.140.0	261	32.2	445	273	8.8	6.6	22.8	0.9
250	26	.0250.260.0	312	33.3	445	273	8.8	6.6	11.4	1.9
250	36	.0250.360.0	363	34.3	445	273	8.8	6.6	7.6	2.9
300	14	.0300.140.0	271	39.3	500	323.9	10	9.1	30.8	1.5
300	26	.0300.260.0	328	40.5	500	323.9	10	9.1	15.4	3
300	32	.0300.320.0	404	44	500	323.9	10	9.2	11	5.1
350	13	.0350.130.0	284	40.4	546	355.6	6	11	33.7	1.9
350	25	.0350.250.0	344	41.7	546	355.6	6	10.9	20	3.8
350	38	.0350.380.0	424	45.5	546	355.6	6	11	15	6.4
400	10	.0400.100.0	287	66.5	596	406.4	15	14.4	141.6	2.6
400	20	.0400.200.0	350	69	596	406.4	15	14.4	70.8	5.2
400	28	.0400.280.0	413	71.5	596	406.4	15	14.4	47.2	7.9
450	10	.0450.100.0	300	79.7	656	457	15	18.2	164.5	3.4
450	19	.0450.190.0	366	82.7	656	457	15	18.2	82.2	6.9
450	26	.0450.260.0	432	85.6	656	457	15	18.2	54.8	10.4
500	11	.0500.110.0	327	89.2	716	508	12	22.5	179.2	4.5
500	20	.0500.200.0	396	92.7	716	508	12	22.5	89.6	9
500	28	.0500.280.0	488	97.3	716	508	12	22.5	53.7	15
600	10	.0600.100.0	350	145.9	816	610	15	32	254.5	7.2
600	16	.0600.160.0	398	147.9	816	610	15	32	152.7	12
600	21	.0600.210.0	476	152.3	816	610	15	32	95.4	19.3

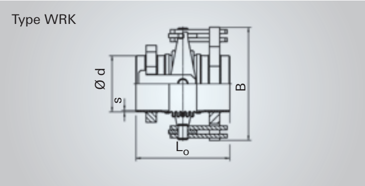
ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 02 ... PN 2.5



Nominal diameter	Nominal angular movement absorption	Typ WRK 02...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
700	9	.0700.090.0	392	208.6	970	711	15	77.8	325.4	10.5
700	17	.0700.170.0	476	215	970	711	15	77.5	181.5	20.9
700	25	.0700.250.0	616	225.5	970	711	15	77.4	102.8	38.4
800	8.4	.0800.084.0	429	279	1080	813	15	100.5	456.3	14
800	18	.0800.180.0	545	287.8	1080	813	15	99.8	248.4	32.6
800	26	.0800.260.0	661	309.7	1080	813	15	100.7	187	51.7
900	7.4	.0900.074.0	452	343.9	1200	914	15	128.3	628	18.6
900	14	.0900.140.0	542	351.4	1200	914	15	127.5	397.2	36.9
900	20	.0900.200.0	692	364.5	1200	914	15	127.5	216.7	67.7
1000	7.8	.1000.078.0	520	482.6	1310	1016	15	157.4	814.7	24.3
1000	14	.1000.140.0	598	483.6	1310	1016	15	156.1	564.1	48.3
1000	17	.1000.170.0	670	502.1	1310	1016	15	157.6	458.8	67
1200	6.6	.1200.066.0	522	722.5	1544	1220	20	295.9	1752	34.3
1200	12	.1200.120.0	618	740.8	1544	1220	20	295.9	876	68.6
1200	18	.1200.180.0	746	764.1	1544	1220	20	295.4	561.3	114.2
1400	7.8	.1400.078.0	643	923.9	1744	1420	15	399.2	2844.6	112.3
1400	12	.1400.120.0	812	976.7	1744	1420	15	399.6	2541	194.1
1600	6.8	.1600.068.0	673	1328.6	1994	1620	15	645.6	4162.6	145.3
1600	11	.1600.110.0	828	1363.7	1994	1620	15	645.6	2497.5	242.1
1800	9.6	.1800.096.0	828	1629.9	2184	1820	15	811.1	3500	304.2
2000	8.6	.2000.086.0	848	2132.9	2404	2020	15	995.4	4738.8	373.3

ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 06 ... PN 6



06

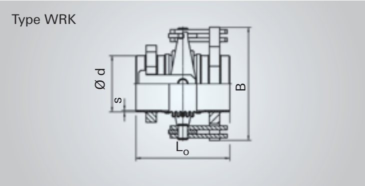
Nominal diameter	Nominal angular movement absorption	Typ WRK 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
50	18	.0050.180.0	217	8.2
50	28	.0050.280.0	235	8.4
50	37	.0050.370.0	253	8.6
65	17	.0065.170.0	217	9.4
65	27	.0065.270.0	235	9.6
65	39	.0065.390.0	262	9.9
80	17	.0080.170.0	220	10.5
80	27	.0080.270.0	240	10.7
80	38	.0080.380.0	270	11.1
100	17	.0100.170.0	223	12.4
100	27	.0100.270.0	245	12.7
100	38	.0100.380.0	278	13.2
125	19	.0125.190.0	245	14.3
125	30	.0125.300.0	276	15
125	39	.0125.390.0	304	15.4
150	15	.0150.150.0	248	16.8
150	27	.0150.270.0	290	17.6
150	36	.0150.360.0	332	18.4
200	14	.0200.140.0	268	27.3
200	29	.0200.290.0	332	28.6
200	40	.0200.400.0	390	31.6

06

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
195	60.3	2.9	0.4	2.5	0
195	60.3	2.9	0.4	1.5	0
195	60.3	2.9	0.4	1.1	0
215	76.1	2.9	0.6	3.2	0
215	76.1	2.9	0.6	1.9	0
215	76.1	2.9	0.6	1.2	0.1
230	88.9	3.2	0.8	3.9	0
230	88.9	3.2	0.8	2.3	0.1
230	88.9	3.2	0.8	1.5	0.2
260	114.3	3.6	1.3	5.5	0.1
260	114.3	3.6	1.3	3.3	0.2
260	114.3	3.6	1.3	2.3	0.3
285	139.7	4	1.8	5	0.2
285	139.7	4	1.8	6	0.3
285	139.7	4	1.8	4.3	0.5
320	168.3	4	2.6	14.3	0.3
320	168.3	4	2.6	7.1	0.6
320	168.3	4	2.6	4.8	0.9
380	219.1	4.5	4.3	22.2	0.6
380	219.1	4.5	4.2	11.7	1.3
380	219.1	4.5	4.3	11.7	2.1

ANGULAR EXPANSION JOINTS WITH WELD ENDS

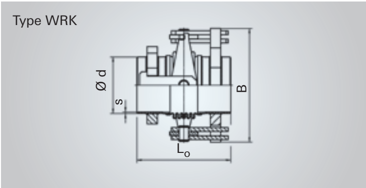
GIMBAL HINGE VERSION TYPE WRK 06 ... PN 6



Nominal diameter	Nominal angular movement absorption	Typ WRK 06...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	14	.0250.140.0	274	38.5	445	273	5	6.6	52.3	1
250	22	.0250.220.0	310	39.9	445	273	5	6.6	31.4	1.7
250	32	.0250.320.0	364	42	445	273	5	6.6	19.6	2.7
300	14	.0300.140.0	294	50.7	495	323.9	5.6	9.3	63.2	1.6
300	22	.0300.220.0	334	52.5	495	323.9	5.6	9.3	37.9	2.7
300	34	.0300.340.0	402	56.3	495	323.9	5.6	9.2	33.6	4.5
350	13	.0350.130.0	317	75.2	580	355.6	8	19.9	87	2
350	25	.0350.250.0	380	78.8	580	355.6	8	19.8	48.7	4
350	34	.0350.340.0	452	84.6	580	355.6	8	20	34.6	6.3
400	10	.0400.100.0	330	98.7	640	406.4	8	26.2	194.5	2.7
400	19	.0400.190.0	396	103.5	640	406.4	8	26.2	97.2	5.5
400	27	.0400.270.0	484	109.5	640	406.4	8	26.2	58.3	9.2
450	9.8	.0450.098.0	343	118	700	457	8	32.9	247.6	3.6
450	18	.0450.180.0	412	123.3	700	457	8	32.9	123.8	7.3
450	24	.0450.240.0	481	128.4	700	457	8	32.8	86.3	10.9
500	10	.0500.100.0	383	152.1	750	508	8	40.7	347	4.9
500	17	.0500.170.0	433	157.2	750	508	8	40.7	208.2	8.2
500	26	.0500.260.0	533	167.5	750	508	8	40.7	115.7	14.7
600	10	.0600.100.0	412	245.9	904	610	8	77.2	493.5	7.8
600	16	.0600.160.0	468	254	904	610	8	77.2	296.1	13
600	25	.0600.250.0	580	268.5	904	610	8	76.7	192.2	23.3

ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 06 ... PN 6



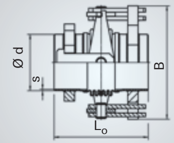
Type WRK

Nominal diameter	Nominal angular movement absorption	Typ WRK 06...	Overall length	Weight approx.
DN	$2\alpha_N$	–	L_o	G
–	Grad	–	mm	kg
700	17	.0700.170.0	536	348.9
700	24	.0700.240.0	638	380.7
800	16	.0800.160.0	590	464.6
800	23	.0800.230.0	722	493.7
900	14	.0900.140.0	660	728.1
900	20	.0900.200.0	792	764.8
1000	13	.1000.130.0	706	864.8
1000	19	.1000.190.0	846	906.2
1200	12	.1200.120.0	726	1165.1
1200	17	.1200.170.0	866	1211.2
1400	11	.1400.110.0	912	1818.4
1600	9.4	.1600.094.0	972	2664.6

Max. width approx.	Weld end		Spring rate		
	outside diameter	wall thickness			
B	d	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
1014	711	8	102.7	464.1	20.8
1014	711	8	104.1	341.5	33.9
1124	813	10	134.9	668.3	32.2
1124	813	10	134.9	401	53.7
1284	914	10	214.8	948.3	41.1
1284	914	10	214.8	569	68.5
1394	1016	10	263.7	1188.9	53.5
1394	1016	10	263.7	713.4	89.2
1594	1220	10	369.6	2001.8	75
1594	1220	10	369.3	1242.8	124.9
1840	1420	15	666	2541	194.1
2086	1620	15	1077	3716.4	251.1

ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 10 ... PN 10

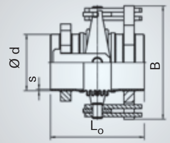
Type WRK



Nominal diameter	Nominal angular movement absorption	Typ WRK 10...	Overall length	Weight approx.	Max. width approx.	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	17	.0050.170.0	217	8.2	195	60.3	2.9	0.4	2.5	0
50	27	.0050.270.0	235	8.4	195	60.3	2.9	0.4	1.5	0
50	37	.0050.370.0	262	8.7	195	60.3	2.9	0.4	0.9	0
65	16	.0065.160.0	217	9.4	215	76.1	2.9	0.6	3.2	0
65	29	.0065.290.0	244	9.7	215	76.1	2.9	0.6	2	0.1
65	37	.0065.370.0	270	10.2	215	76.1	2.9	0.6	1.8	0.1
80	16	.0080.160.0	223	10.6	230	88.9	3.2	0.8	6.3	0
80	25	.0080.250.0	245	10.8	230	88.9	3.2	0.8	3.8	0.1
80	36	.0080.360.0	278	11.4	230	88.9	3.2	0.8	2.4	0.2
100	17	.0100.170.0	226	12.6	260	114.3	3.6	1.3	8.2	0.1
100	26	.0100.260.0	250	13	260	114.3	3.6	1.3	4.9	0.2
100	36	.0100.360.0	281	14	260	114.3	3.6	1.3	6.3	0.3
125	16	.0125.160.0	258	16.7	285	139.7	4	1.8	10.1	0.2
125	25	.0125.250.0	286	17.2	285	139.7	4	1.8	6	0.3
125	32	.0125.320.0	314	17.6	285	139.7	4	1.8	5.3	0.5
150	15	.0150.150.0	261	21.1	320	168.3	4	2.6	25.2	0.3
150	27	.0150.270.0	306	22.3	320	168.3	4	2.6	12.6	0.6
150	36	.0150.360.0	351	23.4	320	168.3	4	2.6	8.4	1
200	14	.0200.140.0	281	33.5	380	219.1	4.5	4.3	39.1	0.6
200	26	.0200.260.0	332	35.1	380	219.1	4.5	4.3	19.6	1.2
200	34	.0200.340.0	383	37.6	380	219.1	4.5	4.3	15.9	1.9

ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 10 ... PN 10

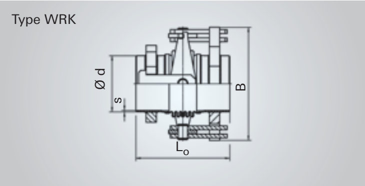
Type WRK



Nominal diameter	Nominal angular movement absorption	Typ WRK 10...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	14	.0250.140.0	304	58.7	480	273	5	12	52.3	1
250	21	.0250.210.0	340	60.4	480	273	5	11.8	46.1	1.7
250	30	.0250.300.0	402	64.4	480	273	5	11.9	29.9	2.9
300	15	.0300.150.0	327	81.9	540	323.9	5.6	16.8	75.7	1.7
300	23	.0300.230.0	374	86.5	540	323.9	5.6	16.9	60	2.9
300	29	.0300.290.0	418	89.5	540	323.9	5.6	16.7	53.6	4.1
350	13	.0350.130.0	330	89.7	580	355.6	8	20	103.7	2.1
350	21	.0350.210.0	379	94.9	580	355.6	8	20.1	82	3.7
350	26	.0350.260.0	425	98.1	580	355.6	8	20	65.5	5.1
400	9.4	.0400.094.0	346	120.5	640	406.4	8	26.3	396.4	3
400	18	.0400.180.0	418	128.6	640	406.4	8	26.3	198.2	6.1
400	26	.0400.260.0	514	139.2	640	406.4	8	26.3	118.9	10.2
450	9.6	.0450.096.0	379	158.7	720	457	8	33.1	481.8	4
450	16	.0450.160.0	429	164.9	720	457	8	33.1	289.1	6.6
450	23	.0450.230.0	504	174.1	720	457	8	33.1	180.7	10.6
500	10	.0500.100.0	429	246.7	794	508	10	54.5	525.9	5.3
500	16	.0500.160.0	483	255.4	794	508	10	54.6	303.2	8.9
500	24	.0500.240.0	564	268	794	508	10	54.4	205.4	14.2
600	15	.0600.150.0	493	328.5	904	610	10	77.3	464.9	13.5
600	23	.0600.230.0	609	348.1	904	610	10	76.8	302.5	24.2

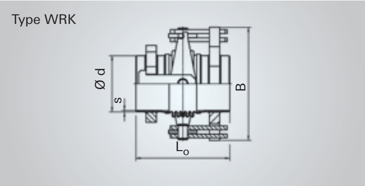
ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 10 ... PN 10



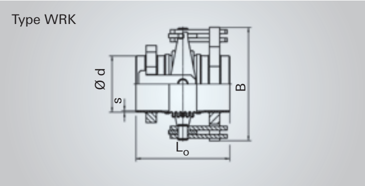
Nominal diameter	Nominal angular movement absorption	Typ WRK 10...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
700	16	.0700.160.0	610	571.6	1064	711	12	130.5	690.5	24.2
700	22	.0700.220.0	706	599.3	1064	711	12	130.5	460.3	36.3
800	15	.0800.150.0	646	689.5	1164	813	12	168	1073.7	33.1
800	22	.0800.220.0	782	731.8	1164	813	12	168.6	577.5	55.4
900	14	.0900.140.0	686	907.7	1294	914	12	214.6	1413.9	42.3
900	20	.0900.200.0	822	951.4	1294	914	12	214.4	879.6	70.4
1000	11	.1000.110.0	782	1368.2	1450	1016	15	354.6	2503.4	55.5
1000	16	.1000.160.0	926	1432.4	1450	1016	15	354.6	1502	92.5
1200	15	.1200.150.0	939	2022.4	1686	1220	15	613.1	2373.6	118.4
1400	10	.1400.100.0	1027	3323.5	1986	1420	15	1042.7	4658.8	187.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 16 ... PN 16



Nominal diameter	Nominal angular movement absorption	Typ WRK 16...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	16	.0050.160.0	217	8.3	195	60.3	2.9	0.4	3.7	0
50	25	.0050.250.0	235	8.5	195	60.3	2.9	0.4	2.2	0
50	34	.0050.340.0	262	8.8	195	60.3	2.9	0.4	1.4	0
65	16	.0065.160.0	220	9.5	215	76.1	2.9	0.6	4.9	0
65	25	.0065.250.0	240	9.8	215	76.1	2.9	0.6	2.9	0.1
65	34	.0065.340.0	278	10.6	215	76.1	2.9	0.7	3.3	0.1
80	14	.0080.140.0	236	12.4	230	88.9	3.2	0.8	11.6	0
80	23	.0080.230.0	260	12.8	230	88.9	3.2	0.8	6.9	0.1
80	32	.0080.320.0	296	13.4	230	88.9	3.2	0.8	4.3	0.2
100	15	.0100.150.0	239	14.9	260	114.3	3.6	1.3	14.7	0.1
100	24	.0100.240.0	265	15.4	260	114.3	3.6	1.3	8.8	0.2
100	33	.0100.330.0	304	16.2	260	114.3	3.6	1.3	5.5	0.4
125	15	.0125.150.0	258	18	285	139.7	4	1.8	18	0.2
125	24	.0125.240.0	286	18.7	285	139.7	4	1.8	10.8	0.3
125	33	.0125.330.0	336	20.2	285	139.7	4	1.8	8.1	0.6
150	14	.0150.140.0	271	24.8	320	168.3	4	2.6	25.2	0.3
150	22	.0150.220.0	301	25.5	320	168.3	4	2.6	17.6	0.5
150	31	.0150.310.0	354	27.3	320	168.3	4	2.6	12.3	0.9
200	14	.0200.140.0	314	54.1	420	219.1	4.5	7.9	63	0.6
200	22	.0200.220.0	350	56.4	420	219.1	4.5	7.9	37.8	1.1
200	31	.0200.310.0	404	59.3	420	219.1	4.5	7.8	27.1	1.8

ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 16 ... PN 16

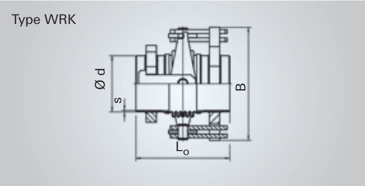


06

Nominal diameter	Nominal angular movement absorption	Typ WRK 16...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	9	.0250.090.0	317	69.4	480	273	5	12.1	159.9	1.1
250	16	.0250.160.0	374	72.8	480	273	5	12.1	79.9	2.2
250	23	.0250.230.0	431	78.4	480	273	5	12.1	67.2	3.3
300	9.6	.0300.096.0	337	97.3	540	323.9	5.6	16.9	245.5	1.7
300	15	.0300.150.0	379	100.7	540	323.9	5.6	16.9	147.3	2.8
300	22	.0300.220.0	463	107.3	540	323.9	5.6	16.8	86.2	5.1
350	8.8	.0350.088.0	357	124.5	600	355.6	8	20.3	288.2	2
350	14	.0350.140.0	399	128	600	355.6	8	20.1	191.3	3.4
350	20	.0350.200.0	483	134.8	600	355.6	8	20	124.6	6.1
400	15	.0400.150.0	444	197.9	684	406.4	8	35.4	310.3	5.5
400	23	.0400.230.0	548	215	684	406.4	8	35.4	172.4	10
450	14	.0450.140.0	454	236	744	457	8	44.4	392.4	6.9
450	22	.0450.220.0	558	255.1	744	457	8	44.4	218	12.5
500	16	.0500.160.0	508	305.4	794	508	10	54.6	446.7	9.2
500	22	.0500.220.0	578	326.1	794	508	10	55	375.7	13.9
600	12	.0600.120.0	578	500.2	944	610	12	96.9	1026.1	16.8
600	16	.0600.160.0	668	524	944	610	12	96.9	684.1	25.3
700	16	.0700.160.0	717	694.7	1064	711	12	130.5	903.2	35.2
800	15	.0800.150.0	800	1075.2	1220	813	15	223.5	1512.4	46.6
900	11	.0900.110.0	806	1573.7	1386	914	15	359.6	2866	42.5
900	16	.0900.160.0	932	1634.5	1386	914	15	358.9	1842.2	70.7
1000	14	.1000.140.0	972	1928.5	1496	1016	15	443.3	2436.3	87.9

ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 25 ... PN 25

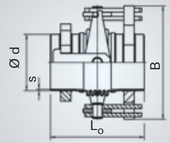


Nominal diameter	Nominal angular movement absorption	Typ WRK 25...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	14	.0050.140.0	230	9.5	195	60.3	2.9	0.4	7	0
50	22	.0050.220.0	250	9.8	195	60.3	2.9	0.4	4.2	0
50	30	.0050.300.0	280	10.2	195	60.3	2.9	0.4	2.6	0.1
65	15	.0065.150.0	233	11	215	76.1	2.9	0.7	8.8	0
65	23	.0065.230.0	255	11.4	215	76.1	2.9	0.7	5.3	0.1
65	29	.0065.290.0	277	11.8	215	76.1	2.9	0.7	3.8	0.1
80	14	.0080.140.0	236	12.5	230	88.9	3.2	0.9	13.8	0
80	22	.0080.220.0	260	12.9	230	88.9	3.2	0.9	8.3	0.1
80	28	.0080.280.0	284	13.4	230	88.9	3.2	0.9	5.9	0.2
100	14	.0100.140.0	249	17.8	260	114.3	3.6	1.3	17.6	0.1
100	22	.0100.220.0	275	18.4	260	114.3	3.6	1.3	10.6	0.2
100	27	.0100.270.0	301	18.9	260	114.3	3.6	1.3	9.9	0.3
125	14	.0125.140.0	274	21.8	285	139.7	4	1.8	31.2	0.2
125	22	.0125.220.0	306	22.8	285	139.7	4	1.8	18.7	0.4
125	27	.0125.270.0	338	23.7	285	139.7	4	1.8	13.4	0.6
150	13	.0150.130.0	314	46.9	360	168.3	4	4.8	43.6	0.3
150	20	.0150.200.0	346	48.6	360	168.3	4	4.7	28.3	0.6
150	27	.0150.270.0	394	50.7	360	168.3	4	4.7	20.7	0.9
200	9	.0200.090.0	324	61.3	420	219.1	4.5	7.9	140.4	0.6
200	16	.0200.160.0	378	64.8	420	219.1	4.5	7.9	70.2	1.3
200	22	.0200.220.0	432	69.5	420	219.1	4.5	8	56.9	2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 25 ... PN 25

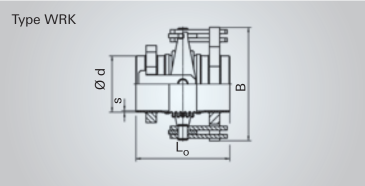
Type WRK



Nominal diameter	Nominal angular movement absorption	Typ WRK 25...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	9	.0250.090.0	330	81.7	480	273	5	12.2	244.9	1.1
250	14	.0250.140.0	370	84.9	480	273	5	12.2	146.9	1.9
250	20	.0250.200.0	430	89.6	480	273	5	12.1	97.3	3.1
300	8.6	.0300.086.0	380	155.4	584	323.9	5.6	22.5	313.3	1.7
300	14	.0300.140.0	424	160.2	584	323.9	5.6	22.5	198.3	2.9
300	18	.0300.180.0	490	167.4	584	323.9	5.6	22.3	146.2	4.7
350	14	.0350.140.0	454	198.7	624	355.6	10	27.3	274.6	3.9
350	20	.0350.200.0	550	212.5	624	355.6	10	27.2	168.6	7.1
400	12	.0400.120.0	484	243.6	684	406.4	10	35.3	527.4	6.4
400	16	.0400.160.0	559	256.6	684	406.4	10	35.3	351.6	9.6
450	12	.0450.120.0	550	384.6	784	457	10	55.4	668	8.3
450	16	.0450.160.0	628	401.9	784	457	10	55.4	445.3	12.5
500	10	.0500.100.0	576	465.7	844	508	12	68.7	1166	9.9
500	16	.0500.160.0	696	499	844	508	12	68.7	647.8	17.9
600	15	.0600.150.0	764	818.6	1000	610	15	130.2	847.4	27.2
700	14	.0700.140.0	853	1232.2	1156	711	15	217.3	1393.9	37.4

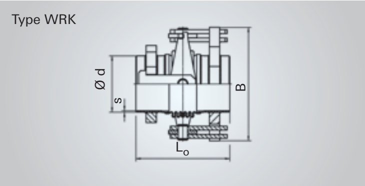
ANGULAR EXPANSION JOINTS WITH WELD ENDS

GIMBAL HINGE VERSION TYPE WRK 40 ... PN 40



Nominal diameter	Nominal angular movement absorption	Typ WRK 40...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	14	.0050.140.0	233	9.6	195	60.3	2.9	0.4	8.7	0
50	21	.0050.210.0	255	9.9	195	60.3	2.9	0.4	5.2	0
50	25	.0050.250.0	277	10.3	195	60.3	2.9	0.4	3.7	0.1
65	12	.0065.120.0	236	11.3	215	76.1	2.9	0.7	15.9	0
65	19	.0065.190.0	260	11.8	215	76.1	2.9	0.7	9.6	0.1
65	26	.0065.260.0	296	12.6	215	76.1	2.9	0.7	6	0.1
80	13	.0080.130.0	249	14.4	225	88.9	3.2	0.9	19	0.1
80	20	.0080.200.0	275	14.9	225	88.9	3.2	0.9	11.4	0.1
80	24	.0080.240.0	301	15.6	225	88.9	3.2	0.9	8.2	0.2
100	7.8	.0100.078.0	249	18.9	260	114.3	3.6	1.3	44.8	0.1
100	12	.0100.120.0	275	19.4	260	114.3	3.6	1.3	26.9	0.2
100	17	.0100.170.0	327	20.9	260	114.3	3.6	1.3	22.2	0.4
125	8.6	.0125.086.0	304	39	330	139.7	4	3.3	72.1	0.2
125	13	.0125.130.0	336	40.6	330	139.7	4	3.3	43.3	0.4
125	17	.0125.170.0	368	42	330	139.7	4	3.3	30.9	0.6
150	8.6	.0150.086.0	314	47.7	360	168.3	4	4.8	95.6	0.3
150	13	.0150.130.0	346	49.6	360	168.3	4	4.8	57.3	0.6
150	17	.0150.170.0	378	51	360	168.3	4	4.7	51	0.8
200	7.8	.0200.078.0	350	76.4	420	219.1	4.5	8	253.2	0.7
200	12	.0200.120.0	390	79.6	420	219.1	4.5	8	151.9	1.2
200	17	.0200.170.0	450	84.3	420	219.1	4.5	8	95	2

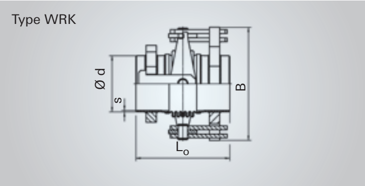
ANGULAR EXPANSION JOINTS WITH WELD ENDS GIMBAL HINGE VERSION TYPE WRK 40 ... PN 40



Nominal diameter	Nominal angular movement absorption	Typ WRK 40...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	12	.0250.120.0	415	142.8	524	273	6.3	16.4	202.6	2
250	17	.0250.170.0	478	150.2	524	273	6.3	16.2	155.8	3.2
300	9.2	.0300.092.0	449	196.8	584	323.9	7.1	22.6	499.5	3.1
300	14	.0300.140.0	541	209.7	584	323.9	7.1	22.6	277.5	5.6
350	9.6	.0350.096.0	506	299.2	674	355.6	10	34.2	530.1	3.9
350	14	.0350.140.0	600	315.4	674	355.6	10	33.9	341.6	7
400	14	.0400.140.0	627	373.7	724	406.4	10	44	460.8	10.3
450	13	.0450.130.0	654	466.9	784	457	10	55.6	701.9	12.4
500	11	.0500.110.0	749	708.3	890	508	12	91.2	1140.4	17.2

ANGULAR EXPANSION JOINTS WITH WELD ENDS

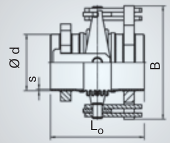
GIMBAL HINGE VERSION TYPE WRK 63 ... PN 63



Nominal diameter	Nominal angular movement absorption	Typ WRK 63...	Overall length	Weight approx.	Max. width approx.	Weld end		Spring rate		
						outside diameter	wall thickness			
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
50	9	.0050.090.0	242	10.6	195	60.3	2.9	0.4	17.8	0
50	13	.0050.130.0	262	10.8	195	60.3	2.9	0.4	10.7	0
50	16	.0050.160.0	284	11.1	195	60.3	2.9	0.4	7.6	0
65	8.6	.0065.086.0	246	13.4	215	76.1	3.2	0.7	27.9	0
65	13	.0065.130.0	270	13.8	215	76.1	3.2	0.7	16.7	0.1
65	17	.0065.170.0	306	14.5	215	76.1	3.2	0.7	10.5	0.1
80	8.2	.0080.082.0	256	17.2	225	88.9	4	0.9	36.3	0
80	13	.0080.130.0	280	17.7	225	88.9	4	0.9	21.8	0.1
80	16	.0080.160.0	304	18.1	225	88.9	4	0.8	18	0.2
100	6.6	.0100.066.0	292	36.9	300	114.3	4.5	2.4	85.2	0.1
100	10	.0100.100.0	320	38.1	300	114.3	4.5	2.4	51.1	0.2
100	14	.0100.140.0	362	39.8	300	114.3	4.5	2.4	32	0.4
125	8.4	.0125.084.0	317	44.8	330	139.7	6.3	3.3	89.7	0.2
125	11	.0125.110.0	334	45.5	330	139.7	6.3	3.3	67.3	0.3
125	16	.0125.160.0	385	47.8	330	139.7	6.3	3.3	45	0.6
150	7	.0150.070.0	347	60.7	360	168.3	5.6	4.8	175.6	0.4
150	11	.0150.110.0	385	62.9	360	168.3	5.6	4.8	105.4	0.7
150	14	.0150.140.0	423	65.3	360	168.3	5.6	4.8	75.3	1
200	5.2	.0200.052.0	393	127.7	464	219.1	8	10.6	513.6	0.8
200	10	.0200.100.0	456	134.5	464	219.1	8	10.6	256.8	1.6
200	13	.0200.130.0	519	140.9	464	219.1	8	10.6	171.2	2.4

ANGULAR EXPANSION JOINTS WITH WELD ENDS

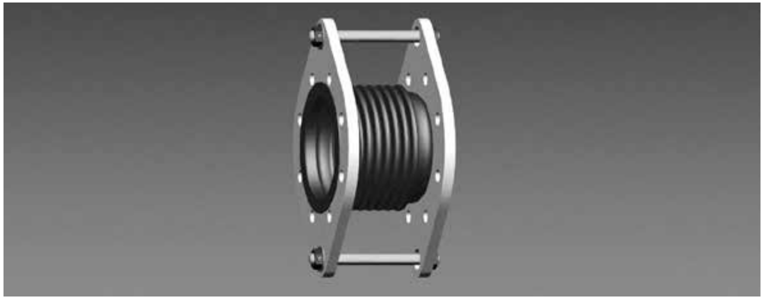
GIMBAL HINGE VERSION TYPE WRK 63 ... PN 63



06

Nominal diameter	Nominal angular movement absorption	Typ WRK 63...	Overall length	Weight approx.	Max. width approx.	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\alpha_N$	–	L_o	G	B	d	s	c_r	c_α	c_p
–	Grad	–	mm	kg	mm	mm	mm	Nm/bar	Nm/deg	Nm/deg bar
250	8	.0250.080.0	465	193	554	273	8.8	16.4	471.3	2.2
250	12	.0250.120.0	557	205.5	554	273	8.8	16.4	261.8	4.1
300	8.2	.0300.082.0	521	305.5	624	323.9	10	28.3	636.1	3.4
300	11	.0300.110.0	600	322.5	624	323.9	10	28.5	442.6	5.7
350	9.6	.0350.096.0	636	393.4	674	355.6	12	34.8	719.7	5.8
350	13	.0350.130.0	723	413.4	674	355.6	12	34.8	479.8	8.7
400	10	.0400.100.0	763	607.1	780	406.4	15	59.4	956.3	11.2

LATERAL EXPANSION JOINTS WITH FLANGES TYPE LBR, LFR



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type LBR: HYDRA lateral expansion joint with loose flanges, for movement in all planes
Type LFR: HYDRA lateral expansion joint with plain fixed flanges, for movement in all planes

Standard version/materials:
Multi-ply bellows made of 1.4541
Flange made of P265GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

LBR	10	·	0150	·	102	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal ($2\lambda = \pm 51 =$ 102 mm)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

06

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ______
- Piping - nominal diameter DN ______

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

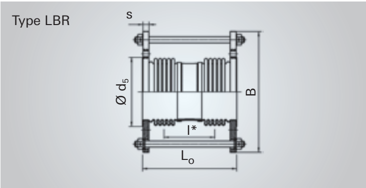
Design data:
- Max. allowable pressure [bar] ______
- Max./min. allowable temperature [°C] ______
- Test pressure PT [bar] ______

Optional:
- Category ______

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 06 ... PN 6



Nominal diameter	Nominal lateral movement absorption	Type LBR 06...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	51	.0050.051.0	252	6	240
50	102	.0050.102.0	362	6.6	240
50	154	.0050.154.0	472	7.1	240
50	196	.0050.196.0	561	8.6	240
65	53	.0065.053.0	262	7.1	260
65	104	.0065.104.0	372	7.7	260
65	151	.0065.151.0	431	8	260
65	204	.0065.204.0	511	9.6	260
80	53	.0080.053.0	275	9.8	290
80	102	.0080.102.0	385	10.5	290
80	144	.0080.144.0	444	10.8	290
80	201	.0080.201.0	595	13.6	290
100	52	.0100.052.0	275	10.9	310
100	103	.0100.103.0	385	11.6	310
100	151	.0100.151.0	454	14.1	310
100	204	.0100.204.0	595	15.9	310
125	51	.0125.051.0	311	14.2	340
125	103	.0125.103.0	451	15.2	340
125	153	.0125.153.0	581	19.9	340
125	203	.0125.203.0	711	22.1	340

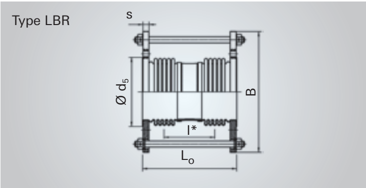
Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
136	6	90	16	5.4	13	0
246	6	90	16	3.8	4	0
356	6	90	16	3	2	0
445	6	90	16	2.5	1	0
141	6	107	16	7.9	16	0
251	6	107	16	5.7	5	0
310	6	107	16	4.9	3	0
390	6	107	16	4.2	2	0
146	6	122	18	9.7	20	0
256	6	122	18	7	7	0
315	6	122	18	6.1	4	0
466	6	122	18	4.6	2	0
141	6	147	18	15.1	27	0
251	6	147	18	10.9	9	0
320	6	147	18	9.3	5	0
461	6	147	18	7.2	3	0
167	6	178	20	17.9	30	0
307	6	178	20	12.5	9	0
437	6	178	20	9.8	5	0
567	6	178	20	8	3	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

06

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 06 ... PN 6



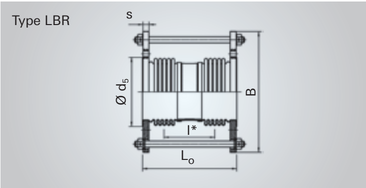
Nominal diameter	Nominal lateral movement absorption	Type LBR 06...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	53	.0150.053.0	330	17.6	365
150	101	.0150.101.0	450	18.8	365
150	144	.0150.144.0	570	23.3	365
150	195	.0150.195.0	690	25.7	365
200	51	.0200.051.0	343	25.1	420
200	100	.0200.100.0	473	27	420
200	153	.0200.153.0	602	34	420
200	198	.0200.198.0	732	37.7	420
250	50	.0250.050.0	367	35	503
250	102	.0250.102.0	527	43.4	503
250	153	.0250.153.0	636	47.8	503
250	212	.0250.212.0	806	54.7	503
300	50	.0300.050.0	377	47.3	600
300	101	.0300.101.0	537	51.3	600
300	152	.0300.152.0	687	55.1	600
300	196	.0300.196.0	840	76.4	600
300	280	.0300.280.0	1140	93	600
350	52	.0350.052.0	409	60.1	650
350	102	.0350.102.0	579	64.6	650
350	148	.0350.148.0	752	78.7	650
350	195	.0350.195.0	902	85.6	650
350	300	.0350.300.0	1252	101.7	650

Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
166	6	202	20	24.4	59	0
286	6	202	20	18.1	21	0
406	6	202	20	14.4	10	0
526	6	202	20	11.9	6	0
166	6	258	22	47.2	90	0
296	6	258	22	34.9	30	0
425	6	258	22	27.7	15	0
555	6	258	22	22.9	9	0
171	6	312	24	89.5	113	0
331	6	312	24	64.1	32	0
440	6	312	24	53.7	18	0
610	6	312	24	42.8	10	0
191	6	365	24	165.9	141	0
351	6	365	24	121.5	43	0
501	6	365	24	97.1	21	0
654	6	365	24	80.6	13	0
954	6	365	24	60.5	6	0
215	6	410	26	184.2	154	0
385	6	410	26	135.3	50	0
558	6	410	26	106.5	24	0
708	6	410	26	89.9	15	0
1058	6	410	26	65.9	7	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 06 ... PN 6



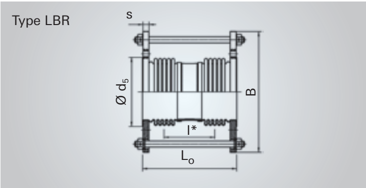
06

Nominal diameter	Nominal lateral movement absorption	Type LBR 06...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2)			Spring rate		
							drilling as per DIN 1092	rim diameter	thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	d_5	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
400	51	.0400.051.0	464	79	724	231	6	465	28	267	233	0
400	100	.0400.100.0	667	93.5	724	434	6	465	28	194.5	70	0
400	158	.0400.158.0	867	104.7	724	634	6	465	28	153.5	33	0
400	200	.0400.200.0	1017	113.1	724	784	6	465	28	132.5	22	0
400	294	.0400.294.0	1417	135.5	724	1184	6	465	28	97.1	10	0
450	50	.0450.050.0	474	88.6	779	236	6	520	28	329.4	283	0
450	97	.0450.097.0	677	104.4	779	439	6	520	28	241.2	86	0
450	152	.0450.152.0	877	116.6	779	639	6	520	28	190.8	41	0
450	192	.0450.192.0	1027	125.8	779	789	6	520	28	165	27	0
450	289	.0450.289.0	1388	152.8	779	1144	6	520	28	124.8	17	0
500	52	.0500.052.0	485	111	865	236	6	570	28	454.5	392	0
500	104	.0500.104.0	702	129.6	865	453	6	570	28	330.4	113	0
500	147	.0500.147.0	852	140.4	865	603	6	570	28	278	65	0
500	207	.0500.207.0	1052	154.8	865	803	6	570	28	229.4	37	0
500	289	.0500.289.0	1352	176.4	865	1103	6	570	28	181.8	20	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 10 ... PN 10



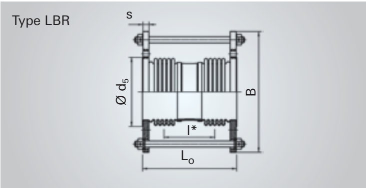
Nominal diameter	Nominal lateral movement absorption	Type LBR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	51	.0050.051.0	258	8.7	265
50	102	.0050.102.0	368	9.2	265
50	146	.0050.146.0	467	10.5	265
50	202	.0050.202.0	617	11.6	265
65	53	.0065.053.0	270	10.2	285
65	104	.0065.104.0	380	10.8	285
65	146	.0065.146.0	439	11.1	285
65	201	.0065.201.0	579	13.3	285
80	53	.0080.053.0	300	12.2	300
80	101	.0080.101.0	420	13.1	300
80	142	.0080.142.0	459	13.4	300
80	202	.0080.202.0	660	16.3	300
100	50	.0100.050.0	289	13.6	320
100	100	.0100.100.0	419	14.4	320
100	115	.0100.115.0	438	14.5	320
100	203	.0100.203.0	728	20.3	320
125	50	.0125.050.0	314	18.1	350
125	100	.0125.100.0	434	19.2	350
125	153	.0125.153.0	554	22.9	350
125	200	.0125.200.0	664	24.8	350

Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
136	10	92	19	5.3	13	0
246	10	92	19	3.8	4	0
345	10	92	19	3	2	0
495	10	92	19	2.3	1	0
141	10	107	20	7.7	16	0
251	10	107	20	5.5	5	0
310	10	107	20	4.8	3	0
450	10	107	20	3.7	2	0
161	10	122	20	9.1	29	0
281	10	122	20	6.5	10	0
320	10	122	20	6	8	0
521	10	122	20	4.2	3	0
159	10	147	22	14.4	27	0
289	10	147	22	10.1	8	0
308	10	147	22	9.6	7	0
598	10	147	22	5.9	2	0
151	10	178	22	17.9	51	0
271	10	178	22	13.1	16	0
391	10	178	22	10.3	8	0
501	10	178	22	8.7	5	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 10 ... PN 10

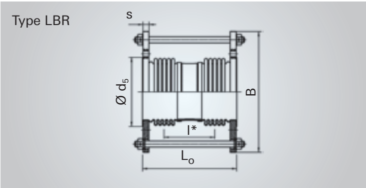


Nominal diameter	Nominal lateral movement absorption	Type LBR 10...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange[2)] drilling as per DIN 1092	Flange[2)] rim diameter	Flange[2)] thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	d_5	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
150	51	.0150.051.0	339	24.6	385	161	10	208	24	29.2	75	0
150	102	.0150.102.0	469	26.4	385	291	10	208	24	21.5	24	0
150	145	.0150.145.0	589	30.9	385	411	10	208	24	17.3	12	0
150	195	.0150.195.0	709	33.4	385	531	10	208	24	14.4	7	0
200	52	.0200.052.0	364	33.7	468	199	10	258	24	59.3	93	0
200	100	.0200.100.0	534	41	468	369	10	258	24	41.6	28	0
200	153	.0200.153.0	673	45.3	468	508	10	258	24	33.4	15	0
200	206	.0200.206.0	853	50.9	468	688	10	258	24	26.6	8	0
250	52	.0250.052.0	394	47.4	555	207	10	320	26	115.8	112	0
250	101	.0250.101.0	553	57.3	555	366	10	320	26	85.7	37	0
250	152	.0250.152.0	713	64.4	555	526	10	320	26	68	18	0
250	198	.0250.198.0	883	72	555	696	10	320	26	55.7	10	0
300	51	.0300.051.0	403	65.8	629	199	10	370	28	195	204	0
300	102	.0300.102.0	563	71.8	629	359	10	370	28	146.4	65	0
300	145	.0300.145.0	716	87.6	629	512	10	370	28	118.2	32	0
300	196	.0300.196.0	866	96.7	629	662	10	370	28	99.4	20	0
300	284	.0300.284.0	1166	114.8	629	962	10	370	28	75.5	9	0
350	50	.0350.050.0	421	79.5	689	213	10	410	28	223.8	244	0
350	100	.0350.100.0	591	86.6	689	383	10	410	28	167	79	0
350	149	.0350.149.0	774	99.6	689	566	10	410	28	131.2	36	0
350	195	.0350.195.0	924	107.2	689	716	10	410	28	111.5	23	0
350	296	.0350.296.0	1274	125	689	1066	10	410	28	82.7	10	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 10 ... PN 10



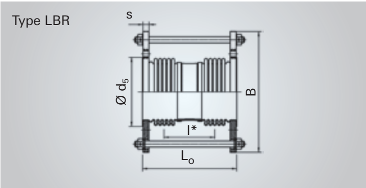
06

Nominal diameter	Nominal lateral movement absorption	Type LBR 10...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange[2)] drilling as per DIN 1092	Flange[2)] rim diameter	Flange[2)] thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	d_5	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
400	51	.0400.051.0	515	133.8	785	251	10	465	37	280.5	402	0
400	106	.0400.106.0	758	150.9	785	494	10	465	37	200.2	110	0
400	146	.0400.146.0	908	160.2	785	644	10	465	37	170.1	65	0
400	200	.0400.200.0	1108	172.6	785	844	10	465	37	141.8	38	0
400	287	.0400.287.0	1458	194.2	785	1194	10	465	37	109.7	19	0
450	51	.0450.051.0	505	150.1	756	246	10	520	32	316.2	504	0
450	98	.0450.098.0	708	168	756	449	10	520	32	234.5	160	0
450	153	.0450.153.0	908	183.4	756	649	10	520	32	186.9	78	0
450	195	.0450.195.0	1058	195	756	799	10	520	32	162.2	51	0
450	285	.0450.285.0	1408	222	756	1149	10	520	32	124	25	0
500	51	.0500.051.0	509	172.2	808	236	10	570	34	387.2	585	0
500	105	.0500.105.0	736	192.8	808	463	10	570	34	279.2	164	0
500	148	.0500.148.0	886	205.2	808	613	10	570	34	235.8	95	0
500	207	.0500.207.0	1086	221.6	808	813	10	570	34	195.2	54	0
500	306	.0500.306.0	1486	254.5	808	1213	10	570	34	145.3	24	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 16 ... PN 16

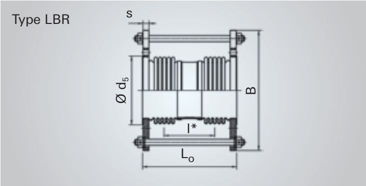


Nominal diameter	Nominal lateral movement absorption	Type LBR 16...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2)			Spring rate		
							drilling as per DIN 1092	rim diameter	thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	d_5	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
50	50	.0050.050.0	279	9.2	265	151	16	92	19	5	20	0
50	103	.0050.103.0	409	10	265	281	16	92	19	3.5	6	0
50	149	.0050.149.0	528	11.3	265	400	16	92	19	2.7	3	0
50	199	.0050.199.0	678	12.4	265	550	16	92	19	2.1	2	0
65	53	.0065.053.0	291	10.9	285	156	16	107	20	7.3	24	0
65	104	.0065.104.0	411	11.7	285	276	16	107	20	5.2	8	0
65	142	.0065.142.0	450	12	285	315	16	107	20	4.8	6	0
65	198	.0065.198.0	681	14.6	285	546	16	107	20	3.2	2	0
80	51	.0080.051.0	301	12.6	300	161	16	122	20	9.1	35	0
80	102	.0080.102.0	431	13.7	300	291	16	122	20	6.5	11	0
80	136	.0080.136.0	460	13.9	300	320	16	122	20	6.1	9	0
80	205	.0080.205.0	720	17.2	300	580	16	122	20	3.9	3	0
100	50	.0100.050.0	308	14.6	320	173	16	147	22	13.7	41	0
100	103	.0100.103.0	458	15.9	320	323	16	147	22	9.3	12	0
100	145	.0100.145.0	588	19.1	320	453	16	147	22	7.3	6	0
100	202	.0100.202.0	787	21.7	320	652	16	147	22	5.5	3	0
125	53	.0125.053.0	346	21.1	350	171	16	178	22	20.2	68	0
125	102	.0125.102.0	476	22.9	350	301	16	178	22	14.9	23	0
125	151	.0125.151.0	596	26.5	350	421	16	178	22	12	12	0
125	196	.0125.196.0	716	28.7	350	541	16	178	22	10.1	7	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 16 ... PN 16

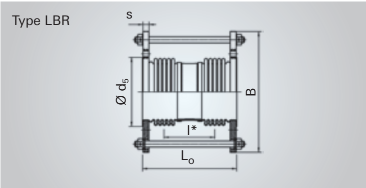


Nominal diameter	Nominal lateral movement absorption	Type LBR 16...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2)			Spring rate		
							drilling as per DIN 1092	rim diameter	thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	d_5	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
150	53	.0150.053.0	360	29.1	413	181	16	208	24	36.5	86	0
150	100	.0150.100.0	490	31.6	413	311	16	208	24	27.4	30	0
150	147	.0150.147.0	630	36.4	413	451	16	208	24	21.7	15	0
150	190	.0150.190.0	760	39.5	413	581	16	208	24	18.1	9	0
200	50	.0200.050.0	367	41.8	500	193	16	258	26	80.7	139	0
200	100	.0200.100.0	547	49.7	500	373	16	258	26	56.7	38	0
200	150	.0200.150.0	676	54.2	500	502	16	258	26	46.8	21	0
200	200	.0200.200.0	866	60.9	500	692	16	258	26	37.1	11	0
250	52	.0250.052.0	465	69.6	589	246	16	320	32	124.3	218	0
250	103	.0250.103.0	684	83.1	589	465	16	320	32	88.6	63	0
250	154	.0250.154.0	884	93	589	665	16	320	32	70.2	31	0
250	207	.0250.207.0	1134	105.3	589	915	16	320	32	55.7	17	0
300	50	.0300.050.0	498	103.7	680	259	16	375	37	184.8	239	0
300	95	.0300.095.0	668	115	680	429	16	375	37	143.5	90	0
300	145	.0300.145.0	868	128.2	680	629	16	375	37	113.6	42	0
300	196	.0300.196.0	1118	144.7	680	879	16	375	37	90.1	22	0
300	296	.0300.296.0	1618	177.8	680	1379	16	375	37	63.7	9	0
350	51	.0350.051.0	519	130.5	667	284	16	410	32	189.4	283	0
350	100	.0350.100.0	719	144	667	484	16	410	32	141.9	101	0
350	149	.0350.149.0	919	157.4	667	684	16	410	32	113.4	51	0
350	199	.0350.199.0	1169	174.1	667	934	16	410	32	90.7	27	0
350	306	.0350.306.0	1719	211	667	1484	16	410	32	62.9	11	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 16 ... PN 16



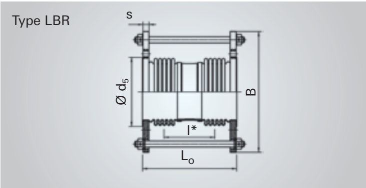
Nominal diameter	Nominal lateral movement absorption	Type LBR 16...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	52	.0400.052.0	554	165.6	723
400	94	.0400.094.0	724	179.5	723
400	147	.0400.147.0	924	195.9	723
400	200	.0400.200.0	1124	212.3	723
400	309	.0400.309.0	1624	253.3	723
450	50	.0450.050.0	560	215.9	815
450	104	.0450.104.0	780	237.9	815
450	155	.0450.155.0	980	257.9	815
450	203	.0450.203.0	1180	277.9	815
450	296	.0450.296.0	1630	322.8	815

Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
284	16	465	34	234.2	412	0
454	16	465	34	184.4	168	0
654	16	465	34	147.5	82	0
854	16	465	34	122.9	48	0
1354	16	465	34	86.8	19	0
284	16	520	37	330.8	521	0
504	16	520	37	247.1	173	0
704	16	520	37	200.8	90	0
904	16	520	37	169.2	55	0
1354	16	520	37	124.9	24	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 25 ... PN 25



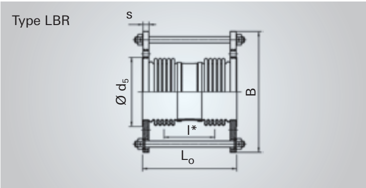
Nominal diameter	Nominal lateral movement absorption	Type LBR 25...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	50	.0050.050.0	291	9.9	265
50	98	.0050.098.0	421	10.7	265
50	148	.0050.148.0	590	12.3	265
50	205	.0050.205.0	790	13.8	265
65	51	.0065.051.0	313	12.1	285
65	99	.0065.099.0	463	13.2	285
65	120	.0065.120.0	454	13.2	285
65	195	.0065.195.0	822	16.7	285
80	52	.0080.052.0	330	15.4	300
80	103	.0080.103.0	469	17.1	300
80	155	.0080.155.0	639	18.8	300
80	193	.0080.193.0	779	20.2	300
100	50	.0100.050.0	342	19.8	335
100	102	.0100.102.0	511	23	335
100	144	.0100.144.0	671	25.3	335
100	192	.0100.192.0	856	28.1	335
125	51	.0125.051.0	362	28.5	398
125	102	.0125.102.0	471	30.3	398
125	153	.0125.153.0	712	36.6	398
125	196	.0125.196.0	897	40.4	398

Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
156	25	92	20	4.9	24	0
286	25	92	20	3.4	7	0
455	25	92	20	2.4	3	0
655	25	92	20	1.8	1	0
185	25	107	22	6.8	26	0
335	25	107	22	4.7	8	0
315	25	107	22	4.8	7	0
694	25	107	22	2.7	2	0
176	25	122	24	8.6	40	0
315	25	122	24	6.1	13	0
485	25	122	24	4.5	6	0
625	25	122	24	3.7	3	0
197	25	147	24	15.4	55	0
366	25	147	24	10.5	16	0
526	25	147	24	8.1	8	0
711	25	147	24	6.4	4	0
195	25	178	26	25.5	68	0
304	25	178	26	20	29	0
545	25	178	26	13.5	9	0
730	25	178	26	10.8	5	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LBR 25 ... PN 25



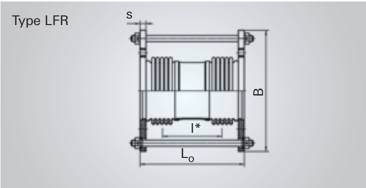
Nominal diameter	Nominal lateral movement absorption	Type LBR 25...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	51	.0150.051.0	376	39.2	460
150	102	.0150.102.0	495	41.8	460
150	146	.0150.146.0	746	50.5	460
150	194	.0150.194.0	951	56.1	460
200	50	.0200.050.0	446	63.8	544
200	101	.0200.101.0	645	73.2	544
200	155	.0200.155.0	915	84	544
200	195	.0200.195.0	1115	92	544
250	51	.0250.051.0	482	106.3	578
250	101	.0250.101.0	701	122.8	578
250	149	.0250.149.0	951	139.1	578
250	204	.0250.204.0	1251	158.7	578
300	61	.0300.061.0	618	147.5	634
300	110	.0300.110.0	843	164.7	634
300	150	.0300.150.0	1043	180	634
300	200	.0300.200.0	1343	202.9	634
300	302	.0300.302.0	1943	248.7	634
350	50	.0350.050.0	551	204.3	735
350	100	.0350.100.0	761	224.4	735
350	145	.0350.145.0	961	243.5	735
350	190	.0350.190.0	1211	267.5	735
350	291	.0350.291.0	1761	320.2	735

Centre-to-centre distance of bellows	Flange 2)			Spring rate		
	drilling as per DIN 1092	rim diameter	thickness			
l*	PN	d_5	s	c_r	c_λ	c_p
mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
205	25	208	28	47.9	86	0
324	25	208	28	37.6	35	0
575	25	208	28	25.9	11	0
780	25	208	28	20.6	6	0
241	25	258	32	84.9	193	0
440	25	258	32	61.5	60	0
710	25	258	32	44.8	23	0
910	25	258	32	37.2	14	0
251	25	320	35	121.2	254	0
470	25	320	35	87.1	75	0
720	25	320	35	65.9	32	0
1020	25	320	35	51	16	0
364	25	375	38	136.2	216	0
589	25	375	38	102.9	84	0
789	25	375	38	84.5	47	0
1089	25	375	38	66.6	25	0
1689	25	375	38	46.8	10	0
284	25	410	42	206.6	368	0
494	25	410	42	155.5	126	0
694	25	410	42	125.9	65	0
944	25	410	42	101.7	35	0
1494	25	410	42	71.4	14	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 06 ... PN 6

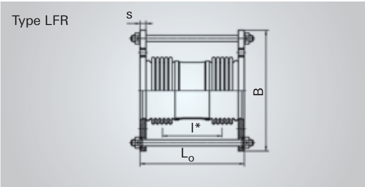


Nominal diameter	Nominal lateral movement absorption	Type LFR 06...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2) drilling DIN 1092	Flange 2) thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
50	51	.0050.051.0	265	6.1	240	136	6	16	5.1	13	0
50	102	.0050.102.0	375	6.6	240	246	6	16	3.7	4	0
50	154	.0050.154.0	485	7.1	240	356	6	16	2.9	2	0
50	196	.0050.196.0	574	8.7	240	445	6	16	2.4	1	0
65	53	.0065.053.0	275	7.1	260	141	6	16	7.5	16	0
65	104	.0065.104.0	385	7.7	260	251	6	16	5.4	5	0
65	151	.0065.151.0	485	8.3	260	351	6	16	4.4	3	0
65	204	.0065.204.0	595	8.8	260	461	6	16	3.6	2	0
80	53	.0080.053.0	287	9.9	290	146	6	18	9.3	20	0
80	102	.0080.102.0	397	10.5	290	256	6	18	6.8	7	0
80	154	.0080.154.0	507	11.1	290	366	6	18	5.4	3	0
80	201	.0080.201.0	607	11.6	290	466	6	18	4.5	2	0
100	52	.0100.052.0	287	11	310	141	6	18	14.4	27	0
100	103	.0100.103.0	397	11.6	310	251	6	18	10.6	9	0
100	151	.0100.151.0	497	12.3	310	351	6	18	8.5	5	0
100	204	.0100.204.0	607	13	310	461	6	18	7	3	0
125	51	.0125.051.0	321	14.2	340	167	6	20	17.3	30	0
125	103	.0125.103.0	461	15.1	340	307	6	20	12.2	9	0
125	153	.0125.153.0	591	16	340	437	6	20	9.6	5	0
125	203	.0125.203.0	721	22	340	567	6	20	7.9	3	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 06 ... PN 6



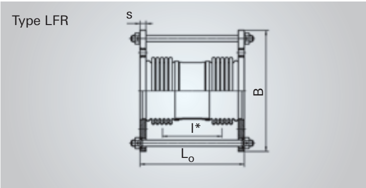
Nominal diameter	Nominal lateral movement absorption	Type LFR 06...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	53	.0150.053.0	339	17.4	365
150	101	.0150.101.0	459	18.6	365
150	151	.0150.151.0	579	19.9	365
150	202	.0150.202.0	699	25.5	365
200	51	.0200.051.0	351	24.8	420
200	100	.0200.100.0	481	26.6	420
200	153	.0200.153.0	611	28.6	420
200	198	.0200.198.0	740	37.4	420
250	50	.0250.050.0	373	34.5	503
250	102	.0250.102.0	513	37.1	503
250	153	.0250.153.0	643	39.6	503
250	212	.0250.212.0	812	54.2	503
300	50	.0300.050.0	383	46.7	600
300	101	.0300.101.0	543	50.7	600
300	152	.0300.152.0	693	54.5	600
300	196	.0300.196.0	846	75.9	600
300	280	.0300.280.0	1146	92.5	600
350	52	.0350.052.0	413	59.1	650
350	102	.0350.102.0	583	63.7	650
350	148	.0350.148.0	756	77.8	650
350	195	.0350.195.0	906	84.7	650
350	300	.0350.300.0	1256	100.8	650

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
166	6	20	23.6	59	0
286	6	20	17.7	21	0
406	6	20	14.1	10	0
526	6	20	11.7	6	0
166	6	22	45.8	90	0
296	6	22	34.1	30	0
426	6	22	27.2	15	0
555	6	22	22.6	9	0
171	6	24	87.5	113	0
311	6	24	65.3	36	0
441	6	24	52.9	18	0
610	6	24	42.4	10	0
191	6	24	162.6	141	0
351	6	24	119.7	43	0
501	6	24	96	21	0
654	6	24	79.8	13	0
954	6	24	60	6	0
215	6	26	181.5	154	0
385	6	26	133.8	50	0
558	6	26	105.6	24	0
708	6	26	89.2	15	0
1058	6	26	65.6	7	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 06 ... PN 6

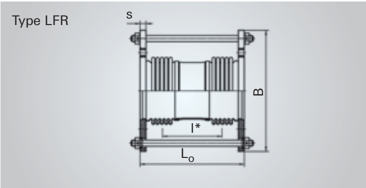


Nominal diameter	Nominal lateral movement absorption	Type LFR 06...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2)		Spring rate		
							drilling DIN 1092	thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
400	51	.0400.051.0	461	77.7	724	231	6	28	267	233	0
400	100	.0400.100.0	664	92.1	724	434	6	28	194.5	70	0
400	158	.0400.158.0	864	103.3	724	634	6	28	153.5	33	0
400	200	.0400.200.0	1014	111.7	724	784	6	28	132.5	22	0
400	294	.0400.294.0	1414	134.2	724	1184	6	28	97.1	10	0
450	50	.0450.050.0	471	87	779	236	6	28	329.4	283	0
450	97	.0450.097.0	674	102.9	779	439	6	28	241.2	86	0
450	152	.0450.152.0	874	115.1	779	639	6	28	190.8	41	0
450	192	.0450.192.0	1024	124.3	779	789	6	28	165	27	0
450	289	.0450.289.0	1384	150.7	779	1144	6	28	124.8	17	0
500	52	.0500.052.0	481	108.7	865	236	6	28	454.5	392	0
500	104	.0500.104.0	698	127.4	865	453	6	28	330.4	113	0
500	147	.0500.147.0	848	138.1	865	603	6	28	278	65	0
500	207	.0500.207.0	1048	152.5	865	803	6	28	229.4	37	0
500	289	.0500.289.0	1348	174.1	865	1103	6	28	181.8	20	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 10 ... PN 10

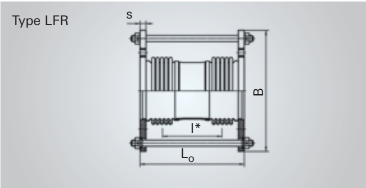


Nominal diameter	Nominal lateral movement absorption	Type LFR 10...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange 2) drilling DIN 1092	Flange 2) thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
50	51	.0050.051.0	268	8.7	265	136	10	19	5.1	13	0
50	102	.0050.102.0	378	9.2	265	246	10	19	3.7	4	0
50	146	.0050.146.0	477	10.5	265	345	10	19	2.9	2	0
50	202	.0050.202.0	627	11.6	265	495	10	19	2.2	1	0
65	53	.0065.053.0	279	10.2	285	141	10	20	7.4	16	0
65	104	.0065.104.0	389	10.8	285	251	10	20	5.4	5	0
65	146	.0065.146.0	489	11.3	285	351	10	20	4.3	3	0
65	201	.0065.201.0	639	13.7	285	501	10	20	3.3	1	0
80	53	.0080.053.0	309	12.2	300	161	10	20	8.7	29	0
80	101	.0080.101.0	429	13	300	281	10	20	6.4	10	0
80	151	.0080.151.0	549	13.9	300	401	10	20	5	5	0
80	202	.0080.202.0	669	14.7	300	521	10	20	4.1	3	0
100	50	.0100.050.0	297	13.6	320	159	10	22	13.9	27	0
100	100	.0100.100.0	427	14.4	320	289	10	22	9.8	8	0
100	146	.0100.146.0	557	15.2	320	419	10	22	7.6	4	0
100	203	.0100.203.0	736	20.3	320	598	10	22	5.8	2	0
125	50	.0125.050.0	321	17.9	350	151	10	22	17.4	51	0
125	100	.0125.100.0	441	19	350	271	10	22	12.8	16	0
125	153	.0125.153.0	561	20.1	350	391	10	22	10.2	8	0
125	200	.0125.200.0	671	21.1	350	501	10	22	8.5	5	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 10 ... PN 10



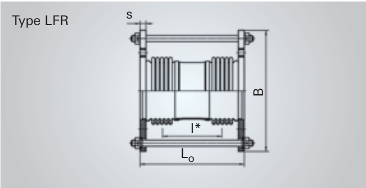
Nominal diameter	Nominal lateral movement absorption	Type LFR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	51	.0150.051.0	343	24.2	385
150	102	.0150.102.0	473	26	385
150	151	.0150.151.0	593	27.7	385
150	202	.0150.202.0	713	33.1	385
200	52	.0200.052.0	369	33.2	468
200	100	.0200.100.0	519	36.1	468
200	153	.0200.153.0	679	39	468
200	206	.0200.206.0	858	50.4	468
250	52	.0250.052.0	397	46.7	555
250	101	.0250.101.0	557	50.7	555
250	152	.0250.152.0	716	63.7	555
250	198	.0250.198.0	886	71.2	555
300	51	.0300.051.0	398	64.3	629
300	102	.0300.102.0	558	70.4	629
300	145	.0300.145.0	711	86.2	629
300	196	.0300.196.0	861	95.2	629
300	284	.0300.284.0	1161	113.3	629
350	50	.0350.050.0	416	77.7	689
350	100	.0350.100.0	586	84.9	689
350	149	.0350.149.0	769	97.8	689
350	195	.0350.195.0	919	105.5	689
350	296	.0350.296.0	1269	123.3	689

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
161	16	24	26	74	0
291	16	24	20	24	0
411	16	24	16	12	0
531	16	24	14	7.3	0
199	10	24	53	92	0
349	10	24	40	31	0
509	10	24	31	15	0
668	10	24	25	8	0
207	10	26	107	112	0
367	10	26	81	37	0
527	10	26	65	18	0
676	10	26	54	10	0
199	10	28	188	202	0
359	10	28	142	65	0
488	10	28	115	32	0
638	10	28	96	19	0
938	10	28	73	9.2	0
213	10	28	215	242	0
383	10	28	160	78	0
542	10	28	127	36	0
692	10	28	110	23	0
1042	10	28	81	10	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 10 ... PN 10



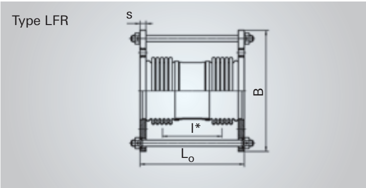
Nominal diameter	Nominal lateral movement absorption	Type LFR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	51	.0400.051.0	509	130.4	785
400	106	.0400.106.0	752	147.6	785
400	146	.0400.146.0	902	156.9	785
400	200	.0400.200.0	1102	169.2	785
400	287	.0400.287.0	1452	190.9	785
450	51	.0450.051.0	499	146.6	756
450	98	.0450.098.0	702	164.5	756
450	153	.0450.153.0	902	179.9	756
450	195	.0450.195.0	1052	191.5	756
450	285	.0450.285.0	1402	218.5	756
500	51	.0500.051.0	503	168.2	808
500	105	.0500.105.0	730	188.8	808
500	148	.0500.148.0	880	201.2	808
500	207	.0500.207.0	1080	217.6	808
500	306	.0500.306.0	1480	250.5	808

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
251	10	37	280.5	402	0
494	10	37	200.2	110	0
644	10	37	170.1	65	0
844	10	37	141.8	38	0
1194	10	37	109.7	19	0
246	10	32	316.2	504	0
449	10	32	234.5	160	0
649	10	32	186.9	78	0
799	10	32	162.2	51	0
1149	10	32	124	25	0
236	10	34	387.2	585	0
463	10	34	279.2	164	0
613	10	34	235.8	95	0
813	10	34	195.2	54	0
1213	10	34	145.3	24	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 16 ... PN 16

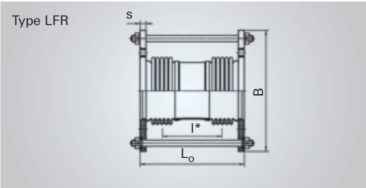


Nominal diameter	Nominal lateral movement absorption	Type LFR 16...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre distance of bellows	Flange [2)] drilling DIN 1092	Flange [2)] thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	cm^2	N/bar	N/mm	N/mm bar
50	50	.0050.050.0	288	9.2	265	151	16	19	4.8	20	0
50	103	.0050.103.0	418	10	265	281	16	19	3.4	6	0
50	149	.0050.149.0	537	11.3	265	400	16	19	2.6	3	0
50	199	.0050.199.0	687	12.4	265	550	16	19	2.1	2	0
65	53	.0065.053.0	299	10.9	285	156	16	20	7	24	0
65	104	.0065.104.0	419	11.7	285	276	16	20	5.1	8	0
65	145	.0065.145.0	529	12.4	285	386	16	20	4	4	0
65	198	.0065.198.0	689	13.4	285	546	16	20	3.1	2	0
80	51	.0080.051.0	309	12.5	300	161	16	20	8.8	35	0
80	102	.0080.102.0	439	13.6	300	291	16	20	6.3	11	0
80	150	.0080.150.0	559	14.5	300	411	16	20	5	6	0
80	205	.0080.205.0	728	17.1	300	580	16	20	3.8	3	0
100	50	.0100.050.0	315	14.5	320	173	16	22	13.3	41	0
100	103	.0100.103.0	465	15.8	320	323	16	22	9.1	12	0
100	145	.0100.145.0	595	16.8	320	453	16	22	7.2	6	0
100	202	.0100.202.0	794	21.6	320	652	16	22	5.4	3	0
125	53	.0125.053.0	351	20.7	350	171	16	22	19.7	68	0
125	102	.0125.102.0	481	22.6	350	301	16	22	14.7	23	0
125	151	.0125.151.0	601	24.3	350	421	16	22	11.9	12	0
125	196	.0125.196.0	721	28.3	350	541	16	22	9.9	7	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 16 ... PN 16



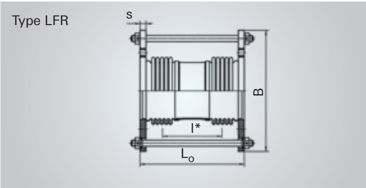
Nominal diameter	Nominal lateral movement absorption	Type LFR 16...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	53	.0150.053.0	363	28.6	413
150	100	.0150.100.0	493	31.1	413
150	153	.0150.153.0	633	33.7	413
150	194	.0150.194.0	763	39	413
200	50	.0200.050.0	369	41.1	500
200	100	.0200.100.0	529	45.3	500
200	150	.0200.150.0	679	49.2	500
200	200	.0200.200.0	868	60.1	500
250	52	.0250.052.0	460	68.2	589
250	103	.0250.103.0	679	81.7	589
250	154	.0250.154.0	879	91.5	589
250	207	.0250.207.0	1129	103.9	589
300	50	.0300.050.0	493	101.6	680
300	95	.0300.095.0	663	112.9	680
300	145	.0300.145.0	863	126.1	680
300	196	.0300.196.0	1113	142.6	680
300	296	.0300.296.0	1613	175.7	680
350	51	.0350.051.0	513	128.1	667
350	100	.0350.100.0	713	141.5	667
350	149	.0350.149.0	913	154.9	667
350	199	.0350.199.0	1163	171.7	667
350	306	.0350.306.0	1713	208.6	667

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
181	16	24	35.8	86	0
311	16	24	27	30	0
451	16	24	21.4	15	0
581	16	24	17.9	9	0
193	16	26	79.4	139	0
353	16	26	58	43	0
503	16	26	46.3	21	0
692	16	26	36.9	11	0
246	16	32	124.3	218	0
465	16	32	88.6	63	0
665	16	32	70.2	31	0
915	16	32	55.7	17	0
259	16	37	184.8	239	0
429	16	37	143.5	90	0
629	16	37	113.6	42	0
879	16	37	90.1	22	0
1379	16	37	63.7	9	0
284	16	32	189.4	283	0
484	16	32	141.9	101	0
684	16	32	113.4	51	0
934	16	32	90.7	27	0
1484	16	32	62.9	11	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 16 ... PN 16



Nominal diameter	Nominal lateral movement absorption	Type LFR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	52	.0400.052.0	546	161.5	723
400	94	.0400.094.0	716	175.4	723
400	147	.0400.147.0	916	191.8	723
400	200	.0400.200.0	1116	208.2	723
400	309	.0400.309.0	1616	249.2	723
450	50	.0450.050.0	552	210.7	815
450	104	.0450.104.0	772	232.7	815
450	155	.0450.155.0	972	252.7	815
450	203	.0450.203.0	1172	272.7	815
450	296	.0450.296.0	1622	317.6	815

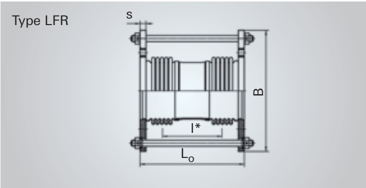
06

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
284	16	34	234.2	412	0
454	16	34	184.4	168	0
654	16	34	147.5	82	0
854	16	34	122.9	48	0
1354	16	34	86.8	19	0
284	16	37	330.8	521	0
504	16	37	247.1	173	0
704	16	37	200.8	90	0
904	16	37	169.2	55	0
1354	16	37	124.9	24	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 25 ... PN 25



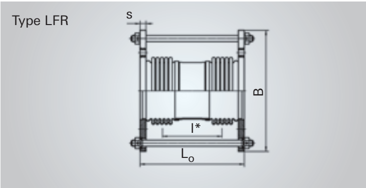
Nominal diameter	Nominal lateral movement absorption	Type LFR 25...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	50	.0050.050.0	299	9.8	265
50	98	.0050.098.0	429	10.6	265
50	148	.0050.148.0	598	12.2	265
50	205	.0050.205.0	798	13.7	265
65	51	.0065.051.0	319	12	285
65	99	.0065.099.0	469	13.1	285
65	153	.0065.153.0	669	14.5	285
65	195	.0065.195.0	828	16.6	285
80	52	.0080.052.0	333	15.1	300
80	103	.0080.103.0	472	16.9	300
80	155	.0080.155.0	642	18.6	300
80	193	.0080.193.0	782	20	300
100	50	.0100.050.0	345	19.5	335
100	102	.0100.102.0	514	22.7	335
100	144	.0100.144.0	674	25	335
100	192	.0100.192.0	859	27.8	335
125	51	.0125.051.0	363	28	398
125	102	.0125.102.0	523	30.7	398
125	153	.0125.153.0	713	36.1	398
125	196	.0125.196.0	898	40	398

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
156	25	20	4.7	24	0
286	25	20	3.3	7	0
455	25	20	2.4	3	0
655	25	20	1.8	1	0
185	25	22	6.7	26	0
335	25	22	4.6	8	0
535	25	22	3.2	3	0
694	25	22	2.6	2	0
176	25	24	8.4	40	0
315	25	24	6	13	0
485	25	24	4.4	6	0
625	25	24	3.6	3	0
197	25	24	15	55	0
366	25	24	10.3	16	0
526	25	24	8	8	0
711	25	24	6.3	4	0
195	25	26	25.1	68	0
355	25	26	17.9	21	0
545	25	26	13.4	9	0
730	25	26	10.7	5	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH PLAIN FIXED FLANGES, FOR MOVEMENT IN ALL PLANES

TYPE LFR 25 ... PN 25

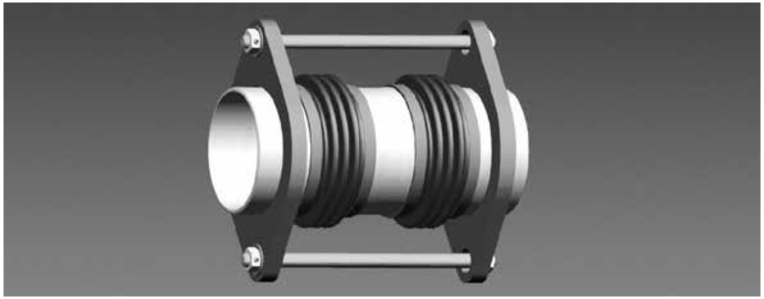


Nominal diameter	Nominal lateral movement absorption	Type LFR 25...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	51	.0150.051.0	371	38.5	460
150	102	.0150.102.0	541	42.4	460
150	151	.0150.151.0	741	49.8	460
150	194	.0150.194.0	946	55.5	460
200	50	.0200.050.0	440	62.5	544
200	101	.0200.101.0	639	71.9	544
200	155	.0200.155.0	909	82.7	544
200	195	.0200.195.0	1109	90.7	544
250	51	.0250.051.0	476	104.4	578
250	101	.0250.101.0	695	120.9	578
250	149	.0250.149.0	945	137.2	578
250	204	.0250.204.0	1245	156.9	578
300	61	.0300.061.0	610	144.1	634
300	110	.0300.110.0	835	161.3	634
300	150	.0300.150.0	1035	176.6	634
300	200	.0300.200.0	1335	199.5	634
300	302	.0300.302.0	1935	245.4	634
350	50	.0350.050.0	543	200.1	735
350	100	.0350.100.0	753	220.2	735
350	145	.0350.145.0	953	239.4	735
350	190	.0350.190.0	1203	263.4	735
350	291	.0350.291.0	1753	316.1	735

Centre-to-centre distance of bellows	Flange 2)		Spring rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	mm	cm^2	N/bar	N/mm	N/mm bar
205	25	28	47.9	86	0
375	25	28	34.4	26	0
575	25	28	25.9	11	0
780	25	28	20.6	6	0
241	25	32	84.9	193	0
440	25	32	61.5	60	0
710	25	32	44.8	23	0
910	25	32	37.2	14	0
251	25	35	121.2	254	0
470	25	35	87.1	75	0
720	25	35	65.9	32	0
1020	25	35	51	16	0
364	25	38	136.2	216	0
589	25	38	102.9	84	0
789	25	38	84.5	47	0
1089	25	38	66.6	25	0
1689	25	38	46.8	10	0
284	25	42	206.6	368	0
494	25	42	155.5	126	0
694	25	42	125.9	65	0
944	25	42	101.7	35	0
1494	25	42	71.4	14	0

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH WELD ENDS TYPE LRR, LRK, LRN



Type designation

The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example

Type LRR: HYDRA lateral expansion joint with weld ends, for movement in all planes
Type LRN: HYDRA lateral expansion joint with weld ends, for movement in one plane
Type LRK: HYDRA lateral expansion joint with weld ends, for movement in all planes

Standard version/materials:

Multi-ply bellow made of 1.4541
Weld ends up to DN 300: P235GH (1.0345)
Weld ends from DN 350: P265GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

LRR	10	·	0150	·	102	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal ($2\lambda = \pm 51 = 102$ mm)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

06

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] __________
- Piping - nominal diameter DN __________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] __________
- Max./min. allowable temperature [°C] __________
- Test pressure PT [bar] __________

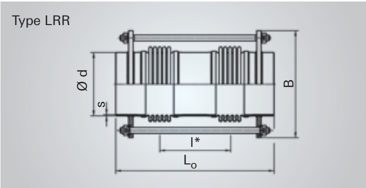
Optional:
- Category __________

Note

Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 06 ... PN 6



06

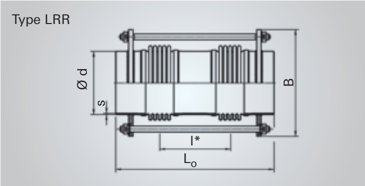
Nominal diameter	Nominal lateral movement absorption	Type LRR 06...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	51	.0050.051.0	361	4.4	205
50	102	.0050.102.0	471	4.9	205
50	154	.0050.154.0	581	5.5	205
50	196	.0050.196.0	670	7	205
65	53	.0065.053.0	371	5.2	225
65	104	.0065.104.0	481	5.8	225
65	151	.0065.151.0	581	6.3	225
65	204	.0065.204.0	691	8.4	225
80	53	.0080.053.0	381	6	240
80	102	.0080.102.0	491	6.6	240
80	154	.0080.154.0	601	7.2	240
80	201	.0080.201.0	701	7.8	240
100	52	.0100.052.0	381	7.2	265
100	103	.0100.103.0	491	7.9	265
100	151	.0100.151.0	591	8.6	265
100	204	.0100.204.0	701	9.3	265
125	51	.0125.051.0	419	8.6	290
125	103	.0125.103.0	559	9.6	290
125	153	.0125.153.0	689	10.4	290
125	203	.0125.203.0	819	11.3	290

06

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
136	60.3	2.9	4.5	13	0
246	60.3	2.9	3.4	4	0
356	60.3	2.9	2.7	2	0
445	60.3	2.9	2.3	1	0
141	76.1	2.9	6.7	16	0
251	76.1	2.9	5	5	0
351	76.1	2.9	4.1	3	0
461	76.1	2.9	3.4	2	0
146	88.9	3.2	8.3	20	0
256	88.9	3.2	6.3	7	0
366	88.9	3.2	5	3	0
466	88.9	3.2	4.3	2	0
141	114.3	3.6	12.9	27	0
251	114.3	3.6	9.8	9	0
351	114.3	3.6	8	5	0
461	114.3	3.6	6.6	3	0
167	139.7	4	15.5	30	0
307	139.7	4	11.3	9	0
437	139.7	4	9	5	0
567	139.7	4	7.5	3	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

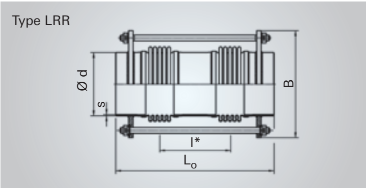
TYPE LRR 06 ... PN 6



Nominal diameter	Nominal lateral movement absorption	Type LRR 06...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
150	53	.0150.053.0	437	11.9	320	166	168.3	4	21.3	59	0
150	101	.0150.101.0	557	13.1	320	286	168.3	4	16.4	21	0
150	151	.0150.151.0	677	14.4	320	406	168.3	4	13.3	10	0
150	202	.0150.202.0	797	15.6	320	526	168.3	4	11.1	6	0
200	51	.0200.051.0	461	18.4	375	166	219.1	4.5	33.1	90	0
200	100	.0200.100.0	591	20.1	375	296	219.1	4.5	25.3	30	0
200	153	.0200.153.0	721	21.8	375	426	219.1	4.5	20.4	15	0
200	198	.0200.198.0	850	30.4	375	555	219.1	4.5	17.2	9	0
250	50	.0250.050.0	471	24.2	435	171	273	5	49.8	113	0
250	102	.0250.102.0	611	26.2	435	311	273	5	37.5	36	0
250	153	.0250.153.0	741	28.2	435	441	273	5	30.6	18	0
250	212	.0250.212.0	910	42.1	435	610	273	5	24.6	10	0
300	50	.0300.050.0	505	31.1	490	191	323.9	5.6	82.1	141	0
300	101	.0300.101.0	665	34.2	490	351	323.9	5.6	60.7	43	0
300	152	.0300.152.0	815	37	490	501	323.9	5.6	48.8	21	0
300	196	.0300.196.0	968	57.4	490	654	323.9	5.6	40.6	13	0
300	280	.0300.280.0	1268	72.1	490	954	323.9	5.6	30.6	6	0
350	52	.0350.052.0	543	40.5	526	215	355.6	8	90.2	154	0
350	102	.0350.102.0	713	44	526	385	355.6	8	67	50	0
350	148	.0350.148.0	886	57	526	558	355.6	8	53.1	24	0
350	195	.0350.195.0	1036	63	526	708	355.6	8	45	15	0
350	300	.0350.300.0	1386	76.9	526	1058	355.6	8	33.2	7	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 06 ... PN 6

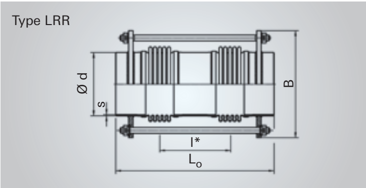


Nominal diameter	Nominal lateral movement absorption	Type LRR 06...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	51	.0400.051.0	595	54.3	608
400	100	.0400.100.0	798	67.1	608
400	158	.0400.158.0	998	76.5	608
400	200	.0400.200.0	1148	83.6	608
400	294	.0400.294.0	1548	102.4	608
450	50	.0450.050.0	615	69.8	700
450	97	.0450.097.0	818	84.7	700
450	152	.0450.152.0	1018	96	700
450	192	.0450.192.0	1168	104.4	700
450	289	.0450.289.0	1528	129.1	700
500	52	.0500.052.0	659	93.6	756
500	104	.0500.104.0	876	110	756
500	147	.0500.147.0	1026	119.1	756
500	207	.0500.207.0	1226	131.4	756
500	289	.0500.289.0	1526	149.7	756

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
231	406.4	8	144.2	233	0
434	406.4	8	105	70	0
634	406.4	8	82.9	33	0
784	406.4	8	71.5	22	0
1184	406.4	8	52.4	10	0
236	457	8	246.3	283	0
439	457	8	182.3	86	0
639	457	8	145.2	41	0
789	457	8	125.9	27	0
1144	457	8	95.7	17	0
236	508	8	283.5	392	0
453	508	8	210.3	113	0
603	508	8	178.4	65	0
803	508	8	148.4	37	0
1103	508	8	118.5	20	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

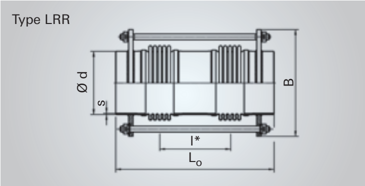
TYPE LRR 10 ... PN 10



Nominal diameter	Nominal lateral movement absorption	Type LRR 10...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
50	51	.0050.051.0	361	4.4	205	136	60.3	2.9	4.5	13	0
50	102	.0050.102.0	471	4.9	205	246	60.3	2.9	3.4	4	0
50	149	.0050.149.0	581	5.5	205	356	60.3	2.9	2.7	2	0
50	202	.0050.202.0	720	7.4	205	495	60.3	2.9	2.1	1	0
65	53	.0065.053.0	371	5.2	225	141	76.1	2.9	6.7	16	0
65	104	.0065.104.0	481	5.8	225	251	76.1	2.9	5	5	0
65	146	.0065.146.0	581	6.3	225	351	76.1	2.9	4.1	3	0
65	201	.0065.201.0	731	7.1	225	501	76.1	2.9	3.2	1	0
80	53	.0080.053.0	401	6.7	240	161	88.9	3.2	7.9	29	0
80	101	.0080.101.0	521	7.6	240	281	88.9	3.2	5.9	10	0
80	151	.0080.151.0	641	8.5	240	401	88.9	3.2	4.7	5	0
80	202	.0080.202.0	761	9.3	240	521	88.9	3.2	3.9	3	0
100	50	.0100.050.0	387	7.2	265	159	114.3	3.6	12.7	27	0
100	100	.0100.100.0	517	8	265	289	114.3	3.6	9.2	8	0
100	146	.0100.146.0	647	8.8	265	419	114.3	3.6	7.2	4	0
100	203	.0100.203.0	764	11	265	532	114.3	3.6	6.1	4	0
125	50	.0125.050.0	427	11.6	290	151	139.7	4	15.3	51	0
125	100	.0125.100.0	547	12.7	290	271	139.7	4	11.7	16	0
125	153	.0125.153.0	667	13.8	290	391	139.7	4	9.4	8	0
125	200	.0125.200.0	777	14.8	290	501	139.7	4	8	5	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 10 ... PN 10

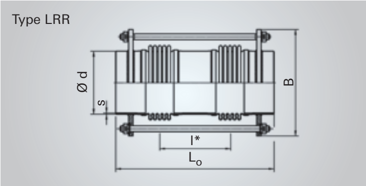


Nominal diameter	Nominal lateral movement absorption	Type LRR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	51	.0150.051.0	447	14.5	320
150	102	.0150.102.0	577	16.1	320
150	151	.0150.151.0	697	17.5	320
150	202	.0150.202.0	817	18.9	320
200	52	.0200.052.0	477	19.3	375
200	100	.0200.100.0	627	21.5	375
200	153	.0200.153.0	787	23.8	375
200	206	.0200.206.0	966	34.5	375
250	52	.0250.052.0	523	30.2	435
250	101	.0250.101.0	683	33.2	435
250	152	.0250.152.0	843	36.3	435
250	198	.0250.198.0	1012	51.7	435
300	51	.0300.051.0	541	43.6	518
300	102	.0300.102.0	701	48.2	518
300	145	.0300.145.0	854	62.6	518
300	196	.0300.196.0	1004	70.3	518
300	284	.0300.284.0	1304	85.7	518
350	50	.0350.050.0	579	64.6	586
350	100	.0350.100.0	749	70.9	586
350	149	.0350.149.0	932	83.1	586
350	195	.0350.195.0	1082	90	586
350	296	.0350.296.0	1432	106.1	586

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
161	168.3	4	20.9	75	0
291	168.3	4	15.8	24	0
411	168.3	4	12.9	12	0
531	168.3	4	10.9	7	0
199	219.1	4.5	32.2	93	0
349	219.1	4.5	23.9	31	0
509	219.1	4.5	18.8	15	0
688	219.1	4.5	15.1	8	0
207	273	5	57.1	112	0
367	273	5	42.6	37	0
527	273	5	34	18	0
696	273	5	28	10	0
199	323.9	5.6	103.4	204	0
359	323.9	5.6	77.9	65	0
512	323.9	5.6	63.1	32	0
662	323.9	5.6	53.2	20	0
962	323.9	5.6	40.4	9	0
213	355.6	8	160.7	244	0
383	355.6	8	122.4	79	0
566	355.6	8	97.4	36	0
716	355.6	8	83.4	23	0
1066	355.6	8	62.5	10	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 10 ... PN 10

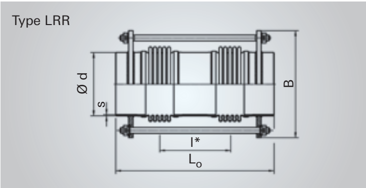


Nominal diameter	Nominal lateral movement absorption	Type LRR 10...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	51	.0400.051.0	645	83.4	640
400	106	.0400.106.0	888	97.9	640
400	146	.0400.146.0	1038	105.6	640
400	200	.0400.200.0	1238	115.8	640
400	287	.0400.287.0	1588	133.7	640
450	51	.0450.051.0	675	112.1	724
450	98	.0450.098.0	878	126.7	724
450	153	.0450.153.0	1078	139	724
450	195	.0450.195.0	1228	148.1	724
450	285	.0450.285.0	1578	169.5	724
500	51	.0500.051.0	719	150	816
500	105	.0500.105.0	946	168.5	816
500	148	.0500.148.0	1096	179.3	816
500	207	.0500.207.0	1296	193.7	816
500	306	.0500.306.0	1696	222.5	816

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
251	406.4	8	187.7	402	0
494	406.4	8	134.1	110	0
644	406.4	8	114	65	0
844	406.4	8	95.1	38	0
1194	406.4	8	73.6	19	0
246	457	8	288.5	504	0
449	457	8	218.9	160	0
649	457	8	176.9	78	0
799	457	8	154.6	51	0
1149	457	8	119.5	25	0
236	508	10	390	585	0
463	508	10	292	164	0
613	508	10	250.4	95	0
813	508	10	210.4	54	0
1213	508	10	159.5	24	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

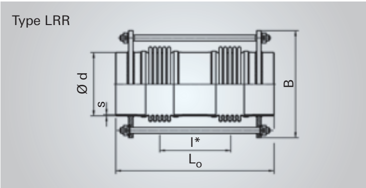
TYPE LRR 16 ... PN 16



Nominal diameter	Nominal lateral movement absorption	Type LRR 16...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
50	50	.0050.050.0	381	4.9	205	151	60.3	2.9	4.3	20	0
50	103	.0050.103.0	511	5.7	205	281	60.3	2.9	3.1	6	0
50	149	.0050.149.0	631	6.4	205	401	60.3	2.9	2.5	3	0
50	199	.0050.199.0	780	8.1	205	550	60.3	2.9	2	2	0
65	53	.0065.053.0	391	5.9	225	156	76.1	2.9	6.4	24	0
65	104	.0065.104.0	511	6.7	225	276	76.1	2.9	4.7	8	0
65	145	.0065.145.0	621	7.4	225	386	76.1	2.9	3.8	4	0
65	198	.0065.198.0	781	8.4	225	546	76.1	2.9	3	2	0
80	51	.0080.051.0	411	8.4	240	161	88.9	3.2	7.8	35	0
80	102	.0080.102.0	541	9.4	240	291	88.9	3.2	5.8	11	0
80	150	.0080.150.0	661	10.4	240	411	88.9	3.2	4.6	6	0
80	205	.0080.205.0	740	10.9	240	490	88.9	3.2	4.1	4	0
100	50	.0100.050.0	415	9.5	265	173	114.3	3.6	11.8	41	0
100	103	.0100.103.0	565	10.8	265	323	114.3	3.6	8.4	12	0
100	145	.0100.145.0	695	11.8	265	453	114.3	3.6	6.7	6	0
100	202	.0100.202.0	894	16.7	265	652	114.3	3.6	5.2	3	0
125	53	.0125.053.0	457	13.6	290	171	139.7	4	14.4	68	0
125	102	.0125.102.0	587	15.2	290	301	139.7	4	10.9	23	0
125	151	.0125.151.0	707	16.7	290	421	139.7	4	9	12	0
125	196	.0125.196.0	827	18.2	290	541	139.7	4	7.6	7	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 16 ... PN 16

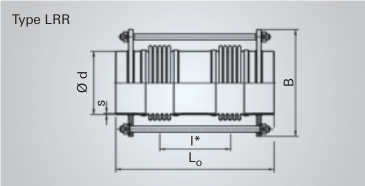


06

Nominal diameter	Nominal lateral movement absorption	Type LRR 16...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
150	53	.0150.053.0	467	16.3	320	181	168.3	4	20	86	0
150	100	.0150.100.0	597	18.3	320	311	168.3	4	15.3	30	0
150	153	.0150.153.0	737	20.3	320	451	168.3	4	12.2	15	0
150	194	.0150.194.0	867	25.1	320	581	168.3	4	10.3	9	0
200	50	.0200.050.0	515	27.8	403	193	219.1	4.5	51.2	139	0
200	100	.0200.100.0	675	31.5	403	353	219.1	4.5	38.1	43	0
200	150	.0200.150.0	825	34.8	403	503	219.1	4.5	30.7	21	0
200	200	.0200.200.0	1014	44.9	403	692	219.1	4.5	24.7	11	0
250	52	.0250.052.0	611	47.9	495	246	273	5	91.7	218	0
250	103	.0250.103.0	830	60.3	495	465	273	5	66.4	63	0
250	154	.0250.154.0	1030	69.2	495	665	273	5	53	31	0
250	207	.0250.207.0	1280	80.3	495	915	273	5	42.4	17	0
300	50	.0300.050.0	668	73.8	574	259	323.9	5.6	148.7	239	0
300	95	.0300.095.0	838	84.1	574	429	323.9	5.6	117.2	90	0
300	145	.0300.145.0	1038	96.1	574	629	323.9	5.6	93.8	42	0
300	196	.0300.196.0	1288	111.2	574	879	323.9	5.6	75	22	0
300	296	.0300.296.0	1788	141.4	574	1379	323.9	5.6	53.6	9	0
350	51	.0350.051.0	698	92.2	610	284	355.6	8	170.8	283	0
350	100	.0350.100.0	898	102.4	610	484	355.6	8	131.2	101	0
350	149	.0350.149.0	1098	112.6	610	684	355.6	8	106.5	51	0
350	199	.0350.199.0	1348	125.4	610	934	355.6	8	86.2	27	0
350	306	.0350.306.0	1898	153.4	610	1484	355.6	8	60.7	11	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 16 ... PN 16



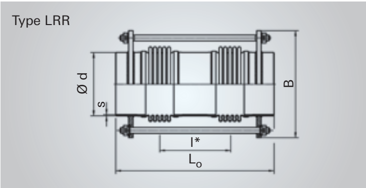
Nominal diameter	Nominal lateral movement absorption	Type LRR 16...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
400	52	.0400.052.0	738	128.7	700
400	94	.0400.094.0	908	140.9	700
400	147	.0400.147.0	1108	155.2	700
400	200	.0400.200.0	1308	169.5	700
400	309	.0400.309.0	1808	205.4	700
450	50	.0450.050.0	758	162.3	760
450	104	.0450.104.0	978	179.5	760
450	155	.0450.155.0	1178	195.1	760
450	203	.0450.203.0	1378	210.7	760
450	296	.0450.296.0	1828	245.8	760

06

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
284	406.4	8	246.3	412	0
454	406.4	8	197.9	168	0
654	406.4	8	160.7	82	0
854	406.4	8	135.3	48	0
1354	406.4	8	97	19	0
284	457	8	300.3	521	0
504	457	8	229.6	173	0
704	457	8	189.2	90	0
904	457	8	160.8	55	0
1354	457	8	120.3	24	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

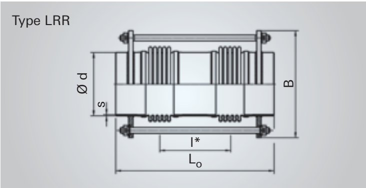
TYPE LRR 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption	Type LRR 25...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
50	50	.0050.050.0	391	5.2	205	156	60.3	2.9	4.3	24	0
50	98	.0050.098.0	521	6	205	286	60.3	2.9	3.1	7	0
50	148	.0050.148.0	690	7.6	205	455	60.3	2.9	2.3	3	0
50	205	.0050.205.0	890	9.1	205	655	60.3	2.9	1.7	1	0
65	51	.0065.051.0	419	7.3	225	185	76.1	2.9	6	26	0
65	99	.0065.099.0	569	8.4	225	335	76.1	2.9	4.2	8	0
65	153	.0065.153.0	769	9.8	225	535	76.1	2.9	3.1	3	0
65	195	.0065.195.0	928	11.9	225	694	76.1	2.9	2.5	2	0
80	52	.0080.052.0	431	9.3	240	176	88.9	3.2	7.5	40	0
80	103	.0080.103.0	571	10.6	240	316	88.9	3.2	5.5	13	0
80	155	.0080.155.0	740	12.7	240	485	88.9	3.2	4.2	6	0
80	193	.0080.193.0	880	14.1	240	625	88.9	3.2	3.5	3	0
100	50	.0100.050.0	443	11.1	265	197	114.3	3.6	11.2	55	0
100	102	.0100.102.0	612	13.9	265	366	114.3	3.6	7.9	16	0
100	145	.0100.145.0	772	16	265	526	114.3	3.6	6.1	8	0
100	192	.0100.192.0	957	18.4	265	711	114.3	3.6	4.9	4	0
125	51	.0125.051.0	495	16.2	290	195	139.7	4	16.8	68	0
125	102	.0125.102.0	655	18.5	290	355	139.7	4	12.4	21	0
125	153	.0125.153.0	845	21.1	290	545	139.7	4	9.4	9	0
125	196	.0125.196.0	1030	26.9	290	730	139.7	4	7.6	5	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

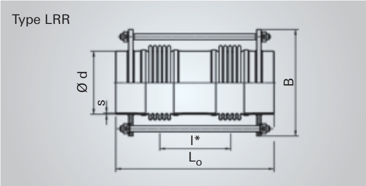
TYPE LRR 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption	Type LRR 25...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
150	51	.0150.051.0	505	19.2	320	205	168.3	4	23.5	86	0
150	102	.0150.102.0	675	22	320	375	168.3	4	17.1	26	0
150	151	.0150.151.0	875	25.1	320	575	168.3	4	12.9	11	0
150	194	.0150.194.0	1080	32.5	320	780	168.3	4	10.3	6	0
200	50	.0200.050.0	601	40.7	435	241	219.1	4.5	61.4	193	0
200	101	.0200.101.0	800	49	435	440	219.1	4.5	45.4	60	0
200	155	.0200.155.0	1070	58.5	435	710	219.1	4.5	33.5	23	0
200	195	.0200.195.0	1270	65.5	435	910	219.1	4.5	28.1	14	0
250	51	.0250.051.0	651	61.4	519	251	273	5	110.3	254	0
250	101	.0250.101.0	870	74.5	519	470	273	5	81.3	75	0
250	149	.0250.149.0	1120	86.8	519	720	273	5	62.6	32	0
250	204	.0250.204.0	1420	101.6	519	1020	273	5	49	16	0
300	61	.0300.061.0	823	111.1	610	364	323.9	5.6	140.6	216	0
300	110	.0300.110.0	1048	126	610	589	323.9	5.6	109.1	84	0
300	150	.0300.150.0	1248	139.2	610	789	323.9	5.6	91	47	0
300	200	.0300.200.0	1548	159.1	610	1089	323.9	5.6	72.8	25	0
300	302	.0300.302.0	2148	198.7	610	1689	323.9	5.6	52.1	10	0
350	50	.0350.050.0	748	136.5	646	284	355.6	10	187.5	368	0
350	100	.0350.100.0	958	152	646	494	355.6	10	144.5	126	0
350	145	.0350.145.0	1158	166.8	646	694	355.6	10	118.6	65	0
350	190	.0350.190.0	1408	185.3	646	944	355.6	10	96.8	35	0
350	291	.0350.291.0	1958	225.9	646	1494	355.6	10	69	14	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

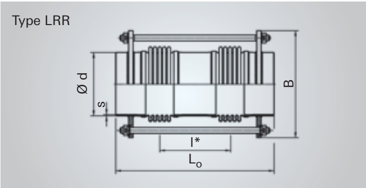
TYPE LRR 40 ... PN 40



Nominal diameter	Nominal lateral movement absorption	Type LRR 40...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
50	53	.0050.053.0	428	6.4	205	194	60.3	2.9	3.9	19	0
50	100	.0050.100.0	628	7.9	205	394	60.3	2.9	2.5	5	0
50	146	.0050.146.0	828	9.4	205	594	60.3	2.9	1.9	2	0
50	204	.0050.204.0	1078	11.2	205	844	60.3	2.9	1.4	1	0
65	49	.0065.049.0	436	8.2	225	198	76.1	2.9	5.8	34	0
65	100	.0065.100.0	636	9.9	225	398	76.1	2.9	3.8	9	0
65	156	.0065.156.0	886	12	225	648	76.1	2.9	2.7	3	0
65	200	.0065.200.0	1086	13.7	225	848	76.1	2.9	2.1	2	0
80	51	.0080.051.0	454	10.7	240	202	88.9	3.2	7.1	39	0
80	101	.0080.101.0	654	12.7	240	402	88.9	3.2	4.8	10	0
80	156	.0080.156.0	904	15.2	240	652	88.9	3.2	3.4	4	0
80	188	.0080.188.0	1054	16.7	240	802	88.9	3.2	2.9	3	0
100	46	.0100.046.0	550	15	265	265	114.3	3.6	10.8	64	0
100	96	.0100.096.0	788	19.3	265	484	114.3	3.6	7.4	21	0
100	146	.0100.146.0	1088	23.8	265	784	114.3	3.6	5.2	8	0
100	197	.0100.197.0	1388	28.3	265	1084	114.3	3.6	4	4	0
125	46	.0125.046.0	582	23.3	318	246	139.7	4	19	79	0
125	94	.0125.094.0	832	28.4	318	496	139.7	4	12.9	20	0
125	152	.0125.152.0	1182	35.6	318	846	139.7	4	8.9	7	0
125	193	.0125.193.0	1432	40.8	318	1096	139.7	4	7.3	4	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 40 ... PN 40

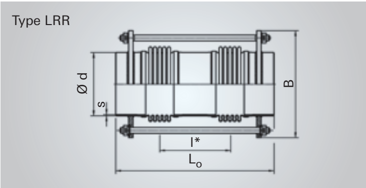


Nominal diameter	Nominal lateral movement absorption	Type LRR 40...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
150	55	.0150.055.0	670	35.9	380
150	96	.0150.096.0	920	42.7	380
150	149	.0150.149.0	1270	52.4	380
150	195	.0150.195.0	1570	60.6	380
200	54	.0200.054.0	740	65	459
200	97	.0200.097.0	940	73	459
200	149	.0200.149.0	1240	85.1	459
200	206	.0200.206.0	1590	99.1	459
250	45	.0250.045.0	720	93.1	555
250	97	.0250.097.0	970	108.7	555
250	151	.0250.151.0	1320	131	555
250	206	.0250.206.0	1670	153.2	555

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
330	168.3	4	33	74	0
580	168.3	4	23.7	24	0
930	168.3	4	16.9	9	0
1230	168.3	4	13.6	5	0
320	219.1	4.5	63.4	165	0
520	219.1	4.5	49.4	64	0
820	219.1	4.5	37.1	26	0
1170	219.1	4.5	28.7	13	0
275	273	6.3	117.1	293	0
525	273	6.3	85.2	88	0
875	273	6.3	61.8	32	0
1225	273	6.3	48.5	16	0

LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 63 ... PN 63

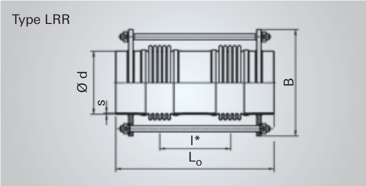


Nominal diameter	Nominal lateral movement absorption	Type LRR 63...	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
50	50	.0050.050.0	520	8.4	205
50	96	.0050.096.0	770	10.2	205
50	155	.0050.155.0	1120	12.8	205
50	198	.0050.198.0	1370	14.6	205
65	55	.0065.055.0	550	11.6	225
65	96	.0065.096.0	800	14.3	225
65	145	.0065.145.0	1100	17.5	225
65	203	.0065.203.0	1450	21.3	225
80	50	.0080.050.0	550	13.6	240
80	98	.0080.098.0	850	17.6	240
80	152	.0080.152.0	1200	22.3	240
80	198	.0080.198.0	1450	25.7	240
100	50	.0100.050.0	620	22.5	293
100	98	.0100.098.0	920	28.3	293
100	155	.0100.155.0	1320	36.1	293
100	197	.0100.197.0	1620	41.9	293
125	55	.0125.055.0	678	36.2	350
125	99	.0125.099.0	978	45.9	350
125	143	.0125.143.0	1278	55.5	350
125	201	.0125.201.0	1678	68.3	350

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
260	60.3	2.9	3.1	32	0
510	60.3	2.9	2	8	0
860	60.3	2.9	1.3	3	0
1110	60.3	2.9	1.1	2	0
265	76.1	3.2	5.7	35	0
515	76.1	3.2	3.8	9	0
815	76.1	3.2	2.7	4	0
1165	76.1	3.2	2	2	0
265	88.9	4	7.3	45	0
565	88.9	4	4.5	10	0
915	88.9	4	3.1	4	0
1165	88.9	4	2.6	2	0
290	114.3	4.5	13	70	0
590	114.3	4.5	8.5	17	0
990	114.3	4.5	5.8	6	0
1290	114.3	4.5	4.7	4	0
334	139.7	6.3	22.9	68	0
634	139.7	6.3	15.6	19	0
934	139.7	6.3	11.8	9	0
1334	139.7	6.3	8.9	4	0

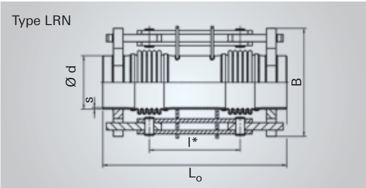
LATERAL EXPANSION JOINTS WITH WELD ENDS

TYPE LRR 63 ... PN 63



Nominal diameter	Nominal lateral movement absorption	Type LRR 63...	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
150	50	.0150.050.0	730	55.2	404	315	168.3	5.6	39.1	118	0
150	98	.0150.098.0	1030	66.8	404	615	168.3	5.6	27.3	32	0
150	153	.0150.153.0	1430	82.3	404	1015	168.3	5.6	19.4	12	0
150	195	.0150.195.0	1730	93.9	404	1315	168.3	5.6	16	7	0
200	53	.0200.053.0	890	100.4	495	425	219.1	8	60.9	192	0
200	95	.0200.095.0	1190	119.5	495	725	219.1	8	44.9	67	0
200	142	.0200.142.0	1590	145	495	1125	219.1	8	33.3	28	0
200	199	.0200.199.0	2090	176.9	495	1625	219.1	8	25.2	13	0

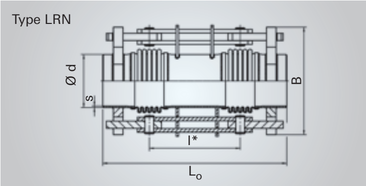
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 06 ... PN 06



Nennweite	Laterale Bewegungs-aufnahme nominal	Typ LRN 06...	Baulänge	Gewicht ca.	Größte Breite ca.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
600	58	.0600.058.0	774	230.5	904
600	108	.0600.108.0	886	246.3	904
600	150	.0600.150.0	1036	262.5	904
600	205	.0600.205.0	1236	284	904
600	302	.0600.302.0	1586	321.6	904
700	53	.0700.053.0	814	296	1014
700	98	.0700.098.0	926	312.6	1014
700	152	.0700.152.0	1082	331.4	1014
700	211	.0700.211.0	1282	354.9	1014
700	299	.0700.299.0	1582	390.2	1014
800	51	.0800.051.0	872	359.7	1124
800	98	.0800.098.0	1004	389.1	1124
800	151	.0800.151.0	1170	416.2	1124
800	206	.0800.206.0	1370	441.8	1124
800	303	.0800.303.0	1720	486.5	1124
900	52	.0900.052.0	992	558.8	1284
900	97	.0900.097.0	1124	596.1	1284
900	150	.0900.150.0	1374	639.2	1284
900	197	.0900.197.0	1490	666	1284
900	295	.0900.295.0	1890	735	1284

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
362	610	15	426.5	432	6.8
418	610	15	369.4	194	8.5
568	610	15	271.8	105	4.6
768	610	15	201	58	2.5
1118	610	15	138.1	27	1.2
362	711	15	573.3	615	9.2
418	711	15	493.8	322	11.4
546	711	15	376	184	8
746	711	15	275.2	99	4.3
1046	711	15	196.2	50	2.1
381	813	15	708.1	1055	12.7
447	813	15	603.6	460	15.4
580	813	15	465.2	228	11
780	813	15	345.9	126	6
1130	813	15	238.7	60	2.9
431	914	15	997.1	1170	12.7
497	914	15	864.7	528	15.9
747	914	15	575.3	234	7
830	914	15	517.8	158	6.8
1230	914	15	349.4	72	3.1

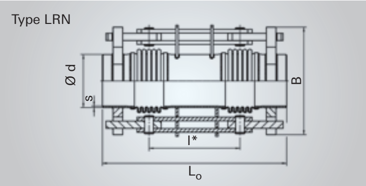
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 06 ... PN 06



Nominal diameter	Nominal lateral movement absorption	Type LRN 06 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
1000	50	.1000.050.0	1042	631.7	1394
1000	104	.1000.104.0	1232	682.2	1394
1000	152	.1000.152.0	1402	721.5	1394
1000	210	.1000.210.0	1652	767.2	1394
1000	303	.1000.303.0	2052	840.2	1394
1200	63	.1200.063.0	1132	886.1	1594
1200	100	.1200.100.0	1302	932.8	1594
1200	155	.1200.155.0	1522	989.8	1594
1200	206	.1200.206.0	1772	1048.1	1594
1200	308	.1200.308.0	2272	1164.5	1594
1400	49	.1400.049.0	1351	1102.6	1840
1400	97	.1400.097.0	1492	1146.7	1840
1400	149	.1400.149.0	1892	1267.5	1840
1400	202	.1400.202.0	2292	1388.3	1840
1400	307	.1400.307.0	3092	1629.9	1840
1600	47	.1600.047.0	1531	1648.1	2086
1600	103	.1600.103.0	1752	1728.1	2086
1600	147	.1600.147.0	2152	1900	2086
1600	190	.1600.190.0	2552	2072	2086
1600	300	.1600.300.0	3552	2502	2086

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
441	1016	15	1196.1	1401	15.8
561	1016	15	940.2	519	16.2
696	1016	15	757.8	281	12.7
946	1016	15	557.5	152	6.8
1346	1016	15	391.8	75	3.3
476	1220	20	1555.5	1420	25.4
611	1220	20	1211.8	689	19.2
796	1220	20	928.7	362	13.6
1046	1220	20	706.7	210	7.8
1546	1220	20	478.1	96	3.6
720.6	1420	15	1848.7	1869	12.8
741.2	1420	15	1797.3	883	24.3
1141.2	1420	15	1167.3	373	10.2
1541.2	1420	15	864.3	204	5.6
2341.2	1420	15	569	89	2.4
820.6	1620	15	2625	2108	12.8
941.2	1620	15	2288.6	801	19.5
1341.2	1620	15	1606	395	9.6
1741.2	1620	15	1237.1	234	5.7
2741.2	1620	15	785.8	94	2.3

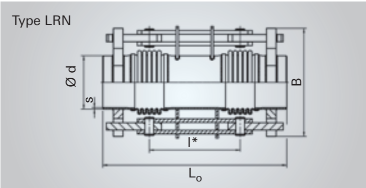
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 06 ... PN 06



Nominal diameter	Nominal lateral movement absorption	Type LRN 06 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
1800	63	.1800.063.0	1452	1791.2	2286
1800	102	.1800.102.0	1852	1975.1	2286
1800	150	.1800.150.0	2352	2204.9	2286
1800	199	.1800.199.0	2852	2434.8	2286
1800	307	.1800.307.0	3569	2760.1	2286
2000	57	.2000.057.0	1539	2697	2596
2000	101	.2000.101.0	2022	3051.6	2596
2000	146	.2000.146.0	2522	3409.3	2596
2000	199	.2000.199.0	3122	3838.6	2596
2000	306	.2000.306.0	3639	4202.2	2596

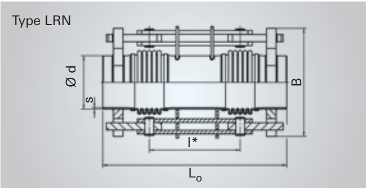
Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
641.2	1820	15	4223	3198	52.9
1041.2	1820	15	2600.6	1213	20
1541.2	1820	15	1756.9	554	9.1
2041.2	1820	15	1326.5	316	5.2
2749.6	1820	15	984.8	174	2.9
649.6	2020	15	6393.4	4216	65.5
1141.2	2020	15	3639.3	1366	20.5
1641.2	2020	15	2530.5	660	9.9
2241.2	2020	15	1853.1	354	5.3
2749.6	2020	15	1510.4	235	3.6

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 10 ...



Nominal diameter	Nominal lateral movement absorption	Type LRN 10 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
600	55	.0600.055.0	800	246.7	904	365	610	10	423.7	667	7
600	103	.0600.103.0	916	267.9	904	423	610	10	365.6	298	8.7
600	155	.0600.155.0	1116	289.4	904	623	610	10	248.2	137	4
600	207	.0600.207.0	1316	310.9	904	823	610	10	187.9	79	2.2
600	298	.0600.298.0	1666	348.5	904	1173	610	10	131.8	39	1.1
700	52	.0700.052.0	888	421.8	1064	374	711	12	698.3	1131	9.9
700	111	.0700.111.0	1066	467.2	1064	488	711	12	535.2	399	9.7
700	152	.0700.152.0	1180	493.7	1064	570	711	12	458.2	244	8.5
700	208	.0700.208.0	1380	527.7	1064	770	711	12	339.2	133	4.6
700	307	.0700.307.0	1730	587.1	1064	1120	711	12	233.2	63	2.2
800	51	.0800.051.0	928	477.8	1164	384	813	12	880.3	1394	12.9
800	98	.0800.098.0	1064	519.8	1164	452	813	12	747.9	604	15.6
800	150	.0800.150.0	1232	558.6	1164	586	813	12	576.2	310	11.1
800	204	.0800.204.0	1432	595	1164	786	813	12	429.6	172	6.1
800	299	.0800.299.0	1782	657.9	1164	1136	813	12	296.8	85	2.9
900	52	.0900.052.0	1018	618.1	1294	434	914	12	992.3	1547	12.9
900	97	.0900.097.0	1154	664.4	1294	502	914	12	857.9	694	16.1
900	146	.0900.146.0	1322	706.5	1294	636	914	12	675	401	12
900	194	.0900.194.0	1522	749.9	1294	836	914	12	513.5	232	6.9
900	291	.0900.291.0	1922	836.9	1294	1236	914	12	347.3	106	3.1

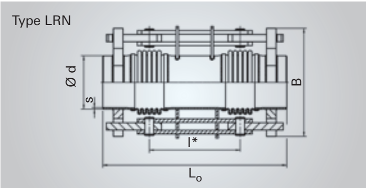
LATERAL EXPANSION JOINT WITH WELD ENDS
FOR MOVEMENT IN ONE PLANE TYPE LRN 10 ... PN 10



Nominal diameter	Nominal lateral movement absorption	Type LRN 10 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1000	58	.1000.058.0	1190	965.5	1450	480	1016	15	1477.7	1868	18.4
1000	102	.1000.102.0	1412	1039.4	1450	666	1016	15	1065	776	11.9
1000	155	.1000.155.0	1634	1111.8	1450	852	1016	15	832.5	395	8.7
1000	212	.1000.212.0	1934	1194.9	1450	1152	1016	15	615.7	216	4.8
1000	298	.1000.298.0	2384	1319.4	1450	1602	1016	15	442.7	112	2.4
1200	51	.1200.051.0	1236	1261.9	1686	490	1220	15	2516.4	2388	23.9
1200	102	.1200.102.0	1474	1427.7	1686	652	1220	15	1904.8	1100	21
1200	151	.1200.151.0	1774	1556.7	1686	952	1220	15	1304.5	516	9.8
1200	201	.1200.201.0	2074	1685.8	1686	1252	1220	15	991.9	298	5.7
1200	300	.1200.300.0	2674	1944	1686	1852	1220	15	670.6	136	2.6
1400	54	.1400.054.0	1690	2227	1986	829	1420	15	2515.7	2330	10.4
1400	106	.1400.106.0	1756	2246.9	1986	858	1420	15	2430.6	1088	19.4
1400	155	.1400.155.0	2156	2485.4	1986	1258	1420	15	1657.8	506	9
1400	204	.1400.204.0	2556	2724	1986	1658	1420	15	1257.8	291	5.2
1400	303	.1400.303.0	3356	3201	1986	2458	1420	15	848.4	133	2.3

LATERAL EXPANSION JOINT WITH WELD ENDS

FOR MOVEMENT IN ONE PLANE TYPE LRN 16 ... PN 16

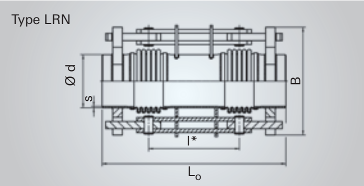


Nominal diameter	Nominal lateral movement absorption	Type LRN 16 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
500	53	.0500.053.0	789	241.4	794
500	107	.0500.107.0	926	265.8	794
500	148	.0500.148.0	1076	282.3	794
500	203	.0500.203.0	1276	304.2	794
500	313	.0500.313.0	1676	348.2	794
600	53	.0600.053.0	916	393.1	944
600	99	.0600.099.0	1086	433.4	944
600	150	.0600.150.0	1336	476.4	944
600	202	.0600.202.0	1586	519.5	944
600	305	.0600.305.0	2086	605.5	944
700	54	.0700.054.0	964	493.9	1064
700	100	.0700.100.0	1138	542.6	1064
700	151	.0700.151.0	1388	598.1	1064
700	202	.0700.202.0	1638	653.5	1064
700	304	.0700.304.0	2138	762.6	1064
800	58	.0800.058.0	1100	770.6	1220
800	105	.0800.105.0	1278	827.1	1220
800	153	.0800.153.0	1528	898.6	1220
800	211	.0800.211.0	1828	984.5	1220
800	307	.0800.307.0	2328	1127.6	1220

06

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
337	508	10	324.9	721	5.6
418	508	10	261.5	293	6
568	508	10	192.4	159	3.2
768	508	10	142.3	87	1.8
1168	508	10	93.5	38	0.7
398	610	12	487.2	1113	8.1
508	610	12	381.7	456	7.5
758	610	12	255.8	205	3.3
1008	610	12	192.3	116	1.9
1508	610	12	128.5	52	0.8
402	711	12	651.4	1342	11.1
514	711	12	509.5	547	10.2
764	711	12	342.8	248	4.6
1014	711	12	258.2	141	2.6
1514	711	12	172.5	68	1.1
460	813	15	981	1385	11.3
574	813	15	780.6	733	10.8
824	813	15	543.8	355	5.2
1124	813	15	398.6	191	2.8
1624	813	15	275.9	92	1.3

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 16 ... PN 16

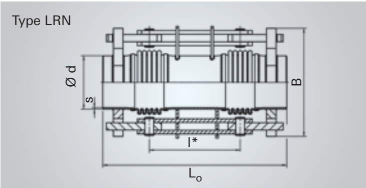


06

Nominal diameter	Nominal lateral movement absorption	Type LRN 16 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
900	52	.0900.052.0	1254	1161.2	1386
900	104	.0900.104.0	1414	1234.4	1386
900	157	.0900.157.0	1632	1319.7	1386
900	205	.0900.205.0	1882	1412.1	1386
900	293	.0900.293.0	2332	1578.4	1386
1000	51	.1000.051.0	1298	1308.4	1496
1000	102	.1000.102.0	1500	1421.3	1496
1000	154	.1000.154.0	1726	1529.3	1496
1000	210	.1000.210.0	2026	1661	1496
1000	303	.1000.303.0	2526	1880.7	1496

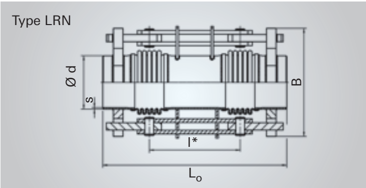
Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
534	914	15	1355.4	1891	8.6
652	914	15	1106.6	839	9.6
836	914	15	858.6	503	6.9
1086	914	15	660.9	298	4.1
1536	914	15	467.3	149	2
554	1016	15	1604.9	2485	11
680	1016	15	1307.5	990	12.1
868	1016	15	1022.4	539	8.9
1168	1016	15	759.8	297	4.9
1668	1016	15	532	146	2.4

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption	Type LRN 25 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
400	50	.0400.050.0	808	206.7	684	374	406,4	10	188,9	648	3,5
400	100	.0400.100.0	1058	236.8	684	599	406,4	10	117,9	202	1,7
400	153	.0400.153.0	1258	261.3	684	774	406,4	10	91,3	101	1,2
400	203	.0400.203.0	1508	288	684	1024	406,4	10	69	58	0,7
400	295	.0400.295.0	1958	336.2	684	1474	406,4	10	47,9	28	0,3
450	51	.0450.051.0	876	327	784	378	457	10	293,2	804	4,4
450	103	.0450.103.0	1080	366.8	784	530	457	10	209,1	272	3,4
450	154	.0450.154.0	1330	409.6	784	780	457	10	142,1	126	1,5
450	195	.0450.195.0	1530	443.9	784	980	457	10	113,1	80	1
450	297	.0450.297.0	2030	529.6	784	1480	457	10	74,8	35	0,4
500	53	.0500.053.0	952	394.1	844	406	508	12	338,4	1013	5,5
500	105	.0500.105.0	1212	446.8	844	636	508	12	216	330	2,8
500	150	.0500.150.0	1372	481.6	844	766	508	12	179,3	190	2,3
500	202	.0500.202.0	1622	527	844	1016	508	12	135,2	108	1,3
500	305	.0500.305.0	2122	617.7	844	1516	508	12	90,6	48	0,5
600	49	.0600.049.0	1082	634.3	1000	482	610	15	540,6	1254	4,4
600	98	.0600.098.0	1232	684	1000	596	610	15	437,2	492	4,8
600	151	.0600.151.0	1446	743.9	1000	778	610	15	334,9	241	3,4
600	202	.0600.202.0	1696	805.4	1000	1028	610	15	253,4	138	1,9
600	303	.0600.303.0	2196	928.4	1000	1528	610	15	170,5	62	0,8

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 25 ... PN 25

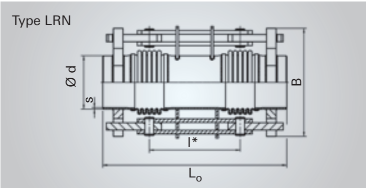


06

Nominal diameter	Nominal lateral movement absorption	Type LRN 25 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_{-N}$	–	L_o	G	B
–	mm	–	mm	kg	mm
700	51	.0700.051.0	1174	931.6	1156
700	103	.0700.103.0	1338	1019	1156
700	150	.0700.150.0	1588	1109.9	1156
700	207	.0700.207.0	1888	1220.1	1156
700	301	.0700.301.0	2388	1401.9	1156

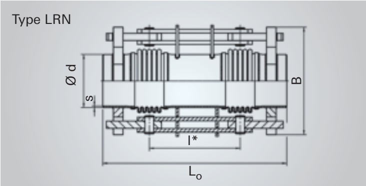
Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
454	711	15	951.1	1413	8.6
584	711	15	745.4	677	8.4
834	711	15	521.9	332	4.1
1134	711	15	384.4	173	2.2
1634	711	15	266.7	83	1

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 40 ... PN 40



Nominal diameter	Nominal lateral movement absorption	Type LRN 40 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
300	52	.0300.052.0	842	184	584	416	323.9	7.1	109.1	413	1.6
300	101	.0300.101.0	1034	207	584	562	323.9	7.1	80.7	151	1.3
300	147	.0300.147.0	1284	232.8	584	812	323.9	7.1	55.9	72	0.6
300	194	.0300.194.0	1534	258.6	584	1062	323.9	7.1	42.7	42	0.3
300	297	.0300.297.0	2084	315.3	584	1612	323.9	7.1	28.1	18	0.1
350	51	.0350.051.0	875	273.4	674	395	355.6	10	173.1	487	2.3
350	106	.0350.106.0	1096	309.1	674	568	355.6	10	119.4	182	1.6
350	155	.0350.155.0	1346	346.9	674	818	355.6	10	82.9	88	0.8
350	204	.0350.204.0	1596	384.7	674	1068	355.6	10	63.5	51	0.4
350	301	.0350.301.0	2096	460.3	674	1568	355.6	10	43.2	24	0.2
400	50	.0400.050.0	874	307.7	724	382	406.4	10	232.8	679	3.6
400	99	.0400.099.0	1128	355.4	724	609	406.4	10	145.7	224	1.7
400	149	.0400.149.0	1332	392.8	724	786	406.4	10	112.1	128	1.2
400	198	.0400.198.0	1582	437.9	724	1036	406.4	10	85	74	0.7
400	296	.0400.296.0	2082	528.2	724	1536	406.4	10	57.3	34	0.3
450	49	.0450.049.0	936	373.4	784	398	457	10	280.8	931	4.5
450	107	.0450.107.0	1202	431.1	784	606	457	10	184	280	2.9
450	154	.0450.154.0	1452	479.4	784	856	457	10	130.2	140	1.4
450	201	.0450.201.0	1702	527.6	784	1106	457	10	100.8	84	0.8
450	304	.0450.304.0	2252	633.8	784	1656	457	10	67.3	37	0.3

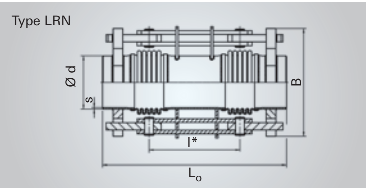
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 40 ... PN 40



Nominal diameter	Nominal lateral movement absorption	Type LRN 40 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
500	47	.0500.047.0	1114	578.1	890
500	96	.0500.096.0	1364	645.6	890
500	146	.0500.146.0	1714	733.1	890
500	196	.0500.196.0	2064	820.6	890
500	296	.0500.296.0	2764	995.6	890

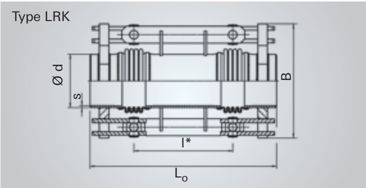
Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
494	508	12	370.1	1158	3.6
702	508	12	260	398	2.6
1052	508	12	173.5	177	1.1
1402	508	12	130.1	100	0.6
2102	508	12	86.8	44	0.2

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ONE PLANE TYPE LRN 63 ... PN 63



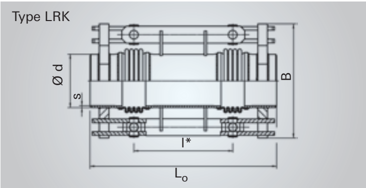
Nominal diameter	Nominal lateral movement absorption	Type LRN 63 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
250	51	.0250.051.0	850	191.6	554	385	273	8.8	85.5	364	1.7
250	104	.0250.104.0	1146	224.3	554	658	273	8.8	50	104	0.7
250	153	.0250.153.0	1446	255.8	554	958	273	8.8	34.3	49	0.3
250	202	.0250.202.0	1746	287.4	554	1258	273	8.8	26.1	28	0.1
300	48	.0300.048.0	908	286.4	624	424	323.9	10	134.5	457	1.7
300	100	.0300.100.0	1158	326	624	624	323.9	10	89.8	194	1.2
300	150	.0300.150.0	1458	374	624	924	323.9	10	60.7	89	0.5
300	200	.0300.200.0	1758	422	624	1224	323.9	10	45.8	51	0.3
300	299	.0300.299.0	2358	518.1	624	1824	323.9	10	30.7	23	0.1
350	49	.0350.049.0	1026	359.5	674	448	355.6	12	155.5	616	2.2
350	97	.0350.097.0	1242	405.4	674	606	355.6	12	114.9	225	1.8
350	147	.0350.147.0	1542	460.8	674	906	355.6	12	76.8	100	0.8
350	198	.0350.198.0	1842	516.1	674	1206	355.6	12	57.7	57	0.4
350	299	.0350.299.0	2442	626.8	674	1806	355.6	12	38.5	25	0.2
400	52	.0400.052.0	1138	533.9	780	509	406.4	15	231.4	691	2.5
400	102	.0400.102.0	1492	628.8	780	836	406.4	15	140.2	234	1.1
400	152	.0400.152.0	1892	737.6	780	1236	406.4	15	94.8	107	0.5
400	196	.0400.196.0	2242	832.8	780	1586	406.4	15	73.9	65	0.3
400	297	.0400.297.0	3042	1050.5	780	2386	406.4	15	49.1	29	0.1

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 06 ... PN 06



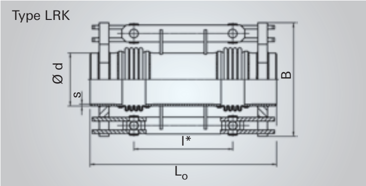
Nennweite	Laterale Bewegungs-aufnahme nominal	Typ LRK 06...	Baulänge	Gewicht ca.	Größte Breite ca.	Centre-to-centre spacing of bellows	Weld end: outside diameter	Weld end: wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
600	58	.0600.058.0	774	261.6	904	362	610	15	426.5	432	6.8
600	108	.0600.108.0	886	277.5	904	418	610	15	369.4	194	8.5
600	150	.0600.150.0	1036	293.7	904	568	610	15	271.8	105	4.6
600	205	.0600.205.0	1236	315.2	904	768	610	15	201	58	2.5
600	302	.0600.302.0	1586	352.8	904	1118	610	15	138.1	27	1.2
700	53	.0700.053.0	814	327.3	1014	362	711	15	573.3	615	9.2
700	98	.0700.098.0	926	343.9	1014	418	711	15	493.8	322	11.4
700	152	.0700.152.0	1082	362.6	1014	546	711	15	376	184	8
700	211	.0700.211.0	1282	386.2	1014	746	711	15	275.2	99	4.3
700	299	.0700.299.0	1582	421.4	1014	1046	711	15	196.2	50	2.1
800	51	.0800.051.0	872	391.1	1124	381	813	15	708.1	1055	12.7
800	98	.0800.098.0	1004	420.4	1124	447	813	15	603.6	460	15.4
800	151	.0800.151.0	1170	447.6	1124	580	813	15	465.2	228	11
800	206	.0800.206.0	1370	473.2	1124	780	813	15	345.9	126	6
800	303	.0800.303.0	1720	517.9	1124	1130	813	15	238.7	60	2.9
900	52	.0900.052.0	992	617.2	1284	431	914	15	997.1	1170	12.7
900	97	.0900.097.0	1124	654.4	1284	497	914	15	864.7	528	15.9
900	150	.0900.150.0	1374	697.5	1284	747	914	15	575.3	234	7
900	197	.0900.197.0	1490	724.3	1284	830	914	15	517.8	158	6.8
900	295	.0900.295.0	1890	793.3	1284	1230	914	15	349.4	72	3.1

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 06 ... PN 06



Nominal diameter	Nominal lateral movement absorption	Type LRK 06 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1000	50	.1000.050.0	1042	690.3	1394	441	1016	15	1196.1	1401	15.8
1000	104	.1000.104.0	1232	740.8	1394	561	1016	15	940.2	519	16.2
1000	152	.1000.152.0	1402	780.1	1394	696	1016	15	757.8	281	12.7
1000	210	.1000.210.0	1652	825.7	1394	946	1016	15	557.5	152	6.8
1000	303	.1000.303.0	2052	898.8	1394	1346	1016	15	391.8	75	3.3
1200	63	.1200.063.0	1132	944.4	1594	476	1220	20	1555.5	1420	25.4
1200	100	.1200.100.0	1302	991.1	1594	611	1220	20	1211.8	689	19.2
1200	155	.1200.155.0	1522	1048.1	1594	796	1220	20	928.7	362	13.6
1200	206	.1200.206.0	1772	1106.4	1594	1046	1220	20	706.7	210	7.8
1200	308	.1200.308.0	2272	1222.8	1594	1546	1220	20	478.1	96	3.6
1400	49	.1400.049.0	1351	1233.9	1840	720.6	1420	15	1848.7	1869	12.8
1400	97	.1400.097.0	1492	1278.1	1840	741.2	1420	15	1797.3	883	24.3
1400	149	.1400.149.0	1892	1398.9	1840	1141.2	1420	15	1167.3	373	10.2
1400	202	.1400.202.0	2292	1519.7	1840	1541.2	1420	15	864.3	204	5.6
1400	307	.1400.307.0	3092	1761.2	1840	2341.2	1420	15	569	89	2.4
1600	47	.1600.047.0	1531	1872	2086	820.6	1620	15	2625	2108	12.8
1600	103	.1600.103.0	1752	1952	2086	941.2	1620	15	2288.6	801	19.5
1600	147	.1600.147.0	2152	2124	2086	1341.2	1620	15	1606	395	9.6
1600	190	.1600.190.0	2552	2296	2086	1741.2	1620	15	1237.1	234	5.7
1600	300	.1600.300.0	3552	2725.9	2086	2741.2	1620	15	785.8	94	2.3

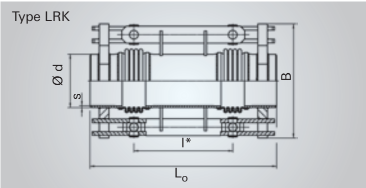
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 06 ... PN 06



Nominal diameter	Nominal lateral movement absorption	Type LRK 06 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
1800	63	.1800.063.0	1469	2018.3	2286
1800	102	.1800.102.0	1852	2198.7	2286
1800	150	.1800.150.0	2352	2428.6	2286
1800	199	.1800.199.0	2852	2658.5	2286
1800	307	.1800.307.0	3569	2983.8	2286

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
649.6	1820	15	4168.4	3116	53.3
1041.2	1820	15	2600.6	1213	20
1541.2	1820	15	1756.9	554	9.1
2041.2	1820	15	1326.5	316	5.2
2749.6	1820	15	984.8	174	2.9

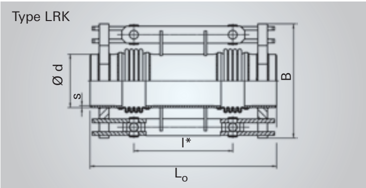
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 10 ... PN 10



06

Nominal diameter	Nominal lateral movement absorption	Type LRK 10 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
600	55	.0600.055.0	800	277.9	904	365	610	10	423.7	667	7
600	103	.0600.103.0	916	299	904	423	610	10	365.6	298	8.7
600	155	.0600.155.0	1116	320.5	904	623	610	10	248.2	137	4
600	207	.0600.207.0	1316	342.1	904	823	610	10	187.9	79	2.2
600	298	.0600.298.0	1666	379.7	904	1173	610	10	131.8	39	1.1
700	52	.0700.052.0	888	480	1064	374	711	12	698.3	1131	9.9
700	111	.0700.111.0	1066	525.4	1064	488	711	12	535.2	399	9.7
700	152	.0700.152.0	1180	551.9	1064	570	711	12	458.2	244	8.5
700	208	.0700.208.0	1380	585.8	1064	770	711	12	339.2	133	4.6
700	307	.0700.307.0	1730	645.2	1064	1120	711	12	233.2	63	2.2
800	51	.0800.051.0	928	535.7	1164	384	813	12	880.3	1394	12.9
800	98	.0800.098.0	1064	577.7	1164	452	813	12	747.9	604	15.6
800	150	.0800.150.0	1232	616.5	1164	586	813	12	576.2	310	11.1
800	204	.0800.204.0	1432	653	1164	786	813	12	429.6	172	6.1
800	299	.0800.299.0	1782	715.9	1164	1136	813	12	296.8	85	2.9
900	52	.0900.052.0	1018	676.5	1294	434	914	12	992.3	1547	12.9
900	97	.0900.097.0	1154	722.8	1294	502	914	12	857.9	694	16.1
900	146	.0900.146.0	1322	764.8	1294	636	914	12	675	401	12
900	194	.0900.194.0	1522	808.3	1294	836	914	12	513.5	232	6.9
900	291	.0900.291.0	1922	895.3	1294	1236	914	12	347.3	106	3.1

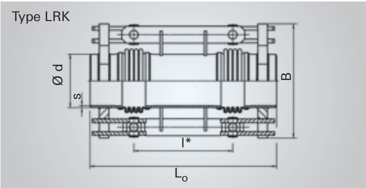
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 10 ... PN 10



Nominal diameter	Nominal lateral movement absorption	Type LRK 10 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
1000	58	.1000.058.0	1190	1097.7	1450
1000	102	.1000.102.0	1412	1171.6	1450
1000	155	.1000.155.0	1634	1244	1450
1000	212	.1000.212.0	1934	1327	1450
1000	298	.1000.298.0	2384	1451.6	1450
1200	51	.1200.051.0	1236	1486.4	1686
1200	102	.1200.102.0	1474	1652.2	1686
1200	151	.1200.151.0	1774	1781.3	1686
1200	201	.1200.201.0	2074	1910.3	1686
1200	300	.1200.300.0	2674	2168.5	1686

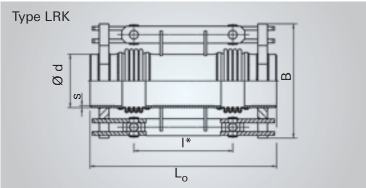
Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
480	1016	15	1477.7	1868	18.4
666	1016	15	1065	776	11.9
852	1016	15	832.5	395	8.7
1152	1016	15	615.7	216	4.8
1602	1016	15	442.7	112	2.4
490	1220	15	2516.4	2388	23.9
652	1220	15	1904.8	1100	21
952	1220	15	1304.5	516	9.8
1252	1220	15	991.9	298	5.7
1852	1220	15	670.6	136	2.6

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 16 ... PN 16



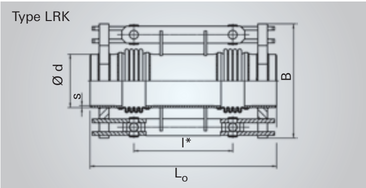
Nominal diameter	Nominal lateral movement absorption	Type LRK 16 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
500	53	.0500.053.0	789	272.4	794	337	508	10	324.9	721	5.6
500	107	.0500.107.0	926	296.9	794	418	508	10	261.5	293	6
500	148	.0500.148.0	1076	313.3	794	568	508	10	192.4	159	3.2
500	203	.0500.203.0	1276	335.3	794	768	508	10	142.3	87	1.8
500	313	.0500.313.0	1676	379.2	794	1168	508	10	93.5	38	0.7
600	53	.0600.053.0	916	450.8	944	398	610	12	487.2	1113	8.1
600	99	.0600.099.0	1086	491.2	944	508	610	12	381.7	456	7.5
600	150	.0600.150.0	1336	534.2	944	758	610	12	255.8	205	3.3
600	202	.0600.202.0	1586	577.2	944	1008	610	12	192.3	116	1.9
600	305	.0600.305.0	2086	663.3	944	1508	610	12	128.5	52	0.8
700	54	.0700.054.0	964	552	1064	402	711	12	651.4	1342	11.1
700	100	.0700.100.0	1138	600.8	1064	514	711	12	509.5	547	10.2
700	151	.0700.151.0	1388	656.2	1064	764	711	12	342.8	248	4.6
700	202	.0700.202.0	1638	711.6	1064	1014	711	12	258.2	141	2.6
700	304	.0700.304.0	2138	820.7	1064	1514	711	12	172.5	68	1.1
800	58	.0800.058.0	1100	902.1	1220	460	813	15	981	1385	11.3
800	105	.0800.105.0	1278	958.6	1220	574	813	15	780.6	733	10.8
800	153	.0800.153.0	1528	1030.1	1220	824	813	15	543.8	355	5.2
800	211	.0800.211.0	1828	1116	1220	1124	813	15	398.6	191	2.8
800	307	.0800.307.0	2328	1259.1	1220	1624	813	15	275.9	92	1.3

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 16 ... PN 16



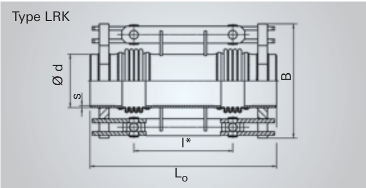
Nominal diameter	Nominal lateral movement absorption	Type LRK 16 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
900	52	.0900.052.0	1254	1387.1	1386	534	914	15	1355.4	1891	8.6
900	104	.0900.104.0	1414	1460.2	1386	652	914	15	1106.6	839	9.6
900	157	.0900.157.0	1632	1545.6	1386	836	914	15	858.6	503	6.9
900	205	.0900.205.0	1882	1637.9	1386	1086	914	15	660.9	298	4.1
900	293	.0900.293.0	2332	1804.2	1386	1536	914	15	467.3	149	2
1000	51	.1000.051.0	1298	1534.5	1496	554	1016	15	1604.9	2485	11
1000	102	.1000.102.0	1500	1647.4	1496	680	1016	15	1307.5	990	12.1
1000	154	.1000.154.0	1726	1755.3	1496	868	1016	15	1022.4	539	8.9
1000	210	.1000.210.0	2026	1887.1	1496	1168	1016	15	759.8	297	4.9
1000	303	.1000.303.0	2526	2106.7	1496	1668	1016	15	532	146	2.4

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption	Type LRK 25 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
400	50	.0400.050.0	808	237.7	684	374	406.4	10	188.9	648	3.5
400	100	.0400.100.0	1058	267.9	684	599	406.4	10	117.9	202	1.7
400	153	.0400.153.0	1258	292.3	684	774	406.4	10	91.3	101	1.2
400	203	.0400.203.0	1508	319.1	684	1024	406.4	10	69	58	0.7
400	295	.0400.295.0	1958	367.2	684	1474	406.4	10	47.9	28	0.3
450	51	.0450.051.0	876	384.9	784	378	457	10	293.2	804	4.4
450	103	.0450.103.0	1080	424.7	784	530	457	10	209.1	272	3.4
450	154	.0450.154.0	1330	467.6	784	780	457	10	142.1	126	1.5
450	195	.0450.195.0	1530	501.8	784	980	457	10	113.1	80	1
450	297	.0450.297.0	2030	587.5	784	1480	457	10	74.8	35	0.4
500	53	.0500.053.0	952	452	844	406	508	12	338.4	1013	5.5
500	105	.0500.105.0	1212	504.8	844	636	508	12	216	330	2.8
500	150	.0500.150.0	1372	539.6	844	766	508	12	179.3	190	2.3
500	202	.0500.202.0	1622	585	844	1016	508	12	135.2	108	1.3
500	305	.0500.305.0	2122	675.7	844	1516	508	12	90.6	48	0.5
600	49	.0600.049.0	1082	765.8	1000	482	610	15	540.6	1254	4.4
600	98	.0600.098.0	1232	815.4	1000	596	610	15	437.2	492	4.8
600	151	.0600.151.0	1446	875.4	1000	778	610	15	334.9	241	3.4
600	202	.0600.202.0	1696	936.9	1000	1028	610	15	253.4	138	1.9
600	303	.0600.303.0	2196	1059.8	1000	1528	610	15	170.5	62	0.8

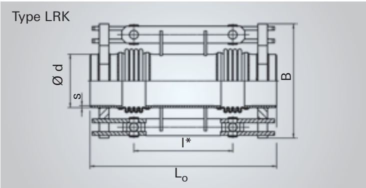
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption	Type LRK 25 ...	Overall length	weight approx.	Max. width approx.
DN	$2\lambda_N$	–	L_o	G	B
–	mm	–	mm	kg	mm
700	51	.0700.051.0	1174	1156.8	1156
700	103	.0700.103.0	1338	1244.1	1156
700	150	.0700.150.0	1588	1335	1156
700	207	.0700.207.0	1888	1445.2	1156
700	301	.0700.301.0	2388	1627	1156

Centre-to-centre spacing of bellows	Weld end		Spring rate		
	outside diameter	wall thickness			
l*	d	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
454	711	15	951.1	1413	8.6
584	711	15	745.4	677	8.4
834	711	15	521.9	332	4.1
1134	711	15	384.4	173	2.2
1634	711	15	266.7	83	1

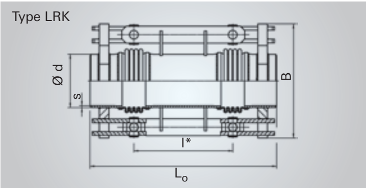
LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 40 ... PN 40



Nominal diameter	Nominal lateral movement absorption	Type LRK 40 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
300	52	.0300.052.0	842	214.9	584	416	323.9	7.1	109.1	413	1.6
300	101	.0300.101.0	1034	237.8	584	562	323.9	7.1	80.7	151	1.3
300	147	.0300.147.0	1284	263.6	584	812	323.9	7.1	55.9	72	0.6
300	194	.0300.194.0	1534	289.4	584	1062	323.9	7.1	42.7	42	0.3
300	297	.0300.297.0	2084	346.2	584	1612	323.9	7.1	28.1	18	0.1
350	51	.0350.051.0	875	332.9	674	395	355.6	10	173.1	487	2.3
350	105	.0350.105.0	1096	368.6	674	568	355.6	10	119.4	182	1.6
350	155	.0350.155.0	1346	406.4	674	818	355.6	10	82.9	88	0.8
350	204	.0350.204.0	1596	444.2	674	1068	355.6	10	63.5	51	0.4
350	301	.0350.301.0	2096	519.8	674	1568	355.6	10	43.2	24	0.2
400	50	.0400.050.0	874	365.5	724	382	406.4	10	232.8	679	3.6
400	99	.0400.099.0	1128	413.2	724	609	406.4	10	145.7	224	1.7
400	149	.0400.149.0	1332	450.6	724	786	406.4	10	112.1	128	1.2
400	198	.0400.198.0	1582	495.7	724	1036	406.4	10	85	74	0.7
400	296	.0400.296.0	2082	586	724	1536	406.4	10	57.3	34	0.3
450	49	.0450.049.0	936	431.3	784	398	457	10	280.8	931	4.5
450	107	.0450.107.0	1202	489	784	606	457	10	184	280	2.9
450	154	.0450.154.0	1452	537.3	784	856	457	10	130.2	140	1.4
450	201	.0450.201.0	1702	585.6	784	1106	457	10	100.8	84	0.8
450	304	.0450.304.0	2252	691.8	784	1656	457	10	67.3	37	0.3

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 40 ... PN 40

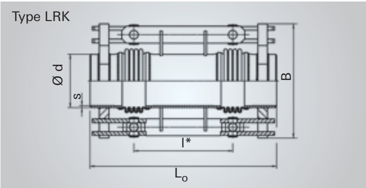
06



06

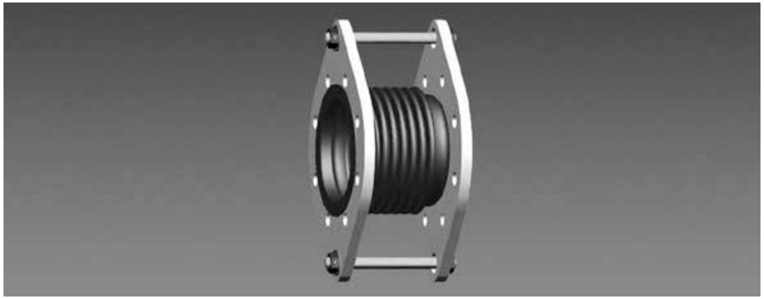
Nominal diameter	Nominal lateral movement absorption	Type LRK 40 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end		Spring rate		
							outside diameter	wall thickness			
DN	$2\lambda_N$	–	L_o	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
500	47	.0500.047.0	1114	709.8	890	494	508	12	370.1	1158	3.6
500	96	.0500.096.0	1364	777.3	890	702	508	12	260	398	2.6
500	146	.0500.146.0	1714	864.8	890	1052	508	12	173.5	177	1.1
500	196	.0500.196.0	2064	952.3	890	1402	508	12	130.1	100	0.6
500	296	.0500.296.0	2764	1127.3	890	2102	508	12	86.8	44	0.2

LATERAL EXPANSION JOINT WITH WELD ENDS FOR MOVEMENT IN ALL PLANES TYPE LRK 63 ... PN 63



Nominal diameter	Nominal lateral movement absorption	Type LRK 63 ...	Overall length	weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld end outside diameter	Weld end wall thickness	Spring rate		
DN	$2\lambda_N$	–	L_0	G	B	l*	d	s	c_r	c_λ	c_p
–	mm	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
250	51	.0250.051.0	850	224.1	554	385	273	8.8	85.5	364	1.7
250	104	.0250.104.0	1146	256.8	554	658	273	8.8	50	104	0.7
250	153	.0250.153.0	1446	288.3	554	958	273	8.8	34.3	49	0.3
250	202	.0250.202.0	1746	319.8	554	1258	273	8.8	26.1	28	0.1
300	48	.0300.048.0	908	345.4	624	424	323.9	10	134.5	457	1.7
300	100	.0300.100.0	1158	385	624	624	323.9	10	89.8	194	1.2
300	150	.0300.150.0	1458	433	624	924	323.9	10	60.7	89	0.5
300	200	.0300.200.0	1758	481.1	624	1224	323.9	10	45.8	51	0.3
300	299	.0300.299.0	2358	577.1	624	1824	323.9	10	30.7	23	0.1
350	49	.0350.049.0	1026	419	674	448	355.6	12	155.5	616	2.2
350	97	.0350.097.0	1242	464.9	674	606	355.6	12	114.9	225	1.8
350	147	.0350.147.0	1542	520.3	674	906	355.6	12	76.8	100	0.8
350	198	.0350.198.0	1842	575.6	674	1206	355.6	12	57.7	57	0.4
350	299	.0350.299.0	2442	686.3	674	1806	355.6	12	38.5	25	0.2
400	52	.0400.052.0	1138	667.9	780	509	406.4	15	231.4	691	2.5
400	102	.0400.102.0	1492	762.8	780	836	406.4	15	140.2	234	1.1
400	152	.0400.152.0	1892	871.6	780	1236	406.4	15	94.8	107	0.5
400	196	.0400.196.0	2242	966.9	780	1586	406.4	15	73.9	65	0.3
400	297	.0400.297.0	3042	1184.6	780	2386	406.4	15	49.1	29	0.1

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, SOUND INSULATING TYPE LBS



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type LBS: HYDRA sound insulating lateral expansion joint for absorbing vibration, with loose flanges

Standard version/materials:
Multi-ply bellows made of 1.4541
Flange made of P 265 GH (1.0425)
Operating temperature: up to 400 °C

Type designation (example)

LBS	10	·	0150	·	102	·	0
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal (2δ = 31 mm)		Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________________
- Piping - nominal diameter DN ____________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar]____________________
- Max./min. allowable temperature [°C] ____________________
- Test pressure PT [bar] ____________________

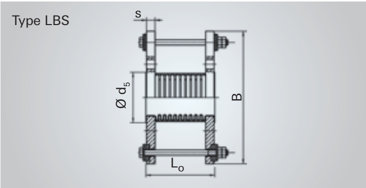
Optional:
- Category ____________________

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

06

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, SOUND INSULATING

TYPE LBS 06 ... PN 06



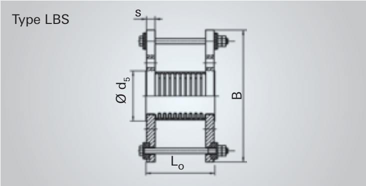
Nominal diameter	Nominal lateral movement absorption		Type LBS 06...	Overall length	Weight approx.	Max. width approx.
	for 1000 load cycles	with vibrations				
DN	$2\lambda_N$	î	–	L_o	G	B
–	mm	mm	–	mm	kg	mm
50	18	0.5	.0050.018	165	6	240
65	20	0.5	.0065.020	180	8	260
80	21	0.5	.0080.021	190	10	290
100	20	0.5	.0100.020	190	12	310
125	19	0.5	.0125.019	210	15	340
150	31	0.5	.0150.031	265	16	365
200	32	0.5	.0200.032	285	23	420
250	36	0.5	.0250.036	330	36	503
300	40	0.5	.0300.040	345	50	600
350	38	0.5	.0350.038	360	63	650
400	31	0.5	.0400.031	390	82	724

Flange 2)			Spring rate			Natural frequency of bellows	
drilling DIN 1092	flange diameter	thickness				axial	radial
PN	d_5	s	c_r	c_λ	c_p	ω_α	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
PN06	90	16	6.1	77	0	200	385
PN06	107	16	8.9	91	0	155	340
PN06	122	18	11	99	0	145	325
PN06	147	18	17	162	0	125	345
PN06	178	20	21	212	0	115	355
PN06	202	20	26	117	0	90	355
PN06	258	22	48	165	0	75	325
PN06	312	24	84	298	0	55	285
PN06	365	24	155	358	0	50	250
PN06	410	26	180	418	0	50	270
PN06	465	28	270	501	0	55	335

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, SOUND INSULATING

TYPE LBS 10 ... PN 10



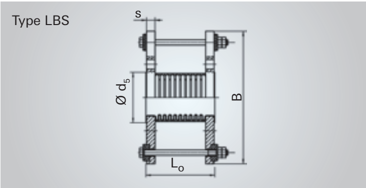
Nominal diameter	Nominal lateral movement absorption		Type LBS 10...	Overall length	Weight approx.	Max. width approx.
	for 1000 load cycles	with vibrations				
DN	$2\lambda_N$	î	–	L_o	G	B
–	mm	mm	–	mm	kg	mm
50	18	0.5	.0050.018	175	9	265
65	20	0.5	.0065.020	200	12	285
80	21	0.5	.0080.021	210	13	300
100	20	0.5	.0100.020	210	16	320
125	19	0.5	.0125.019	215	19	350
150	31	0.5	.0150.031	285	25	385
200	32	0.5	.0200.032	300	34	468
250	36	0.5	.0250.036	345	50	555
300	40	0.5	.0300.040	370	69	629
350	38	0.5	.0350.038	380	84	689
400	31	0.5	.0400.031	430	137	785

Flange[2]			Spring rate			Natural frequency of bellows	
drilling DIN 1092	flange diameter	thickness				axial	radial
PN	d_5	s	c_r	c_λ	c_p	ω_α	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
PN16	92	19	5.7	77	0	200	385
PN16	107	20	8.1	136	0	160	315
PN16	122	20	10	146	0	150	305
PN16	147	22	16	236	0	125	325
PN16	178	22	20	364	0	115	355
PN16	208	24	29	191	0	90	355
PN10	258	24	58	266	0	75	315
PN10	320	26	113	339	0	55	260
PN10	370	28	178	532	0	45	225
PN10	410	28	213	620	0	40	210
PN10	465	37	289	1003	0	55	305

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, SOUND INSULATING

TYP LBS 16 ... PN 16



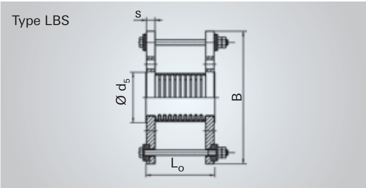
Nominal diameter	Nominal lateral movement absorption		Type LBS 16...	Overall length	Weight approx.	Max. width approx.
	for 1000 load cycles	with vibrations				
DN	$2\lambda_N$	î	–	L_o	G	B
–	mm	mm	–	mm	kg	mm
50	17	0.5	.0050.017	185	10	265
65	22	0.5	.0065.022	210	12	285
80	20	0.5	.0080.020	210	14	300
100	15	0.5	.0100.015	200	16	320
125	15	0.5	.0125.015	210	19	350
150	32	0.5	.0150.032	290	28	413
200	33	0.5	.0200.033	310	44	500
250	25	0.5	.0250.025	355	68	589
300	27	0.5	.0300.027	385	102	680
350	25	0.5	.0350.025	380	139	667
400	33	0.5	.0400.033	450	172	723

Flange[2)]			Spring rate			Natural frequency of bellows	
drilling DIN 1092	flange diameter	thickness				axial	radial
PN	d_5	s	c_r	c_λ	c_p	ω_α	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
PN16	92	19	5.5	119	0	205	360
PN16	107	20	7.8	130	0	140	260
PN16	122	20	10	178	0	145	300
PN16	147	22	16	402	0	135	390
PN16	178	22	25	573	0	130	425
PN16	208	24	36	220	0	90	315
PN16	258	26	78	421	0	70	285
PN16	320	32	133	499	0	85	410
PN16	375	37	199	741	0	70	360
PN16	410	32	214	1035	0	65	350
PN16	465	34	250	1192	0	55	275

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

LATERAL EXPANSION JOINTS WITH LOOSE FLANGES, SOUND INSULATING

TYP LBS 25 ... PN 25



Nominal diameter	Nominal lateral movement absorption		Type LBS 25...	Overall length	Weight approx.	Max. width approx.
	for 1000 load cycles	with vibrations				
DN	$2\lambda_N$	î	–	L_o	G	B
–	mm	mm	–	mm	kg	mm
50	18	0.5	.0050.018	190	10	265
65	20	0.5	.0065.020	215	14	285
80	21	0.5	.0080.021	215	16	300
100	20	0.5	.0100.020	215	21	335
125	19	0.5	.0125.019	230	29	398
150	31	0.5	.0150.031	300	41	460
200	32	0.5	.0200.032	325	63	544
250	36	0.5	.0250.036	370	122	578
300	40	0.5	.0300.040	405	151	634
350	38	0.5	.0350.038	420	226	735

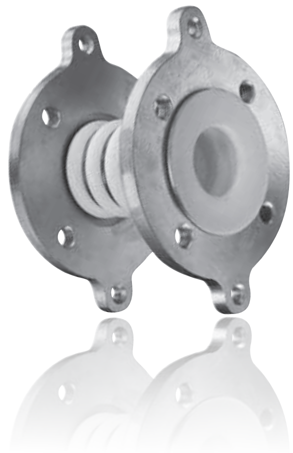
Flange[2)]			Spring rate			Natural frequency of bellows	
drilling DIN 1092	flange diameter	thickness				axial	radial
PN	d_5	s	c_r	c_λ	c_p	ω_α	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
PN40	92	20	5.5	159	0	225	400
PN40	107	22	7.5	205	0	160	295
PN40	122	24	9.8	289	0	155	325
PN40	147	24	19	476	0	135	380
PN40	178	26	30	671	0	135	410
PN40	208	28	48	310	0	90	315
PN25	258	32	94	592	0	105	425
PN25	320	35	128	788	0	85	390
PN25	375	38	171	1344	0	75	340
PN25	410	42	223	1354	0	65	310

2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

SPECIAL RANGES

The standard ranges described in Chapter 6 are supplemented in this chapter by a series of special ranges of expansion joints and related products. These products are primarily designed either for special applications – engine manufacturing, apparatus construction, district heating – or for special performance data, e.g. high pressures. Type series are available for the more frequently demanded dimension ranges. Special designs outside these ranges can be supplied on request. The following pages provide a quick overview of the special ranges.

07



Exhaust expansion joints with special cuffs

Series
various

Nominal diameters
DN 20-200

Pressure ratings
PN1

Single-ply expansion joints for apparatus construction

Series
AON

Nominal diameters
DN 100-3000

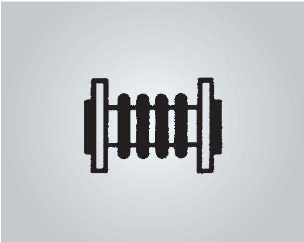
Pressure stages
dependent on nominal diameter

Axial expansion joints with PTFE lining

Series
ABT

Nominal diameters
DN 50-500
DN 50-300

Pressure stages
PN10 and PN25

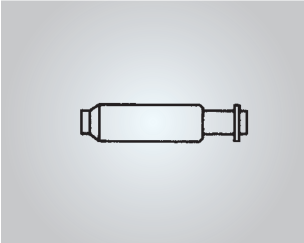


Axial expansion joints with automatic release mechanism

Series
ARH

Nominal diameters
DN 40-1000

Pressure stages
PN 16 and PN 25

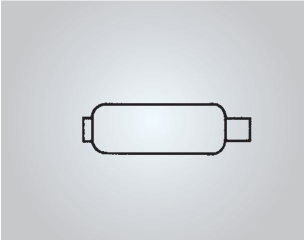


Pressure balanced axial expansion joints

Series
DRD

Nominal diameters
DN 400-1000

Pressure stages
PN 25 and PN 40

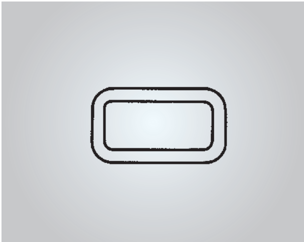


Rectangular expansion joints

Series
XOZ etc.

Nominal diameters
Max. length of side b = 3700

Pressure stages
Max. PS = 2 bar



Axial expansion joints for vacuum technology

Series
AVZ

Nominal diameters
DN 16-500

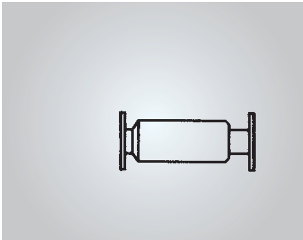
Pressure stages
PN 1

Axial expansion joints for heating and ventilation installations

Series
various

Nominal diameters
DN 15-100

Pressure stages
PN 6-25

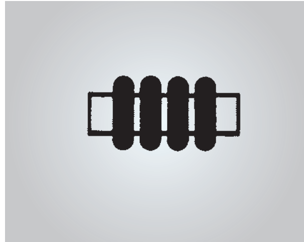


Expansion joints and metal bellows for high pressures

Series
various

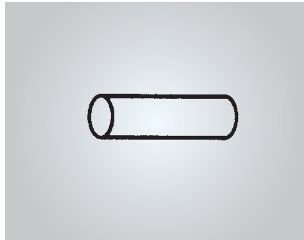
Nominal diameters
DN 10-1000

Pressure stages
Max. PN 400



Thin-walled pipes

Diameter
d_i = 40-1000



EXHAUST EXPANSION JOINTS WITH SPECIAL CUFFS

Special conditions apply to exhaust expansion joints that must be mounted directly at the engine:

- High temperatures ($\upsilon > 400$ °C)
- Temperature peaks, according to engine output
- Absorption of thermal expansion and sustained vibrations
- Compact dimensions, because of restricted space
- Assembly and disassembly must be rapid if the engine needs to be overhauled or repaired

To meet these requirements we supply special designs based on existing tool series, which are tailored to specific applications and have in some cases been developed jointly with the engine manufacturers.
Special tools can also be manufactured if necessary. When developing new designs, we are able to make use of our wide-ranging experience and our specially adapted testing facilities, which is an advantage with regard to both development times and costs.

Fig. 7.1 Exhaust expansion joints with special cuffs

Assembly of exhaust expansion joints
The requirement for simple installation is met by special installation cuffs (see Figs. 7.2 and 7.3).

The moVix connection is a quick-fixing device developed by Witzenmann, which uses a wire-mesh ring made of heat-resistant material to seal and secure. This ring is press-fitted together with the conical cuff of the bellows by means of a V-band clamp. An unmachined pipe is a sufficient counterpart (Fig. 7.4).

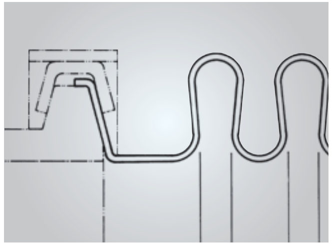


Fig. 7.2 Conical cuff for V-band clamp

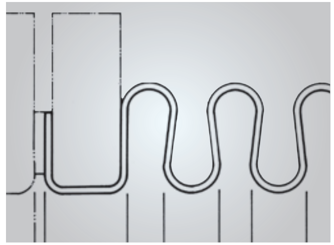


Fig. 7.3 Flange cuff for split flanges

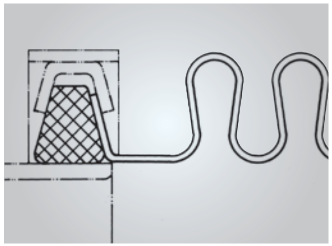


Fig. 7.4 moVix connection

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION

The special range of single ply expansion joints designed for apparatus and vessel construction meets the special demands of these fields to a special degree.

- Thick single ply for welding direct to the vessel wall
- Good lateral rigidity, which supersedes axial guidance in the vessel
- Small corrugations without circumferential welds for optimum overall dimensions

Fig. 7.7 Single ply expansion joint without connection parts

Design and choice of expansion joints
The values in the table apply to one corrugation. The required number of corrugations n_w is dependent on the required movement.

Number of corrugations n_w

(7.1) $$n_W = 2\delta_{RT} / 2\delta_{WN}$$

Movement absorption, cold $2\delta_{RT}$
Movement absorption per corrugation $2\delta_{WN}$
(see table for nominal movement)
The nominal movement, total length and spring rate of the multi-corrugation expansion joint are dependent on the selected number of corrugations (rounded up to integer number).

Nominal deflection $2\delta_N$ in mm

(7.2) $$2\delta_N = 2\delta_{WN} \cdot n_W$$

(rounded down to whole mm)

Overall length L_o in mm

(7.3) $$L_O = l_W \cdot n_W + 2l_B$$

Length of single corrugation l_W in mm
Length of cuff l_B in mm

Spring rate of single bellows c_δ in N/mm

(7.4) $$c_\delta = c_{\delta W} / n_W$$

Spring rate of the single corrugation $c_{\delta W}$ in N/mm

The cuff diameter d_B can be adapted to the available connections. The dimension tables specify the permissible diameter range. Please indicate the desired dimension in the order.

It should be noted that the cylindrical section of the cuff IBZ should be at least 10 mm long on account of the production technology used. The length of transition zone must be between 4 mm and IW/2 .

For use in systems subject to approval, preliminary examination, acceptance test, certification and documentation must be agreed upon when the order is placed.

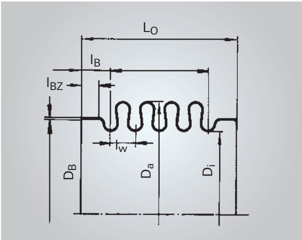


Fig. 7.8 Dimensions/descriptions

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION TYPE AON

Type designation

The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 9 digits

Example

Type AON: HYDRA single ply expansion joint for apparatus construction

Standard design/materials

Single ply bellows made of 1.4541
Operating temperature: up to 550 °C

Type designation (example)

AON	10	· 0164	· 020
Type	Nominal pressure (PN10)	Inside diameter (Di from table)	Movement absorption, nominal (δ = ±10 = 20 mm)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ______
- Piping - nominal diameter DN ______

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar] ______
- Max./min. allowable temperature [°C] ______
- Test pressure PT [bar] ______

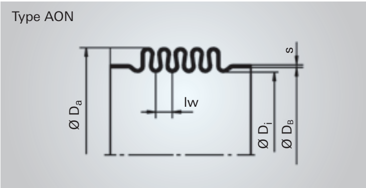
Optional:
- Category ______

Note

Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION

TYPE AON...

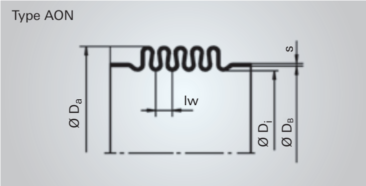


Nominal diameter	Nominal pressure	Nominal axial movement absorption per corru-gation	Type AON ...	Weight per corrugation approx.	Bellows			Bellows					Spring rate axial per corrugation
					wall thickness	diameter		corrugated length of a corrugation	cuff diameter		maximum number of corrugations	effective cross-section	
						inside	outside		inside	outside			
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a	l_w	$D_{B\,min.}$	$D_{B\,max.}$	n_w	A	$C_{\delta W}$
–	–	mm	–	kg	mm	mm	mm	mm	mm	mm	–	cm^2	N/mm
100	25	1.9	25.0110.	0.1	1	110	145	12	112	143	9	181	7400
100	50	1.3	50.0110	0.2	1.5	110	146	13	112	143	7	185	20500
125	20	2.5	20.0135	0.2	1	135	175	14	137	173	10	266	5960
125	40	1.7	40.0135	0.2	1.5	135	176	15	137	173	6	267	18600
150	10	4	10.0164	0.2	1	164	216	15	166	214	11	398	3370
150	20	2.7	20.0164	0.4	1.5	164	216	16	166	213	8	399	11400
150	50	1.9	50.0164	0.5	2	164	215	17	166	211	8	394	25700
200	6	5.8	06.0214	0.4	1	214	276	17	216	274	15	642	2500
200	16	4	16.0214	0.6	1.5	214	278	18	216	275	15	654	7900
200	32	2.8	32.0214	0.7	2	214	275	19	216	271	16	638	19200
250	6	7	06.0268	0.5	1	268	336	19	271	334	14	946	2400
250	12.5	4.4	12.0268	0.8	1.5	268	334	20	271	331	15	938	8550
250	25	3.4	25.0268	1	2	268	336	21	271	332	14	951	20000
250	63	2.2	63.0268	1.5	3	268	336	22	271	330	15	946	60500
300	5	8.4	05.0318	0.7	1	318	392	20	321	390	13	1282	2150
300	10	5.6	10.0318	1	1.5	318	392	21	321	389	13	1285	7200
300	20	4.2	20.0318	1.3	2	318	393	22	321	389	13	1288	17300
300	50	2.8	50.0318	2	3	318	393	24	321	387	13	1288	52000
350	4	9.6	04.0350	0.8	1	350	429	21	353	427	12	1534	1950
350	10	6.4	10.0350	1.2	1.5	350	429	22	353	426	12	1531	6500
350	16	4.6	16.0350	1.6	2	350	428	23	353	424	12	1527	16900
350	50	3	50.0350	2.3	3	350	426	25	353	420	13	1514	54000

07

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION

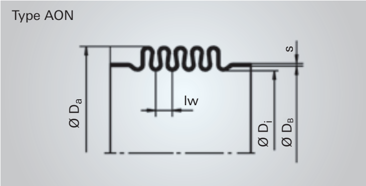
TYPE AON...



Nominal diameter	Nominal pressure	Nominal axial movement absorption per corrugation	Type AON ...	Weight per corrugation approx.	Bellows: wall thickness	Bellows: diameter inside	Bellows: diameter outside	Bellows: corrugated length of a corrugation	Bellows: cuff diameter inside	Bellows: cuff diameter outside	Bellows: maximum number of corrugations	Bellows: effective cross-section	Spring rate axial per corrugation
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a	l_w	$D_{B\ min.}$	$D_{B\ max.}$	n_w	A	$C_{\delta W}$
–	–	mm	–	kg	mm	mm	mm	mm	mm	mm	–	cm^2	N/mm
400	4	10	04.0400	0.9	1	400	480	22	403	478	12	1917	21000
400	8	7.2	08.0400	1.4	1.5	400	484	23	403	481	11	1944	6000
400	16	5.6	16.0400	2	2	400	486	24	403	482	11	1963	14100
400	40	3.8	40.0400	2.9	3	400	486	26	403	480	11	1963	42000
450	5	10	05.0451	1	1	451	530	24	454	528	12	2324	2350
450	10	6.6	10.0451	1.5	1.5	451	530	24	454	527	12	2329	7900
450	16	4.8	16.0451	2	2	451	530	25	454	526	12	2324	19800
450	40	3.4	40.0451	3.1	3	451	530	27	454	524	12	2333	58000
500	3.2	13.6	03.0502	1.3	1	502	595	24	505	593	10	2922	1600
500	8	8.8	08.0502	2	1.5	502	595	25	505	592	10	2918	5500
500	12.5	6	12.0502	2.5	2	502	590	26	505	586	11	2875	15800
500	32	4.4	32.0502	3.9	3	502	593	28	505	587	11	2903	43000
550	6	8.4	06.0552	1.2	1	552	622	25	556	620	13	3187	38000
550	12.5	5.8	12.0552	1.8	1.5	552	624	25	556	621	13	3202	12000
550	20	4.2	20.0552	2.3	2	552	623	26	556	619	13	3187	31300
550	40	3	40.0552	3.6	3	552	626	28	556	620	13	3227	85000
600	3.2	14.4	03.0603	1.6	1	603	698	26	607	696	10	4004	1800
600	6	9.2	06.0603	2.4	1.5	603	697	26	607	694	10	3987	6200
600	12.5	6.6	12.0603	3.2	2	603	695	27	607	691	10	3970	16400
600	32	4.2	32.0603	4.6	3	603	692	29	607	686	10	3937	53700
700	2.5	16.6	02.0704	2.1	1	704	807	27	708	805	9	5333	1600
700	6	12.6	06.0704	3.2	1.5	704	810	28	708	807	9	5365	5100
700	10	7.8	10.0704	4	2	704	804	29	708	800	9	5294	14800
700	25	5.2	25.0704	6.1	3	704	806	31	708	800	9	5320	48800

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION

TYPE AON...



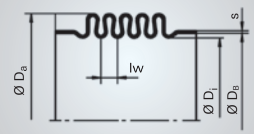
Nominal diameter	Nominal pressure	Nominal axial movement absorption per corru-gation	Type	Weight per corrugation approx.	Bellows		
			AON ...		wall thickness	diameter	
						inside	outside
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a
–	–	mm	–	kg	mm	mm	mm
800	2.5	19	02.0805	2.5	1	805	915
800	6	12	06.0805	3.7	1.5	805	912
800	10	9.4	10.0805	5	2	805	915
800	25	5.2	25.0805	7	3	805	906
900	4	13	04.0914	2.4	1	914	1002
900	8	9.2	08.0914	3.6	1.5	914	1004
900	12.5	7	12.0914	4.9	2	914	1005
900	25	4.6	25.0914	7.4	3	914	1007
1000	8	10	08.1016	4.3	1.5	1016	1110
1000	12.5	8	12.1016	5.8	2	1016	1113
1000	25	5.4	25.1016	8.8	3	1016	1115
1100	6	11.2	06.1111	4.9	1.5	1111	1210
1100	12.5	8	12.1111	6.4	2	1111	1208
1100	20	5.6	20.1111	9.8	3	1111	1212
1200	6	11.2	06.1211	5.3	1.5	1211	1310
1200	10	8.4	10.1211	7.1	2	1211	1310
1200	20	5.6	20.1211	10.8	3	1211	1312
1400	8	13.8	08.1412	10.6	2	1412	1536
1400	12.5	10.8	12.1412	17.1	3	1412	1548
1600	6	15.6	06.1612	12.9	2	1612	1746
1600	12.5	12	12.1612	20.7	3	1612	1758
1800	6	16	06.1812	14.6	2	1812	1946
1800	12.5	11.8	12.1812	22.9	3	1812	1955

Bellows					Spring rate axial per corrugation
corrugated length of a corrugation	cuff diameter		maximum number of corrugations	effective cross-section	
	inside	outside			
l_w	$D_{B\ min.}$	$D_{B\ max.}$	n_w	A	$C_{\delta W}$
mm	mm	mm	–	cm^2	N/mm
29	809	913	8	6837	1300
30	809	909	8	6786	5500
31	809	911	8	6837	12500
33	809	900	9	6706	56000
30	918	1000	10	8187	3100
31	918	1001	10	8211	9800
32	918	1001	10	8235	23500
34	918	1001	10	8252	78000
33	1020	1107	9	10038	9400
34	1020	1109	9	10082	21000
36	1020	1109	9	10118	70000
33	1115	1207	9	11892	9000
35	1115	1204	9	11863	23000
37	1115	1206	9	11921	73000
33	1215	1307	9	13903	9800
36	1215	1306	9	13914	23500
38	1215	1306	9	13956	78000
54	1420	1420	6	19261	13400
56	1420	1420	6	19557	36000
54	1620	1620	6	24773	12400
56	1620	1620	6	25109	33000
54	1820	1820	6	30666	13800
56	1820	1820	6	30946	39000

SINGLE PLY EXPANSION JOINTS FOR APPARATUS CONSTRUCTION

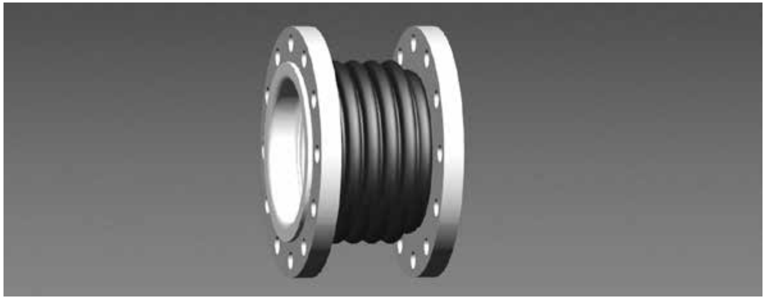
TYPE AON...

Type AON



Nominal diameter	Nominal pressure	Nominal axial movement absorption per corru-gation	Type AON ...	Weight per corrugation approx.	Bellows: wall thickness	Bellows: diameter inside	Bellows: diameter outside	Bellows: corrugated length of a corrugation	Bellows: cuff diameter inside	Bellows: cuff diameter outside	Bellows: maximum number of corrugations	Bellows: effective cross-section	Spring rate axial per corrugation
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a	l_w	$D_{B\ min.}$	$D_{B\ max.}$	n_w	A	$C_{\delta W}$
–	–	mm	–	kg	mm	mm	mm	mm	mm	mm	–	cm^2	N/mm
2000	6	18	06.2012	17.2	2	2012	2156	54	2020	2020	6	37531	12300
2000	10	13.6	10.2012	27.4	3	2012	2168	56	2020	2020	6	37944	34000
2200	6	18	06.2212	18.9	2	2212	2356	54	2220	2220	6	44713	13500
2200	10	13.4	10.2212	29.8	3	2212	2366	56	2220	2220	6	45088	38800
2400	5	20	05.2412	22	2	2412	2568	54	2420	2420	6	53011	12000
2400	10	14	10.2412	33.5	3	2412	2572	56	2420	2420	6	53175	38000
2600	5	20	05.2612	24.1	2	2612	2770	54	2620	2620	6	61575	13400
2600	8	14	08.2612	36.3	3	2612	2772	56	2620	2620	6	61663	40000
2800	5	20	05.2812	25.4	2	2812	2966	54	2820	2820	6	70497	14400
2800	8	14	08.2812	39.1	3	2812	2972	56	2820	2820	6	70780	44000
3000	5	19.6	05.3012	26.9	2	3012	3164	54	3020	3020	6	80123	16000
3000	8	14	08.3012	41.9	3	3012	3172	56	3020	3020	6	80525	47000

AXIAL EXPANSION JOINTS WITH PTFE LINING TYPE ABT



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 9 digits

Example
Type ABT: HYDRA axial expansion joint with PTFE liner and loose flanges

Standard design/materials
Multi-ply bellows made of 1.4541
Flange made of S235JRG2 (1.0038) or P250GH (1.0460)
Operating temperature: up to 230 °C

Type designation (example)

ABT	10	·	0150	·	060
Type	Nominal pressure (PN10)		Nominal diameter (DN150)		Movement absorption, nominal (2δ = ±30 = 60 mm)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l]
- Piping - nominal diameter DN

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

Design data:
- Max. allowable pressure [bar]
- Max./min. allowable temperature [°C]
- Test pressure PT [bar]

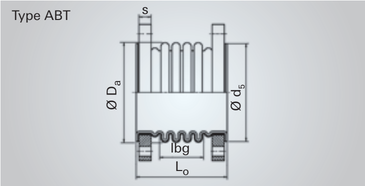
Optional:
- Category

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.
On request, flanges can also be supplied with other hole patterns / flange sheet thicknesses. In this case, the specified overall length L0 may change.

07

AXIAL EXPANSION JOINTS WITH PTFE LINING

TYPE ABT 10... PN 10

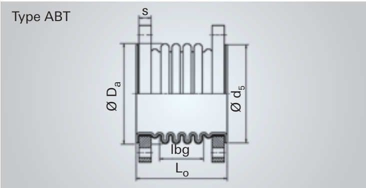


Nominal diameter	Nominal axial movement absorption[1]	Type	Overall length	Weight approx.	Flange[2]			Bellows			Nominal movement absorption[1]		Spring rate		
		ABT 10 ...			drilling as per EN 1092	flange diameter	thickness	outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
–	$2\delta_N$	–	L_o	G	PN	d_5	s	D_a	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
–	mm	–	mm	kg	-	mm	mm	mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
50	13	.0050.013	183	6	16	92	20	88	95	45	17	5	462	6	443
50	27	.0050.027	298	7	16	92	20	88	209	44	35	21	348	4	69
65	17	.0065.017	183	7	16	107	20	106	95	67	18	5	355	7	511
65	32	.0065.032	298	8	16	107	20	107	210	67	34	21	281	5	92
80	20	.0080.020	188	8	16	122	20	120	100	87	19	6	315	7	529
80	35	.0080.035	278	9	16	122	20	121	189	88	33	18	273	7	130
100	20	.0100.020	182	10	16	147	22	148	88	135	16	4	499	19	1684
100	40	.0100.040	270	11	16	147	22	148	176	135	31	16	250	9	211
125	29	.0125.029	224	14	16	178	22	170	120	179	20	7	361	18	875
125	50	.0125.050	366	17	16	178	22	172	260	181	33	25	415	21	217
150	30	.0150.030	251	18	16	208	24	204	140	261	17	7	751	56	1947
150	60	.0150.060	391	23	16	208	24	204	280	261	34	27	376	28	243
200	42	.0200.042	250	25	10	258	24	258	140	432	19	8	447	54	1908
200	78	.0200.078	422	33	10	258	24	261	310	434	34	31	395	49	348
250	42	.0250.042	245	32	10	320	26	315	120	666	15	5	797	148	7052
250	81	.0250.081	394	38	10	320	26	315	270	667	30	23	480	90	839
200	42	.0200.042	250	25	10	258	24	258	140	432	19	8.5	442	53	1883
200	78	.0200.078	422	33	10	258	24	261	310	434	30	35	391	48	344
250	44	.0250.044	245	32	10	320	26	318	120	666	17	6.1	525	98	4696
250	81	.0250.081	394	38	10	320	26	318	270	667	24	25	341	63	604

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PTFE LINING

TYPE ABT 10... PN 10



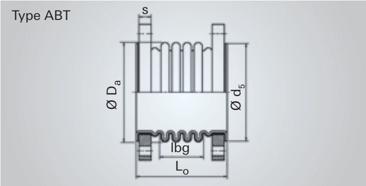
Nominal diameter	Nominal axial movement absorption	Type ABT 10 ...	Overall length	Weight approx.	Flange 2)		
					drilling as per EN 1092	flange diameter	thickness
–	$2\delta_N$	–	L_o	G	PN	d_5	s
–	mm	–	mm	kg	-	mm	mm
300	55	.0300.055	291	40	10	370	26
300	95	.0300.095	433	51	10	370	26
350	60	.0350.060	304	60	10	410	30
350	92	.0350.092	415	71	10	410	30
400	52	.0400.052	293	74	10	465	32
400	104	.0400.104	437	85	10	465	32
450	65	.0450.065	342	95	10	520	36
450	120	.0450.120	549	127	10	520	36
500	50	.0500.050	323	116	10	570	38
500	126	.0500.126	523	144	10	570	38
600	65	.0600.065	351	147	10	670	42
600	116	.0600.116	499	168	10	670	42

Bellows			Nominal movement absorption 1)		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
369	165	932	17	8	806	207	5237
369	306	932	30	26	666	171	1259
404	175	1119	17	9	723	224	5031
403	280	1119	26	21	666	207	1812
457	148	1449	13	6	1209	484	15203
457	296	1449	26	22	605	242	1901
518	180	1821	14	8	1638	838	17788
518	384	1813	27	30	1421	728	3395
571	150	2235	10	4	3588	2253	68839
568	360	2235	26	27	1543	964	5113
674	184	3201	11	6	2456	2185	44362
675	329	3201	20	19	1348	1200	7622

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PTFE LINING

TYPE ABT 25... PN 25



Nominal diameter	Nominal axial movement absorption	Type ABT 25 ...	Overall length	Weight approx.	Flange[2)]		
					drilling as per EN 1092	flange diameter	thickness
–	$2\delta_N$	–	L_o	G	PN	d_5	s
–	mm	–	mm	kg	-	mm	mm
50	15	.0050.015	203	6	40	92	20
50	24	.0050.024	310	7	40	92	20
65	14	.0065.014	199	8	40	107	22
65	26	.0065.026	281	9	40	107	22
80	16	.0080.016	214	10	40	122	24
80	29	.0080.029	306	11	40	122	24
100	21	.0100.021	224	14	40	147	26
100	35	.0100.035	330	17	40	147	26
125	20	.0125.020	222	20	40	178	28
125	35	.0125.035	300	22	40	178	28
150	26	.0150.026	263	24	40	208	30
150	47	.0150.047	375	30	40	208	30
200	30	.0200.030	243	36	25	258	32
200	52	.0200.052	330	40	25	258	32
250	35	.0250.035	272	51	25	320	35
250	61	.0250.061	368	57	25	320	35
200	30	.0200.030	243	36	25	258	32
200	52	.0200.052	330	40	25	258	32
250	35	.0250.035	272	51	25	320	35
250	61	.0250.061	368	57	25	320	35

Bellows			Nominal movement absorption[1)]		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
89	114	44	19	6	540	7	365
90	220	44	31	20	601	8	111
108	105	67	15	5	1091	21	1312
108	189	67	28	15	606	12	225
123	115	88	15	5	1210	31	1586
123	207	88	27	16	672	17	272
150	120	135	16	6	905	35	1668
151	225	135	27	17	772	30	408
174	104	181	13	4	842	44	2790
172	182	181	23	12	559	29	597
204	140	260	15	6	1486	110	3848
204	252	260	26	19	826	61	660
261	124	436	13	5	1201	148	6608
261	210	436	23	14	686	144	1232
320	132	672	13	5	1640	309	11496
320	228	672	22	14	968	182	2418
261	116	436	13	5	1186	145	7463
261	203	436	19	15	677	83	1391
322	128	672	13	5.1	1244	236	9912
322	224	672	18	16	711	135	1849

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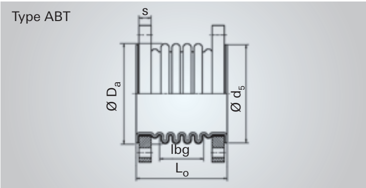
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PTFE LINING

TYPE ABT 25... PN 25

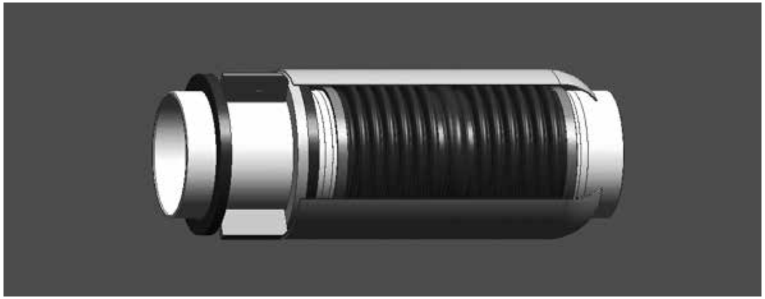


Nominal dia-meter	Nominal axial movement absorption	Type ABT 25 ...	Overall length	Weight approx.	Flange 2)		
					drilling as per EN 1092	flange diameter	thickness
–	$2\delta_N$	–	L_o	G	PN	d_5	s
–	mm	–	mm	kg	-	mm	mm
300	39	.0300.039	297	71	25	370	38
300	69	.0300.069	410	80	25	370	38
350	40	.0350.040	309	103	25	410	42
350	70	.0350.070	420	112	25	410	42
400	43	.0400.043	345	146	25	465	48
400	86	.0400.086	505	166	25	465	48
450	50	.0450.050	402	190	25	520	54
450	90	.0450.090	566	219	25	520	54
500	40	.0500.040	373	228	25	570	58
500	90	.0500.090	541	264	25	570	58
600	45	.0600.045	386	325	25	670	68
600	90	.0600.090	550	369	25	670	68

Bellows			Nominal movement absorption 1)		Spring rate		
outside diameter	corrugated length	effective cross-section	angular	lateral	axial	angular	lateral
D_a	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/deg	N/mm
374	148	932	12	5	2043	534	16755
374	258	932	21	16	1169	305	3161
405	148	1116	11	5	2304	717	22491
405	259	1116	20	15	1317	410	4197
460	160	1439	11	5	3002	1211	32525
460	320	1439	22	20	1502	606	4065
523	199	1831	11	6	5693	2944	51035
525	358	1831	20	20	2976	1546	8278
579	158	2255	8	4	6245	3979	110310
574	336	2255	18	18	3307	2088	12721
680	156	3190	8	3	6946	6233	176157
680	318	3190	15	14	3473	3117	21197

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only.
The movements (axial, angular, lateral) apply to 1000 load changes and are to be regarded as alternativ, i.e. the sum of their proportions in percentages should not exceed 100 %.
2) Available with other hole patterns / thicknesses on request. The overall length L0 may change then.

AXIAL EXPANSION JOINTS WITH PRETENSION TYPE ARH



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type ARH: HYDRA axial expansion joints with pretension

Standard design/materials
Multi-ply bellows made of 1.4541
Operating temperature: up to 300 °C

Type designation (example)

ARH	10	· 0150	· 100	· 1
Type	Nominal pressure (PN10)	Nominal diameter (DN150)	Movement absorption, nominal (2δ = ±50 = 100 mm)	Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ____________________
- Piping - nominal diameter DN ____________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

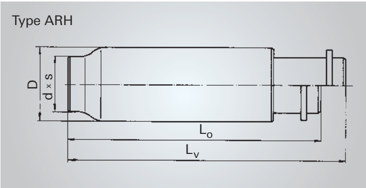
Design data:
- Max. allowable pressure [bar] ____________________
- Max./min. allowable temperature [°C] ____________________
- Test pressure PT [bar] ____________________

Optional:
- Category ____________________

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.

AXIAL EXPANSION JOINTS WITH PRETENSION

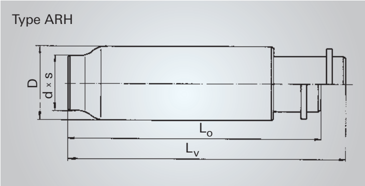
TYPE ARH 16... PN 16



Nominal diameter	Nominal axial movement absorption	Type ARH 16...	Overall length		Weight approx.	Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
			unloaded	pre-tensioned		outside diameter	wall thickness				
–	$2\delta_N$	–	L_o	L_V	G	d	s	D	A	c_δ	F_s
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN
50	32	.0050.032.1	325	341	4	60.3	4	106	46	97	5
50	64	.0050.064.1	495	527	5	60.3	4	106	46	48.5	5
50	90	.0050.090.1	615	660	5	60.3	4	106	46.6	116	5
65	40	.0065.040.1	350	370	5	76.1	4	120	68.7	85	8
65	80	.0065.080.1	530	570	6	76.1	4	122	68.7	42.5	8
65	110	.0065.110.1	680	735	7	76.1	4	122	70.9	58	8
80	58	.0080.058.1	375	404	6	88.9	4	135	90.8	127	11
80	116	.0080.116.1	770	828	11	88.9	4	135	90.8	63.5	11
100	90	.0100.090.1	570	615	10	114.3	4	161	138.9	71	11
100	130	.0100.130.1	700	765	13	114.3	4	161	140	62	11
125	100	.0125.100.1	615	665	14	139.7	4	196	187.5	82	11
125	150	.0125.150.1	815	890	18	139.7	4	196	189.9	69	11
150	100	.0150.100.1	640	690	19	168.3	4.5	224	265.9	88.5	19
150	150	.0150.150.1	750	825	22	168.3	4.5	224	271.7	77.5	19
150	180	.0150.180.1	900	990	24	168.3	4.5	224	273.2	78	19
200	100	.0200.100.1	700	750	29	219.1	6.3	287	435.6	126	19
200	150	.0200.150.1	800	875	35	219.1	6.3	287	437.4	99	19
200	180	.0200.180.1	960	1050	44	219.1	6.3	287	431.9	93.5	19
250	100	.0250.100.1	605	655	38	273	7.1	344	676.6	248	27
250	150	.0250.150.1	865	940	54	273	7.1	344	672	136	27
250	200	.0250.200.1	1050	1150	68	273	7.1	344	676.6	124	40

AXIAL EXPANSION JOINTS WITH PRETENSION

TYPE ARH 16... PN 16

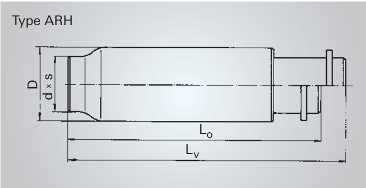


Nominal diameter	Nominal axial movement absorption	Type	Overall length		Weight approx.	Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
		ARH 16...	unloaded	pre-tensioned		outside diameter	wall thickness				
–	$2\delta_N$	–	L_o	L_V	G	d	s	D	A	c_δ	F_s
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN
300	100	.0300.100.1	590	640	57	323.9	8	405	937.5	271	40
300	150	.0300.150.1	825	900	73	323.9	8	405	937.5	186	40
300	200	.0300.200.1	1000	1100	81	323.9	8	405	937.5	135.5	40
350	100	.0350.100.1	600	650	68	355.6	8	437	1116.3	311	40
350	150	.0350.150.1	880	955	85	355.6	8	437	1113.3	201.5	40
350	200	.0350.200.1	1045	1145	108	355.6	8	437	1116.3	155.5	40
400	100	.0400.100.1	585	635	79	406.4	8	487	1455.6	376	65
400	150	.0400.150.1	860	935	101	406.4	8	487	1452.2	254.5	65
400	200	.0400.200.1	1035	1135	129	406.4	8	487	1455.6	188	65
450	100	.0450.100.1	615	665	122	457	8	545	1851.3	477	71
450	150	.0450.150.1	770	845	140	457	8	545	1847.5	333	71
450	200	.0450.200.1	1025	1125	165	457	8	545	1851.3	238.5	71
500	100	.0500.100.1	655	705	132	508	8	610	2264.8	503	73
500	150	.0500.150.1	820	895	174	508	8	610	2264.8	366	73
500	200	.0500.200.1	1115	1215	207	508	8	610	2264.8	251.5	73
600	100	.0600.100.1	740	790	201	610	8	711	3217	676	94
600	150	.0600.150.1	880	955	198	610	8	711	3191.9	409	94
600	200	.0600.200.1	1220	1320	267	610	8	711	3217	338	94

07

AXIAL EXPANSION JOINTS WITH PRETENSION

TYPE ARH 16... PN 16

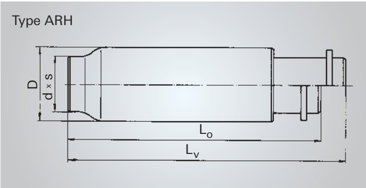


Nominal diameter	Nominal axial movement absorption	Type ARH 16...	Overall length		Weight approx.
			unloaded	pre-tensioned	
–	$2\delta_N$	–	L_o	L_V	G
–	mm	–	mm	mm	kg
700	100	.0700.100.1	745	795	282
700	150	.0700.150.1	895	970	315
700	200	.0700.200.1	1185	1285	367
800	100	.0800.100.1	835	885	370
800	150	.0800.150.1	980	1055	409
800	200	.0800.200.1	1310	1410	481
900	100	.0900.100.1	875	925	491
900	150	.0900.150.1	1030	1105	543
900	200	.0900.200.1	1340	1440	622
1000	100	.1000.100.1	895	945	571
1000	150	.1000.150.1	1100	1175	641
1000	200	.1000.200.1	1340	1440	717

Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
outside diameter	wall thickness				
d	s	D	A	c_δ	F_s
mm	mm	mm	cm^2	N/mm	kN
711	10	820	4329.9	782	98
711	10	820	4329.9	547	98
711	10	820	4329.9	391	98
813	10	930	5634.5	1038	133
813	10	930	5641.2	728	133
813	10	930	5634.5	519	133
914	10	1050	7223.2	1285	126
914	10	1050	7223.2	900	126
914	10	1050	7223.2	642.5	126
1016	10	1160	8874.8	1436	124
1016	10	1160	8858.1	920	124
1016	10	1160	8874.8	718	124

AXIAL EXPANSION JOINTS WITH PRETENSION

TYPE ARH 25... PN 25

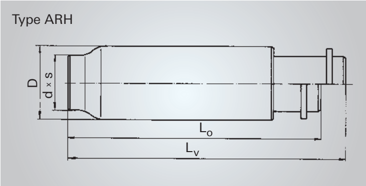


Nominal diameter	Nominal axial movement absorption	Type ARH 25...	Overall length		Weight approx.
			unloaded	pre-tensioned	
–	$2\delta_N$	–	L_o	L_V	G
–	mm	–	mm	mm	kg
50	35	.0050.035.1	365	382.5	6
50	70	.0050.070.1	570	605	8
65	40	.0065.040.1	370	390	7
65	80	.0065.080.1	580	620	10
80	80	.0080.080.1	600	640	12
80	100	.0080.100.1	695	745	13
100	100	.0100.100.1	675	725	19
125	100	.0125.100.1	685	735	26
125	130	.0125.130.1	855	920	34
150	100	.0150.100.1	665	715	31
150	140	.0150.140.1	845	915	37
200	100	.0200.100.1	740	790	50
200	150	.0200.150.1	935	1010	60
250	100	.0250.100.1	785	835	74
250	160	.0250.160.1	1035	1115	92
250	180	.0250.180.1	1070	1160	108

Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
outside diameter	wall thickness				
d	s	D	A	c_δ	F_s
mm	mm	mm	cm^2	N/mm	kN
60.3	4	106	47.2	130	5
60.3	4	106	47.2	65	5
76.1	4	120	70.1	136	5
76.1	4	122	70.1	68	6
88.9	4	135	89.1	77.5	6
88.9	4	135	92.5	92.5	6
114.3	4	161	141	98	10
139.7	4	196	188.7	103	10
139.7	4	196	189.9	105	10
168.3	4.5	224	271.7	145	10
168.3	4.5	224	268.8	108.5	10
219.1	6.3	287	443	214	10
219.1	6.3	287	443	142.5	17
273	7.1	344	665.1	276.5	17
273	7.1	344	665.1	170	17
273	7.1	344	678.9	172.5	17

AXIAL EXPANSION JOINTS WITH PRETENSION

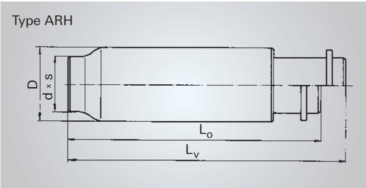
TYPE ARH 25... PN 25



Nominal diameter	Nominal axial movement absorption	Type ARH 25...	Overall length		Weight approx.	Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
			unloaded	pre-tensioned		outside diameter	wall thickness				
–	$2\delta_N$	–	L_o	L_V	G	d	s	D	A	c_δ	F_s
–	mm	–	mm	mm	kg	mm	mm	mm	cm²	N/mm	kN
300	100	.0300.100.1	640	690	96	323.9	8	405	951.1	400	36
300	150	.0300.150.1	980	1055	122	323.9	8	405	926.7	240.5	36
300	200	.0300.200.1	1125	1225	162	323.9	8	405	951.1	200	36
350	100	.0350.100.1	655	705	107	355.6	8	437	1134.1	438	36
350	150	.0350.150.1	930	1005	141	355.6	8	437	1134.1	301	36
350	200	.0350.200.1	1155	1255	178	355.6	8	437	1134.1	219	36
400	100	.0400.100.1	660	710	130	406.4	8	487	1475.9	536	70
400	150	.0400.150.1	925	1000	170	406.4	8	487	1475.9	382.5	70
400	200	.0400.200.1	1165	1265	221	406.4	8	487	1475.9	268	70
450	100	.0450.100.1	715	765	192	457	8	545	1866.5	665	70
450	150	.0450.150.1	855	930	226	457	8	545	1878.1	436	70
450	200	.0450.200.1	1195	1295	286	457	8	545	1866.5	332.5	70
500	100	.0500.100.1	725	775	207	508	8	610	2286	760	70
500	150	.0500.150.1	920	995	286	508	8	610	2286	815	70
500	200	.0500.200.1	1215	1315	347	508	8	610	2286	380	70
600	100	.0600.100.1	805	855	324	610	8	711	3257.3	937	99
600	150	.0600.150.1	1130	1205	416	610	8	711	3257.3	602	99
600	200	.0600.200.1	1310	1410	470	610	8	711	3257.3	468.5	99

AXIAL EXPANSION JOINTS WITH PRETENSION

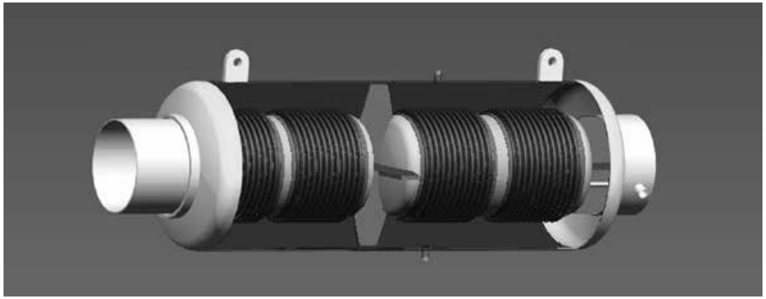
TYPE ARH 25... PN 25



Nominal diameter	Nominal axial movement absorption	Type ARH 25...	Overall length		Weight approx.
			unloaded	pre-tensioned	
–	$2\delta_N$	–	L_o	L_V	G
–	mm	–	mm	mm	kg
700	100	.0700.100.1	905	955	471
700	150	.0700.150.1	1055	1130	561
700	200	.0700.200.1	1450	1550	676
800	100	.0800.100.1	915	965	573
800	150	.0800.150.1	1055	1130	659
800	200	.0800.200.1	1430	1530	815
900	100	.0900.100.1	970	1020	814
900	150	.0900.150.1	1145	1220	921
900	200	.0900.200.1	1465	1565	1110
1000	100	.1000.100.1	1025	1075	947
1000	150	.1000.150.1	1315	1390	1141
1000	200	.1000.200.1	1530	1630	1283

Weld ends		External pipe diameter	Effective bellows cross-section	Axial spring rate	Shear force
outside diameter	wall thickness				
d	s	D	A	c_δ	F_s
mm	mm	mm	cm^2	N/mm	kN
711	10	820	4335.8	1124	131
711	10	820	4406.1	832	131
711	10	820	4335.8	562	131
813	10	930	5667.8	1448	131
813	10	930	5721.3	1019	131
813	10	930	5667.8	724	131
914	10	1050	7268.4	1671	198
914	10	1050	7276	1132	183
914	10	1050	7268.4	835.5	183
1016	10	1160	8883.1	1889	183
1016	10	1160	8908.2	1198	183
1016	10	1160	8883.1	944.5	183

PRESSURE BALANCED AXIAL EXPANSION JOINTS TYPE DRD



Type designation
The type designation consists of 2 parts
1. Type series, defined by 3 letters
2. Nominal size, defined by 10 digits

Example
Type DRD: HYDRA pressure balanced axial expansion joint

Standard design/materials
Multi-ply bellows made of 1.4541
Operating temperature: up to 300 °C

Type designation (example)

DRD	25	0400	400	1
Type	Nominal pressure (PN25)	Nominal size (DN400)	Movement absorption, nominal (2δ = ±200 = 400 mm)	Inner sleeve (0 = without, 1 = with)

Order text according to guideline 2014/68/EU "Pressure Equipment Directive"
Please state the following with your order:

For standard versions
- Type designation

With material variation
- Type designation
- Details of the materials

According to the Pressure Equipment Directive, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1 & 2:
- Vessel - volume V [l] ______________________________
- Piping - nominal diameter DN ______________________________

Medium property according to Art. 13:
- Group 1 – dangerous
- Group 2 – all other fluids

State of medium
- Gaseous or liquid if PD > 0.5 bar
- Liquid if PD ≤ 0.5 bar

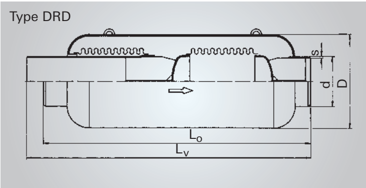
Design data:
- Max. allowable pressure [bar] ______________________________
- Max./min. allowable temperature [°C] ______________________________
- Test pressure PT [bar] ______________________________

Optional:
- Category ______________________________

Note
Tell us the dimensions that deviate from the standard and we customize the expansion joint to your specification.

PRESSURE BALANCED AXIAL EXPANSION JOINTS

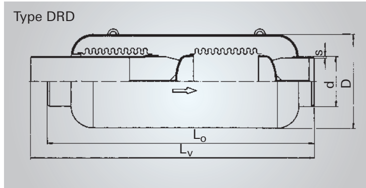
TYPE DRD 25... PN 25



Nom-inal dia-meter	Nominal axial movement absorption	Type DRD 25...	Overall length unloaded	Overall length pre-tensioned	Weight approx.	Weld ends outside diameter	Weld ends wall thickness	Casing outside diameter	Axial spring rate
–	$2\delta_N$	–	L_o	L_V	G	d	s	D	c_δ
–	mm	–	mm	mm	kg	mm	mm	mm	N/mm
400	320	.. 0400.320.1	2900	3060	800	406.4	8	650	194.5
500	340	.. 0500.340.1	3100	3270	1450	508	8	813	264.5
600	260	.. 0600.260.1	3100	3230	1730	610	8	914	383
700	260	.. 0700.260.1	3300	3430	2760	711	10	1060	450
800	260	.. 0800.260.1	3350	3480	3360	813	10	1220	526.5
900	280	.. 0900.280.1	3500	3640	4800	914	12	1420	638.5
1000	280	.. 1000.280.1	3700	3840	5620	1016	15	1520	661

PRESSURE BALANCED AXIAL EXPANSION JOINTS

TYPE DRD 40... PN 40



Nom-inal dia-meter	Nominal axial movement absorption	Type DRD 40...	Overall length un-stressed	Overall length pre-stressed	Weight approx.	Weld ends outside diameter	Weld ends wall thickness	Casing outside diameter	Axial spring rate
–	2δN	–	L_o	L_V	G	d	s	D	c_δ
–	mm	–	mm	mm	kg	mm	mm	mm	N/mm
400	260	.. 0400.260.1	3200	3330	930	406.4	10	650	255.5
500	220	.. 0500.220.1	3300	3410	1610	508	10	813	460.5
600	220	.. 0600.220.1	3350	3460	2100	610	12	914	581
700	180	.. 0700.180.1	3550	3640	3220	711	15	1060	1017.5
800	180	.. 0800.180.1	3700	3790	4140	813	15	1220	1139.5
900	180	.. 0900.180.1	4100	4190	6320	914	20	1420	1423.5
1000	170	.. 1000.170.1	4200	4285	7410	1016	20	1520	1663

RECTANGULAR EXPANSION JOINTS TYPE XOZ, XFZ, XRZ, XSZ

Design and choice of expansion joints

The necessary number of corrugations n_w is dependent on the movement

Number of corrugations n_w

(7.5) $n_W = 2\delta_{RT} / 2\delta_{WN}$

Axial movement absorption, cold $2\delta_{RT}$ in mm
Axial movement absorption per corrugation $2\delta_{WN}$ in mm

Nominal movement, corrugated length and spring rate of the multi-corrugation expansion joint are dependent on the selected number of corrugations (rounded up to an integer number):

Corrugated length in mm

(7.6) $l = l_W \cdot n_W$

Length of individual corrugations l_W in mm
Number of corrugations n_w

The length of the cuffs or the connection parts must be taken into account when determining the total length L_O of the complete expansion joint.

Axial spring rate of one corrugation $c_{\delta W}$ in N/mm

(7.7) $c_{\delta W} = c_{\delta E} / n_W + 2(b_1 + b_2)c_{\delta l}$

Spring rate of four corners, $c_{\delta E}$ in N/mm
Spring rate for 1 mm profile length, $c_{\delta l}$ in N/mm
Length of sides b_1, b_2 in mm

Spring rate of complete expansion joint c_δ in N/mm

(7.8) $c_\delta = c_{\delta W} / n_W$

Connection parts	Type series
None	XOZ
Flange	XFZ
Weld ends	XRZ
others	XSZ

Fig. 7.9 Connection parts / Type series

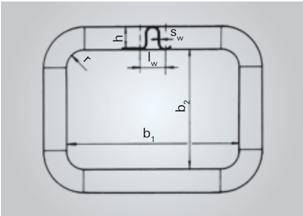


Fig. 7.10 Type XOZ

Please consult us for further details.

AXIAL EXPANSION JOINTS FOR VACUUM TECHNOLOGY

Expansion joints for vacuum systems are usually designed using single-ply bellows with relatively thin walls. Their small adjusting forces and moments place only a very slight load on the connection flanges, which is essential to ensure absolute tightness of the flange connections during operation. The bellows can be welded to the connection flanges gap-free and vacuum-tight due to the use of special flanged weld seams.
High and highest leak tightness levels can be verified by means of He.-leak tightness tests. The minimum leakage rate which can be determined is 10^{-10} mbar·l·s^{-1}.

Flanges are used predominantly for the connections:
DN 16-50
Small flanges according to DIN 28 403
DN 63-500
Clamp flanges according to DIN 28 404

The vacuum expansion joints can be designed on request with total lengths and movement adapted to specific applications.

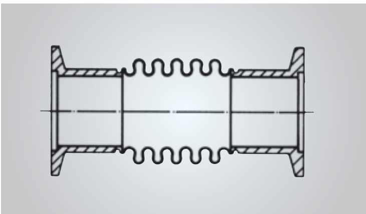


Fig. 7.11 Axial expansion joint with small flanges

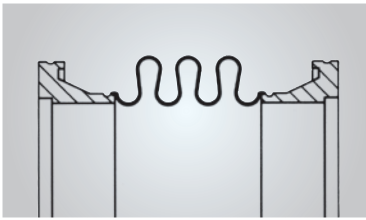


Fig. 7.12 Axial expansion joint with clamping flanges

AXIAL EXPANSION JOINTS FOR HEATING AND VENTILATION INSTALLATIONS

We have developed a series of axial expansion joints especially for the needs of heating and sanitary construction, whose different types of connection are adapted to specific assembly conditions:
- Weld ends
- Loose or fixed flanges, drilled according to DIN
- Screwed nipples with pipe thread, male or female

The connection parts are made of carbon steel as standard, whilst the corrugated metal bellows are made of stainless steel 1.4541. These provide excellent corrosion resistance for reliable operation extending over several decades. The expansion joints are designed accordingly for 10000 full load cycles (in contrast with the standard range), as necessary in heating and ventilation installations owing the more frequent temperature changes.

Guiding sleeves are provided in some designs; they simplify aligned installation, although they cannot replace slide points or anchors. Designs with an external protection cover are pretensioned in the factory. This means that assembly errors are largely eliminated and the installation of thermal insulation is simplyfied.
Nominal diameters: DN 15-100
Nominal pressures: PN 6-25
Exact dimensions and performance data are specified in a separate publication "Metal hoses and expansion joints for technical building equipment".

Fig. 7.13 Expansion joints for heating and ventilating installations

EXPANSION JOINTS AND METAL BELLOWS FOR HIGH PRESSURES

Our standard ranges include expansion joints with nominal pressure ratings which are fully sufficient under normal circumstances for piping and plant construction. If a higher nominal pressure is necessary in individual cases, for example in heat exchangers, individually designed expansion joints can also be supplied. If the combined requirements of inner pressure and movement cause the technical limits to be reached, it is sometimes possible to use reinforcing rings or to apply pressure to the bellows externally (see also Chapter 8, "Special designs"). In addition, metal bellows, such as those used for stem sealing in valves, must often be designed for high pressures, which are mostly applied externally.

Fig. 7.14 High-pressure bellows

Delivery options

The graph below provides an overview of the delivery options with regard to multi-ply high-pressure bellows with lyre-shaped corrugations. It shows the external pressure load which can be achieved when the pressure is applied externally. Additional tools are necessary for some nominal diameters in the shaded area.

If the pressure is applied internally, the pressure values achieved are almost identical if low movement values demand only a few number of corrugations. If larger movements are required, the permissible pressure is reduced for reasons of stability.

Please consult us for further details.

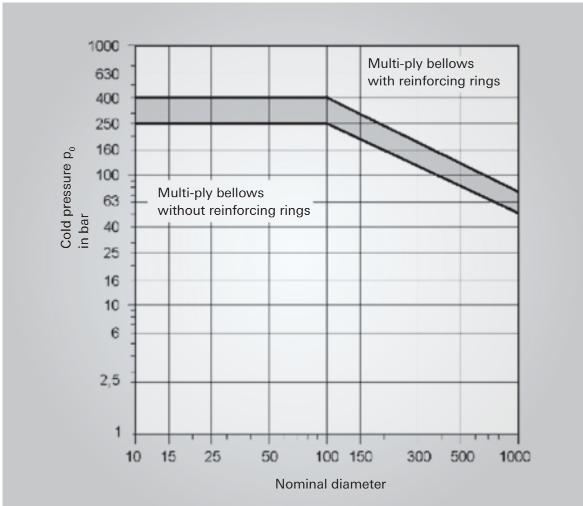


Fig. 7.15 Maximum pressure of multi-ply bellows made of 1.4541 (lyre-shaped corrugations)

THIN-WALLED PIPES

Thin-walled pipes with a longitudinal weld seam are available in any diameters. The diameters have close tolerances.
If desired, we can provide cylinders with end cuffs, beads or corrugations, or further process them to produce vessels.

Fig. 7.16 Thin-walled pipes, with longitudinal weld seam

Delivery options
The table below specifies the length which can be supplied for 1.4541 and 1.4571 that also apply to materials with similar strength values.
The supplied lengths may have to be reduced for materials whose strength values are very different from those specified here.
Special materials can also be used instead of austenitic stainless steels like 1.4541 and 1.4571. Almost all the stainless steels and special alloys listed in Chapter 17 are available.

Stainless steel pipes with fixed diameters are available in longer sizes (up to approx. 6 m) in the diameter range DN 5 – 150.
Please consult us if you require further details.

07

Available lengths

Diameter Range	Length, dependent on wall thickness, in mm valid for stainless steel 1.4541 and 1.4571			
	Standard wall thickness s_N in mm			
	0.3	0.5	0.7	1.0
d_i	–	–	–	–
mm	–	–	–	–
40 - 60	600	400	250	200
61 - 80	800	800	600	400
81 - 90	1200	800	600	400
91 - 110	1200	1200	800	800
111 - 150	1200	1200	1200	800
151 - 1000	1200	1200	1200	1200

Fig. 7.17

07

CUSTOM-BUILT DESIGNS

08

Expansion joints made of special materials
Aggressive media, extremely low weight, electrical conductivity and magnetic permeability are possible reasons for using either expansion joint bellows or complete expansion joints made of special materials, such as:

- Copper
- Aluminium
- Titanium

Outstanding knowledge and experience in the field of welding and forming techniques are necessary to manufacture them.

Fig. 8.1 Exp. joint as hollow conductor made of aluminium

Fig. 8.2 Pressure balanced expansion joint

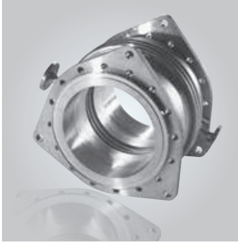


Fig. 8.3 Chamber expansion joint made of titanium for the chemical industry

Fig. 8.4 Metal bellows made of copper

Fig. 8.5 Axial expansion joint with aluminium flanges for absorbing vibrations

Fig. 8.6 Axial expansion joint made of Alloy 825 for heat exchanger (DN 1200/PN 40)

08

Axial expansion joints for chemical tankers

Special expansion joints for product and chemical tankers combine the high flexibility and pressure resistance of multi-ply expansion joints with the excellent resistance to chemicals and seawater provided by an internal PTFE liner. Its other main characteristic: it can be flushed, even if the pipeline is routed horizontally!

This special axial expansion joint has a multi-ply, stainless steel bellows with a special corrugation shape, to which support elements for the internal liner can be fitted. The internal liner is made of polytetrafluoroethylene (PTFE) and is resistant to the chemicals that have to be transported. Its shallowly corrugated shape and its smooth surface prevent the conveyed products from sticking and permit the pipe to be cleaned by flushing. There are no residue chemicals, even if the expansion joint is installed horizontally. The liner is bent around the flanges with a special corrosion-proof coating, and also acts as a seal. The outer ply of the bellows is made of Alloy 825. It is corrosion-proof, resistant to seawater and allows the expansion joint to be used on deck.

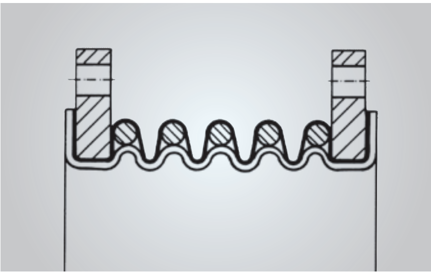


Fig. 8.7 Axial expansion joint for chemical tankers

Axial expansion joints, pressure applied externally

The bellows of this design is arranged so that the pressure is applied externally to it. This makes the design more complex, since bellows with a larger diameter and an additional, pressure resistant outer casing are necessary, but on the other hand offers a number of potential, crucial advantages:

- Extremely large movement absorption in conjunction with low adjusting forces, since stability problems which would have to be taken into account if the pressure was applied internally are practically insignificant
- The bellows are protected from damage by the outer casing
- No residues of aggressive liquids or condensates remain in the corrugations, since they can drain off
- No deposits of solids can remain in the corrugations, since the corrugations are not located in the line of flow
- The expansion joint and the downstream pipe can be completely drained and vented. (Note: Normally it is not necessary to drain the bellows corrugations of HYDRA expansion joints with small corrugations, since only a small volume of liquid can remain in the corrugations.)

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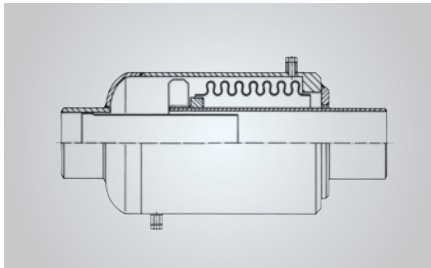


Fig. 8.8 Axial expansion joint, pressure applied externally

Axial expansion joints for gas pipes under bridges

The axial expansion joint with externally applied pressure has been specially designed to withstand the dynamic stresses of bridge pipes. It meets very stringent safety requirements necessary for very busy road bridges.

Its features are:

- Large axial movement absorption for compensating long pipe sections
- Any aggressive condensates only wet the bellows corrugations on the outside and can drain off before corrosion occurs
- The inner sleeve provides a smooth flow
- The bellows encloses a toroidal chamber which is open at one end only and which permits a periodic leak tightness test with a suitable instrument
- The external protection cover prevents the bellows from being damaged during transport and installation, and thereby makes it more reliable
- Drain valves in the outer casing allow the pipe to be drained
- Installation is simplified by an adjustable assembly and pretension device

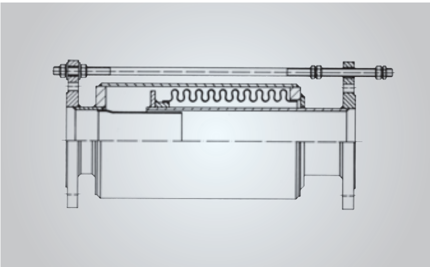


Fig. 8.9 Axial expansion joint for gas pipes under bridges

Axial expansion joint with leakage monitoring

If critical media (toxic, explosive, flammable) are conveyed, it is reasonable to provide permanent leakage monitoring at the flexible pipe elements, to enable any leak to be detected at an early stage. The multi-ply bellows has a unique advantage – the patented leakage indicator.

Check holes in the intermediate plies, made at defined points in the cuff region of the bellows, are guided into a toroidal chamber, which is monitored for leaks. This enables detecting any damage anywhere in the inner ply early (see Chapter 10, "The Multi-ply Principle").

Other types of leakage monitoring are possible at low operating pressures using a double-ply bellows and special connection parts (Fig. 8.11) or a chamber expansion joint (Fig. 8.12).

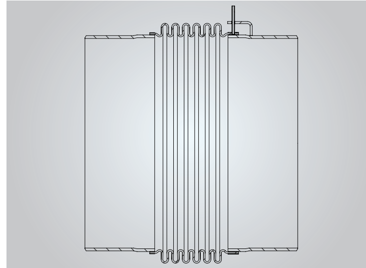


Fig. 8.10 Axial expansion joint with leakage monitoring

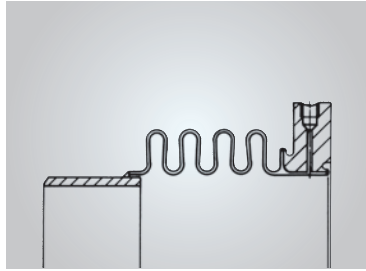


Fig. 8.11 Leakage monitoring with double-ply bellows

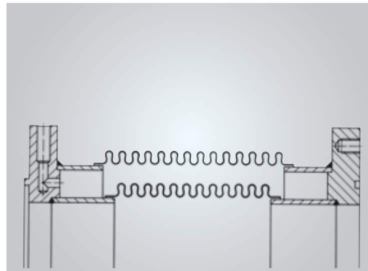


Fig. 8.12 Chamber expansion joint for leakage monitoring

Chamber expansion joints

(Fig. 8.13)
Heated pipes or double pipes for conveying highly viscous media or media which solidify at ambient temperature require chamber expansion joints to compensate thermal expansion and to ensure "force free" connections. The chamber expansion joint with flange connection shown below is a frequently used type; the actual medium flows inside it, whilst the toroidal chamber is used for
heating.

The connection for the heating fluid, e.g. steam, is provided via the flanges, usually using metal hoses (Fig. 8.13). Weld ends can also be provided as connectors instead of flanges. For cooling pipes chamber expansion can also be used. Chamber expansion joints whose toroidal chamber is fitted with a leakage detection facility can be used specifically for leak tightness testing, for example in conjunction with toxic media (Fig. 8.12).

Expansion joints with toroidal bellows

(Fig 8.14)
This type of bellows is suitable for extremely high pressures in conjunction with relatively modest movements, which are conditions that can occur in apparatus construction. The circumferential stresses in the bellows are reduced by the thick walls of the connection parts. If several toroidal corrugations are necessary due to the required movement, reinforcing rings must be fitted between them (Fig. 8.15).

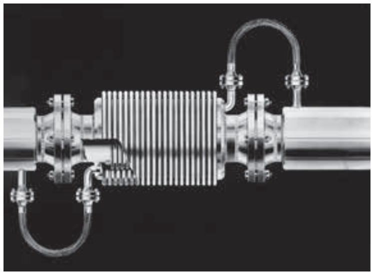


Fig. 8.13 Chamber expansion joint

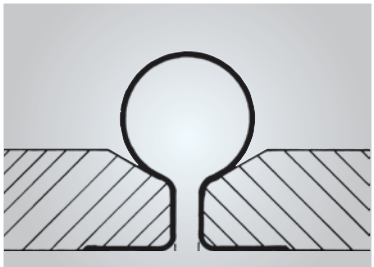


Fig. 8.14 Expansion joint with toroidal bellows

Expansion joint with reinforcing rings

(Fig 8.15)
Reinforcing rings are used if the circumferential stresses become excessive as a result of high operating pressures, generally combined with large diameters, and it is no longer either technically possible or economically advisable to increase the number of plies or the thickness of the bellows wall. Reinforcing rings absorb the circumferential stresses instead, so that the wall of the bellows can remain relatively thin and flexible overall.

Axial expansion joints as dismounting pieces

(Fig 8.16)
This expansion joint is used to create space for assembling and dismounting fittings. Therefore the expansion joint is loosen from the fitting and compressed with threaded rods.
At the same time the expansion joint reduces the connecting forces and moments acting on the fitting. The use of axial expansion joints is restricted by the axial pressure thrust. If the forces are too high, restrained expansion joints must be used.

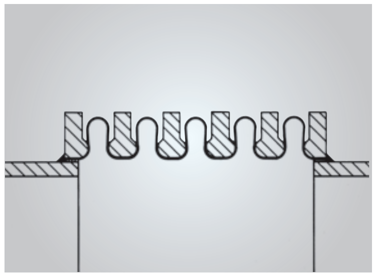


Fig. 8.15 Expansion joint with reinforcing rings

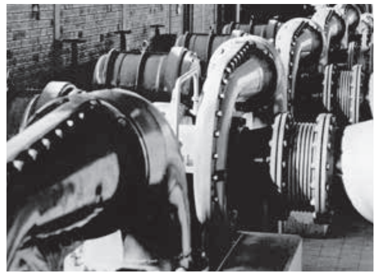


Fig. 8.16 Axial expansion joint as dismounting piece

Expansion joints with pretensioners

(Fig. 8.17 / 8.18)
Axial expansion joints can be fitted with pretensioners to simplify assembly on the construction site.

The pretensioning bracket is set to a fixed pretension, with which the expansion joint is adjusted in the factory to the installation dimension. The bracket must be removed before the pipe is put into service (Fig. 8.17).

The adjustable pretension device, which comprises threaded rods and nuts that link the connection parts of the expansion joints together, enables the installation length to be set simply and rapidly for assembly (Fig. 8.18). See Chapter 7, Type ARH.

Pretensioners are usually only designed to absorb the adjusting forces. They cannot absorb either additional loads or the axial pressure thrust.

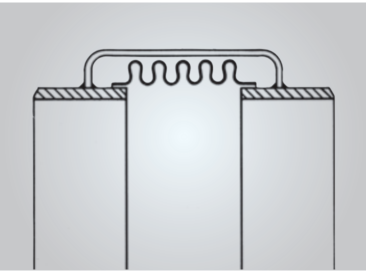


Fig. 8.17 Expansion joint with pretensioning bracket

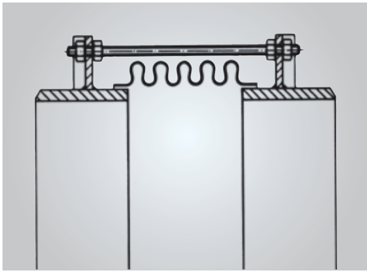


Fig. 8.18 Expansion joint pretensioned with threaded rod

Expansion joints with stroke limitations

(Fig 8.19)
Stoke limiters can be provided for axial expansion joints if:

- The stroke must be distributed between several expansion joints in special cases
- Pressure tests must be performed during the construction work before the final anchors are secured in position
- The anchors are likely to fail or the pipe is likely to move excessively as a result of an incident (Chapter 7, Type ARH)

Flange expansion joints with external protection cover

(Fig 8.20)
If damage is likely to be caused to the bellows by external factors due to the installation location, the expansion joints can be fitted with external protection covers. The cover can be detached from the design shown here, for example to enable the flanges to be assembled.

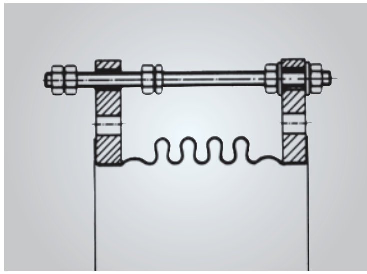


Fig. 8.19 Expansion joint with stroke limitation

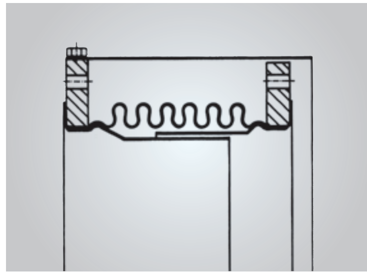


Fig. 8.20 Flange expansion joint with external protective sleeve

Axial expansion joints with welding neck flanges

Fig. 8.22)
The axial expansion joints in the standard range are available with either loose flanges or plain fixed flanges with the same total length. The special design shown here can be supplied if welding neck flanges with a raised face are desired and the slight increase in the total length does not matter.

Universal expansion joints as centrifuge connections

Fig. 8.23)
The universal expansion joint is designed to be highly durable in the face of large lateral vibration amplitudes and has a lateral natural frequency which is sufficiently high in relation to the excitation frequency (rotation speed) of the centrifuge.

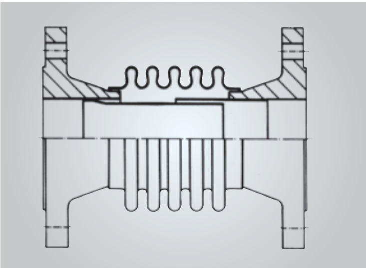


Fig. 8.22 Axial expansion joint with welding neck flanges

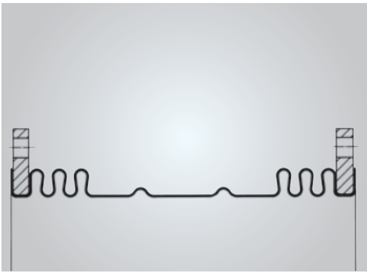


Fig. 8.23 Universal expansion joint as centrifuge connection

Universal expansion joints for hot blast systems

Fig. 8.24)
These expansion joints are designed for axial and lateral movements. Their inner sleeve is such that large gaps can’t occur, even in the extreme positions of the expansion joint, and that the weight of the fireproof internal liner can be borne.

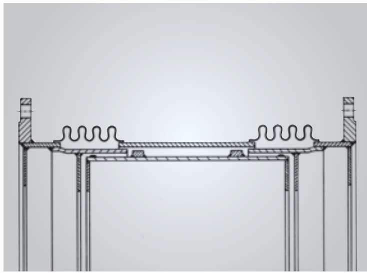
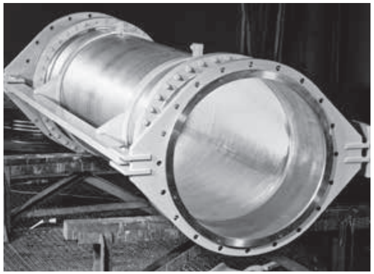


Fig. 8.24 Universal expansion joint for a hot blast system, DN 2500

Lateral expansion joints for paper machines
(Fig. 8.25)
This expansion joint has been developed for connecting the head boxes of paper machines, which are required to effect a pendulum movement. The movable section comprises a reinforced PTFE liner, which is smooth and has no corrugations on the inside to prevent the conveyed material from settling. In addition to a lateral movement of up to 300 mm, it can absorb a slight angular movement of 2 to 4 deg as well as slight torsion.

Lateral expansion joints with diffuser
(Fig. 8.26)
This expansion joint has been developed for connection to compressors. It combines an elastic expansion joint with a diffuser. As a "force free" connection, it is capable of compensating misalignment and absorbing vibrations.



(Fig. 8.25) Lateral expansion joint for paper machines

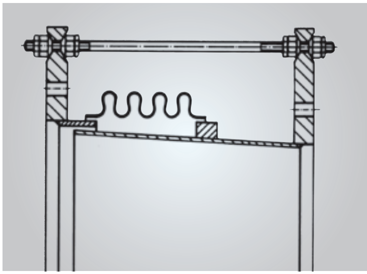


Fig. 8.26 Lateral expansion joint with diffuser

Angular expansion joint with conical inner sleeve
(Fig. 8.27)
Internal sleeves in angular expansion joints must have a sufficient clearance to ensure flexibility. One solution is to use a one-piece, conical inner sleeve. Note: This slightly reduces the cross-section.

Angular expansion joint with internal restraint hardware
(Fig. 8.28)
This design – in the form of a single hinge or of a gimbal hinged expansion joint – may be useful if external anchoring is not possible due to limited space. If a reduction in the cross-section is unacceptable, the anchoring can be designed to permit an almost smooth free opening. In this case, however, a larger bellows must be used. It should be noted that the internal hinge is in contact with the medium.

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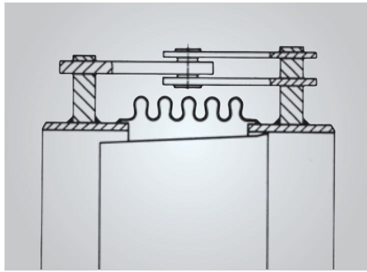


Fig. 8.27 Angular expansion joint with conical inner sleeve

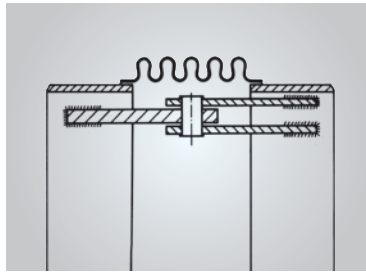


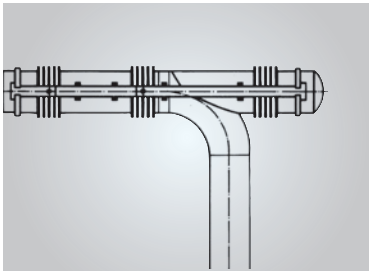
Fig. 8.28 Angular expansion joint with internal restraint hardware

Elbow-connected pressure balanced expansion joints

(Fig. 8.29)
The design and construction of an elbow-connected pressure balanced expansion joint is dependent on specific requirements and takes the operating conditions and the necessary movement values into account (see also Chapter 12, "Axial compressive force and pressure balanced designs"). Fig. 8.29 shows an axially and laterally flexible, elbow-connected pressure balanced lateral expansion joint.

Angular expansion joints with PTFE bearings

(Fig. 8.30)
If the adjusting moments of our angular expansion joints, which are already small, are too high for your particular application, it is possible to reduce the frictional moment in the hinges still further by using a special bearing. The PTFE compound bearing we use for this purpose has a special design which permits it to withstand high contact pressures without the plastic antifriction coating being pushed aside. The good sliding characteristics of the bearing are thus maintained throughout the entire operating period. The bearing can withstand temperatures up to 280 °C and is absolutely maintenance-free.



(Fig. 8.29) Elbow-connected pressure balanced expansion joint

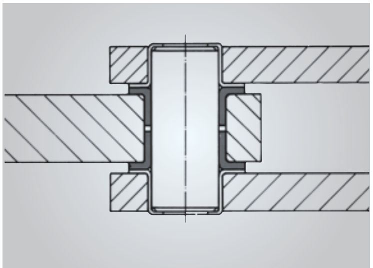


Fig. 8.30 Hinge with special bearing

Oval expansion joints

(Fig. 8.31)
Oval expansion joints can theoretically be manufactured with any dimensions and fitted with the necessary connection parts. It is however not advisable to use them except in cases where an element with a round cross-section cannot be used.

Since expensive tools are necessary for each dimension, it is only economical to use an oval expansion joint if large quantities are required. The pressure resistance of an oval bellows is limited.

Mechanical seals

(Fig. 8.32)
A corrugated metal bellows forms part of a mechanical seal on a rotating shaft. The bellows is assembled pressure-tight to the case, the slide ring is fitted onto the other side. The elasticity and spring force of the bellows ensures that the sealing ring always makes full contact.

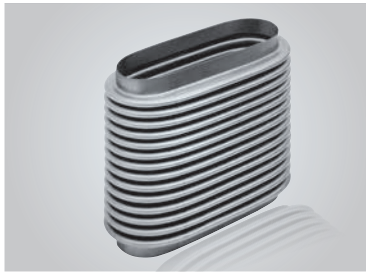


Fig. 8.31 Metal bellows with oval cross-section

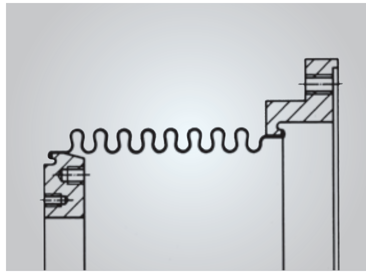


Fig. 8.32 Floating ring seal

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Volumetric compensation reservoirs

(Fig. 8.33)
A metal bellows takes care of the temperature-related, volumetric compensation of a liquid by means of expansion or compression. The movement is counter to a compressed gas cushion if the liquid is under pressure.

Valve stem seals

(Fig. 8.34)
On valves high demands are made in terms of leak tightness and freedom from maintenance. Nowadays, they are fitted with metal bellows instead of glands for sealing the axially moved valve stem. High and highest pressures can be handled safely and maintenance-free with absolute tightness.

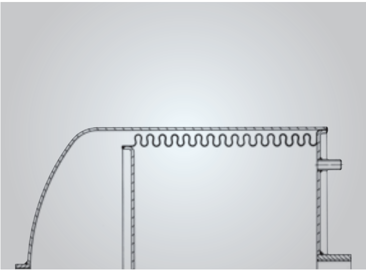


Fig. 8.33 Volumetric compensation container

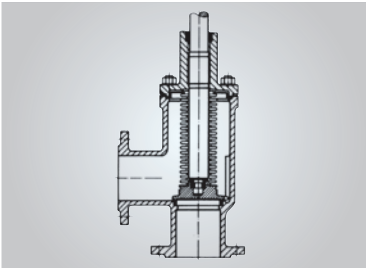


Fig. 8.34 Valve spindle seal

Pressure cells

(Fig. 8.35)
If hydraulic pressure is applied to a metal bellows sealed with caps at both ends, the bellows can transfer a pressure-related force, similar to a hydraulic piston, whilst remaining absolutely tight. The figure shows a hydraulic element used to press-fit lock gates.

Flexible couplings

(Fig. 8.36)
Metal bellows can be used as flexible coupling elements; they transfer torsional moments within their strength and stability limits, and compensate the axial, angular and lateral misalignment of the rotating shaft ends.

Fig. 8.35 Pressure cell

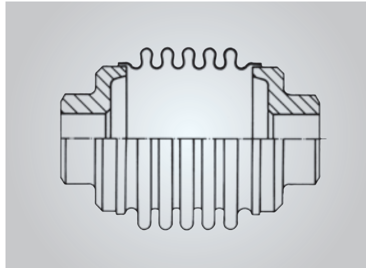


Fig. 8.36 Flexible coupling

INSTALLATION OF EXPANSION JOINTS

Installing expansion joints in a pipe can cause substantial changes in its behaviour. Anchors and guides are subjected to different loads and the functions they must perform are not the same as in an uncompensated pipe system.

The general rules that must be considered when installing expansion joints are summarized in Chapter 16, "Installation Instructions".

This chapter describes principles to be considered when sizing and implementing the anchors, guides and supports.
It also contains information on:

- Use of lateral expansion joints within a three-hinge system
- Installation of elbow-connected pressure balanced expansion joints
- Pretensioning options

If in doubt, please make use of the advice of our specialists.

FIXED POINTS

All compensation systems must be limited by adequately sized anchors to ensure a safe functioning of the system. There are four different types of anchors, each with different functions and loads.

End anchors

These are either located at the ends of a compensated pipe system or used to separate two different compensation systems (Fig. 9.1). They are generally subjected to a high load.
The following forces act on end anchors:
- Axial pressure thrust (axial expansion joints only)
- Adjustment force of the expansion joint or compensation system
- Frictional force between pipe and supports
- Other plant-specific forces (wind, snow, weight of pipe or medium)

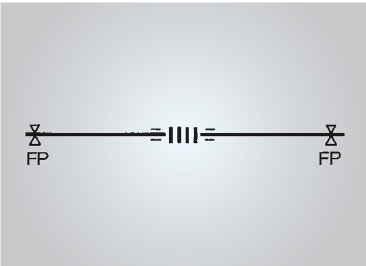


Fig 9.1 Straight pipe run with axial expansion joint and end anchors

Intermediate anchors

These separate two expansion joints of similar construction which are necessary in long, straight pipe runs, and are generally only subjected to a slight load (Fig. 9.2).

The following differential forces act on intermediate anchors:
- Axial pressure thrust (axial expansion joints only) if different nominal diameters must be separated or if there are pressure differences (flow losses at throttles or valves). Axial expansion joints made by different manufacturers usually have different pressure thrusts, which can result in considerable differential forces even if the nominal diameter is the same.
- Adjustment force if expansion joints of different lengths and with different movements are used. Even if the expansion joints and the movements are the same, a differential force which is 30 % of the adjustment force should be assumed, since the spring rates of the expansion joints are subject to fluctuations in this region due to production and material tolerances.
- Frictional force between the pipe and guides. Particular attention should be paid to this point, since the frictional forces may differ substantially during operation depending on the type of support.
- Other plant-related forces, which must be taken into account when calculating the load on the anchors.

The intermediate anchor becomes an end anchor during pressure tests in a section of the pipe or if the system contains a gate valve.

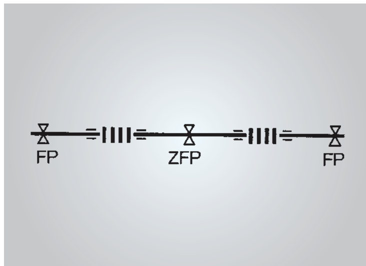


Fig. 9.2 Straight pipe run, subdivided into two compensated sections by intermediate anchor

Sliding anchors
These serve to guide the pipeline, but must act as normal anchors in at least one direction, e.g. if universal expansion joints are used (Fig. 9.3). The same forces act on sliding anchors as on end anchors. It should be noted in addition that a large frictional force is generated at the sliding anchor due to the high anchor force which is active there. This frictional force must also be taken into account when sizing the end anchor FP_1.

Elbow anchors
These separate two identical compensation systems at the crown of a pipe elbow. This type of anchor is a mixture of an end anchor and an intermediate anchor. The same forces must consequently be taken into account as with end anchors, in addition to the differential forces that occur with the intermediate anchors if the bends are too small.

The redirection of the flow in the pipe elbow results in a centrifugal force, which must also be absorbed by the elbow anchor if an axial compensation system is used. This force is usually negligible, however. The individual force components must be added together geometrically, in order to obtain the magnitude and direction of the resulting anchor force F_{res}.

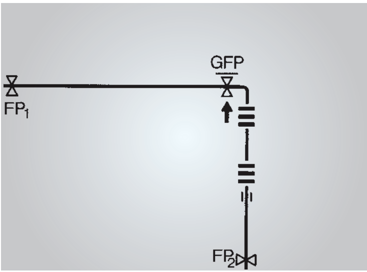


Fig. 9.3 Bent pipeline with universal expansion joint and one sliding anchor

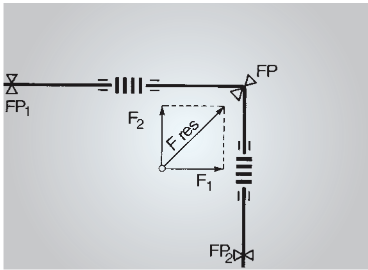


Fig. 9.4 Bent system with axial expansion joints and elbow anchor

ANCHOR FORCES

Axial pressure thrust
Chapter 12 "Axial Pressure Thrust and Pressure-balanced Designs" describes the origin and effect of the pressure thrust in detail, the calculation formula will suffice at this point.

Axial pressure thrust F_p in kN
(axial compensation only)

(9.1) $$F_p = 0.01A \cdot p$$

Effective cross-section A in cm² (see dimension table of the axial expansion joints)
Pressure p in bar (take maximum pressure, e.g. test pressure)

If the internal pressure is greater than the external pressure, the expansion joint will be elongated by the pressure thrust without anchors, whereas if the external pressure is greater than the internal pressure, it will be compressed. If pressure tests are performed section by section during construction of an extensive pipe system, and if the strong end anchors are not locked in position, axial expansion joints must be protected by suitable stroke limiters (see Chapter 7 Type ARH, for example), or alternatively the intermediate anchors must be made correspondingly stronger.

Adjustment force of the compensation system
The axial spring rate c_δ is specified in the dimension tables for axial expansion joints. The adjustment force is calculated as follows:

Axial adjustment force F_δ in kN

(9.2) $$F_\delta = 0.001c_\delta \cdot \delta$$

Axial spring rate c_δ in N/mm
(taken from dimension tables for axial expansion joints)
Half overall movement absorption δ in mm (with 50 % pretensioning)

In hinge systems, the adjusting forces are more difficult to calculate than for axial expansion joints. Calculation programs are normally used to determine these forces (e.g. ROHR2 or CAESAR II).

Frictional force between pipe and supports

The entire frictional force of the pipe section between the compensation system and the anchor, i.e. the sum of the frictional forces of all supports, acts on each anchor.

Frictional force F_R in kN

(9.3) $$F_R = \Sigma F_L \cdot K_L$$

Support load F_L in kN
Friction coefficient of support K_L :
Empirical values for K_L:
Steel / steel: 0.2 – 0.5
Steel / PTFE: 0.1 – 0.2
Roller bearings: 0.05 – 0.1

It should be considered that the frictional force acts on an anchor in alternating directions – as a pressure thrust when the pipe is heated up and as a tensile force when it is cooled down.
The distribution of the frictional-force components acting on the two anchors can be altered by changing the arrangement of the compensation system along the pipe section between the anchors. If, for example, the compensation system is positioned directly at an anchor, this anchor (FP_1) must not absorb any frictional force; on the other hand, the second anchor (FP_2) must absorb the entire frictional force of this section (Fig. 9.5).
If the compensation system is positioned centrally between both anchors, each anchor must absorb half the frictional force of the complete section (Fig. 9.6).

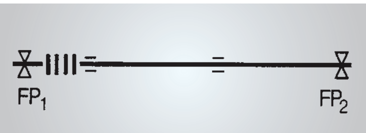


Fig. 9.5 Asymmetrical arrangement of the expansion joint. Frictional force acting on one anchor.

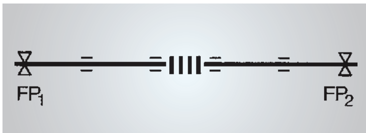


Fig. 9.6 Symmetrical arrangement of the expansion joint. Frictional force distributed uniformly.

Centrifugal force in kN

This is only released at the elbow anchors of axially compensated pipes, and is generally negligible (Fig. 9.7). A significant force is only generated by heavy media with a high flow velocity.

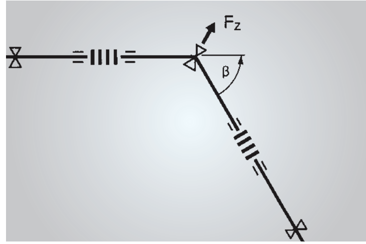


Fig. 9.7 Centrifugal force at the elbow anchor

Centrifugal force F_Z in kN

(9.4) $$F_Z = \frac{A \cdot \rho \cdot v^2 \cdot \sin\beta}{10{,}000}$$

09

Effective cross-section A in cm^2 (see dimension tables for axial expansion joints)
Density of medium ρ in g/cm^3
Flow velocity v in m/sec
Angle of pipe elbow β in degrees

Other plant-related forces

In addition to the forces generated as a direct result of the installation of expansion joints, the anchor sizing must also take into account those forces produced by the system or the pipeline route, or by additional loads:

- Weight of pipe, medium and insulation
- Weight of dust deposits both inside and outside
- Weight of condensate
- Wind and snow loads
- Forces due to mass acceleration in event of an earthquake
- Forces due to pipe deformation as a result of inadequate compensation

If pipes used for gaseous media are subjected to a water pressure test, the weight of the water must be taken into account in addition.

GUIDES

Particular attention must be paid to the pipe guides in the region of expansion joints or compensation systems. The different requirements of the compensation systems must be taken into account.

Guides for axial compensation

The conditions dictated by the plant must always be taken into consideration when sizing supports and calculating the distances between the supports. The following rules must also be observed if axial expansion joints are used:

- The first guide after the axial expansion joint must be no more than 3 x DN away from the expansion joint, i.e. $L_1 \approx 3 \cdot DN$ (Fig. 9.8)
- The distance between the first and second supports after the expansion joint must be approximately half the normal distance between supports, i.e. $L_2 \approx 0.5 \cdot L_F$ (Fig 9.9)
- The normal distance between supports L_F may have to be reduced if there is a risk of pipe buckling (Fig. 9.10)

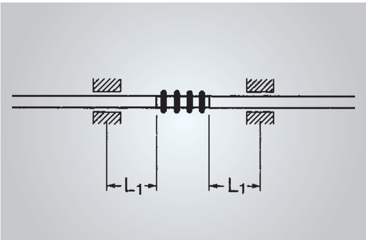


Fig. 9.8 Guide installed directly at axial expansion joint

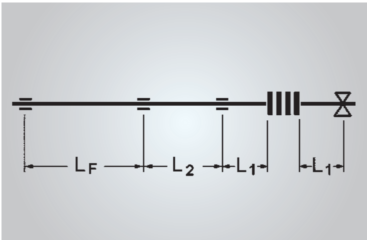


Fig. 9.9 Guide installed in pipe

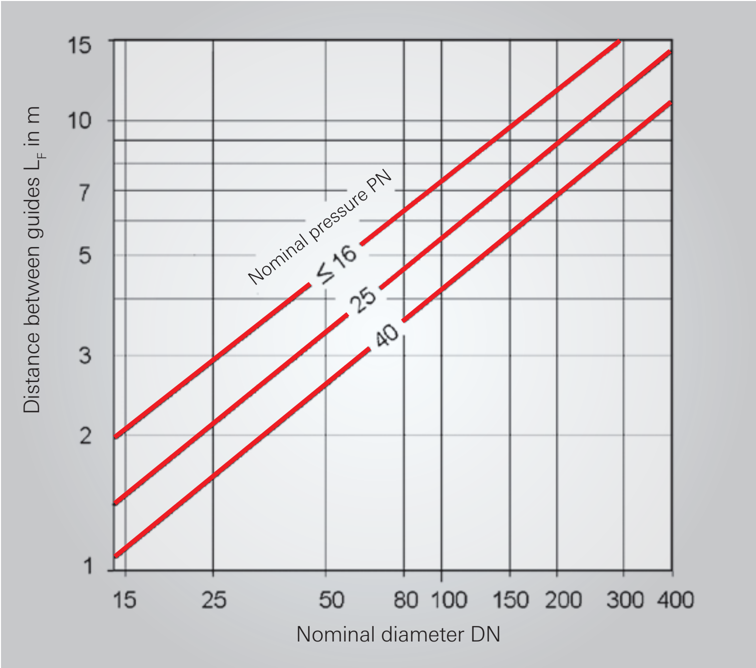


Fig. 9.10 Distances between pipe guides for axial compensation (approx. values)

Guides for lateral compensation or double-hinge systems

In the case of lateral compensation, there is always a "residual elongation" which must be absorbed by bending the pipe.
This residual elongation is made up of two components:

- Thermal expansion in the uncompensated pipe section (with expansion joint)
- Arc height derived from the circular movement of the lateral expansion joint or the two angular expansion joints (Fig. 9.11)

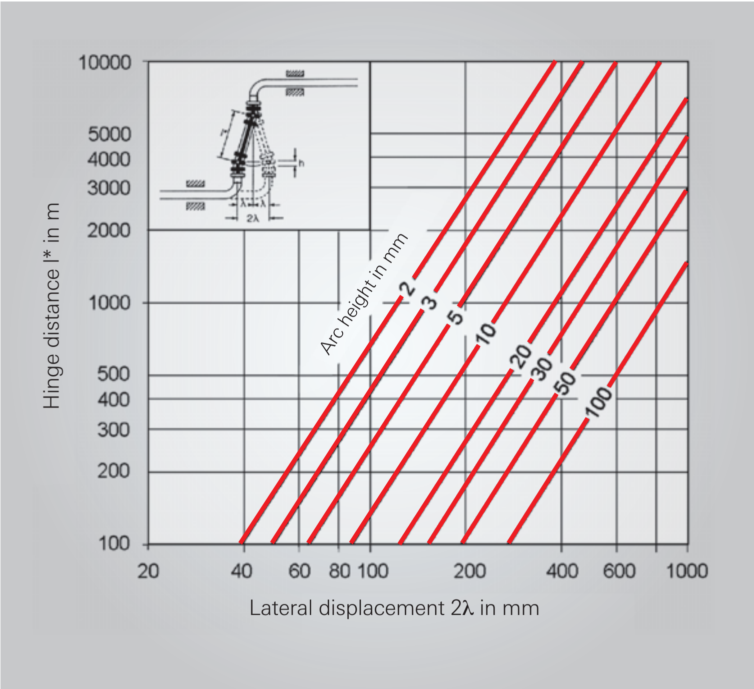


Fig. 9.11 Length variation of a double-hinge system with lateral movement (arc height)

Arc height h in mm

(9.5) $$h = l^* - \sqrt{l^{*2} - \lambda^2}$$

Hinge distance l* in mm
half lateral displacement λ in mm

Sufficient freedom of movement must therefore be permitted at one end of the expansion joint respectively the double-hinge system, or otherwise reactive forces will occur (Fig. 9.12).

Guide 3 must have sufficient clearance in order not to impede the residual elongation. In other words, it is only a guide in one direction. In vertical systems, the guide can be omitted if there are no forces and if vibrations are not possible. Guides 2 and 4 must be able to absorb the bending forces of the pipe.

If long intermediate pipes are installed in horizontal systems, they must be supported in order to prevent excessive lateral forces from acting on the expansion joint (Fig. 9.13).

The slip plane of the supports must always be perpendicular to the pivots of the expansion joints.

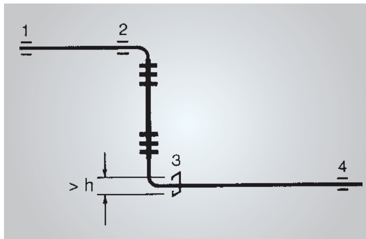


Fig. 9.12 Vertical double-hinge-system

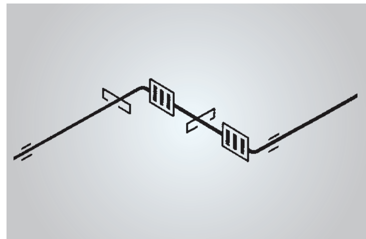


Fig. 9.13 Horizontal hinge-system on sliding guides

Flexible hangers or supports must be provided for vertical systems or systems which are flexible on all planes and for heavy loads (Figs. 9.14 and 9.15).

It should be noted that pipe bending from residual elongations causes additional forces on the restraint hardware of the expansion joint. For vacuum service or unusual pretensioning of the expansion joints, the additional bending forces placed on the restraint hardware may be so heavy that reinforcement is necessary. In this case, the additional forces must be specified in inquiries and orders.

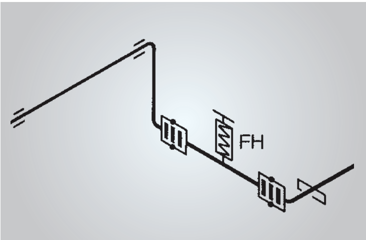


Fig. 9.14 Horizontal double-hinge system with suspended intermediate pipe

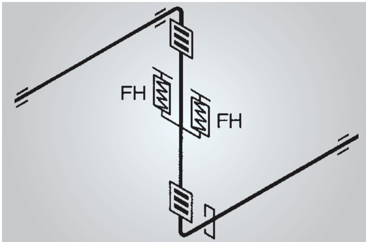


Fig. 9.15 Vertical double-hinge system with suspended intermediate pipe

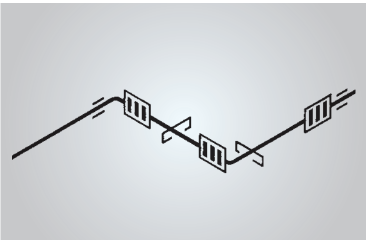


Fig. 9.16 Plane three-hinge system with both intermediate pipes supported

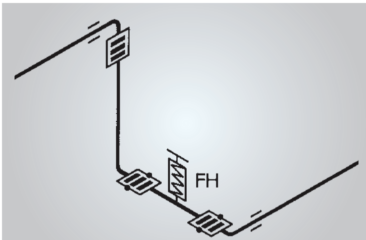


Fig. 9.17 Three-hinge system with suspended intermediate pipe flexible on all planes

Guides for three-hinge systems

The loads placed on the guides of three-hinge systems are only slightly greater than those placed on standard pipe guides. The only additional loads are the adjusting forces of the system, which are usually small.

Special attention should be paid to the absorption of the weight of the pipe sections between the angular expansion joints. These sections are often long and their weight can place an excessive load on the expansion joints.

The examples below demonstrate load transfer by means of supports or spring hangers.

If a plane three-hinge system is installed at an inclination angle α (Fig. 9.19), it is important to ensure that the pin axes are always parallel to one another and perpendicular to the support plane, i.e. the axes of the expansion joints must be inclined by the angle α when they are installed.

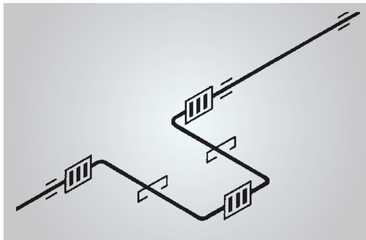


Fig. 9.18 three-hinge system in U-configuration with pipe legs supported at centre of gravity

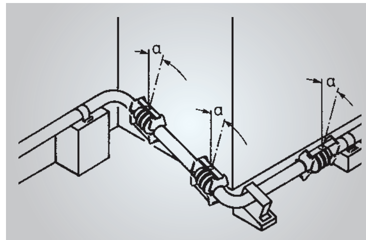


Fig. 9.19 Inclined three-hinge system

09

INSTALLATION NOTES

Restraint hardware orientation of lateral expansion joints

Almost all lateral expansion joints have two tie rods or hinged tie bars, which give them additional angular flexibility in one plane (Fig. 9.20). The same applies to lateral expansion joints for movement in all planes. Lateral expansion joints cannot be bend in the second plane, since the restraint hardware works like a parallelogram in this plane (Fig.9.21).
As mentioned earlier in the “Guides” section of this chapter, there is always an uncompensated movement component, which must be absorbed by bending the pipe, when lateral expansion joints (double hinges) are used. The pipe can be bent in different ways depending on the position of the restraint hardware.

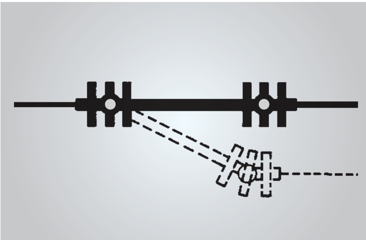


Fig. 9.20 Lateral expansion joint, flexible on all planes. Deflection transversal to anchor plane

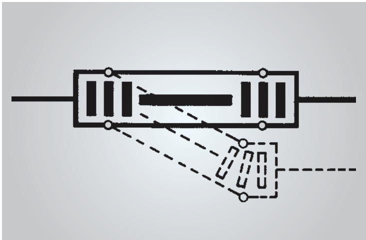


Fig. 9.21 Lateral expansion joint, flexible on all moments. planes. Deflection in anchor plane

Deflection transversal to restraint hardware plane

The pipe is bent in approximately the manner of a beam clamped at one end (Figs. 9.22 and 9.24), since the small adjusting moment of the expansion joint is insignificant. Thus, the free bending length can be kept relatively short and the additional loads on the expansion joint remain small.

Deflection in restraint hardware plane

The pipe is bent in approximately the manner of a beam clamped at both ends, since the restraint hardware transfers a significant moment (Figs. 9.23 and 9.25). The S-bend resulting in the pipe necessitates a much greater free length than in the first example. In addition, much greater moments and forces are generated and may place an excessive load on the hardware of the expansion joint.

Potentially the load-bearing capacity of the restraint hardware must be checked on the basis of the additional forces and moments.

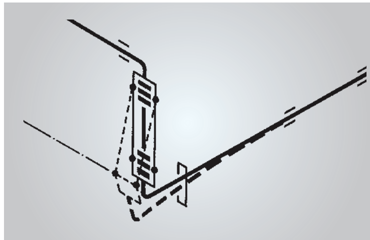


Fig. 9.22

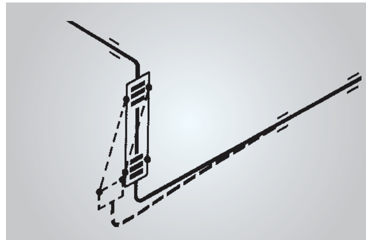


Fig. 9.23

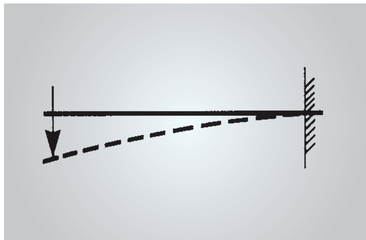


Fig. 9.24

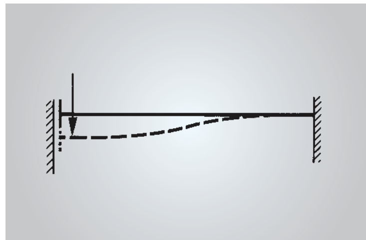


Fig. 9.25

Two lateral expansion joints arranged at an angle
Two short lateral expansion joints are often arranged above a corner in order to cope with small, lateral movements in all planes or with vibrations at machine connections (Fig. 9.26).
In this case, it is important to ensure that the pairs of tie rods or hinged tie bars belonging to the two expansion joints are offset 90° in relation to one another. This prevents the connecting pipe elbow from tilting excessively, which would cause the expansion joints to fail prematurely.

Combination of lateral and angular expansion joints in a three-hinge system
Since one lateral expansion joint has the same kinematic characteristics as two angular expansion joints with an intermediate pipe, it is also possible to construct a three-hinge system with one lateral expansion joint and one angular expansion joint.

If the hinge system is installed in a confined space, especially if it is a 3-dimensional system, it may be cheaper to use a combination of angular and lateral expansion joints. Purely angular systems are usually cheaper if large hinge distances are desired (greater than 5 x DN).

The restraint hardware of the lateral expansion joint must be arranged in the system so that an angular movement towards the angular expansion joint is allowed (Figs. 9.27 and 9.28). The lateral expansion joint functions like a parallelogram with regard to transversal movements in a 3-dimensional system.

Only lateral expansion joints with hinge pins located exactly above the centre of the bellows should be used. If the lateral expansion joints have tie rods or if they have hinges located away from the centre of the bellows, it is considerably more difficult to calculate the bending angles, the forces and moments and the stability of the system.

This pipe system must always be examined by the expansion joint manufacturer to ensure that it can function properly, even if no problems are apparent after the initial, rough calculations.

Lateral expansion joints with more than two tie rods cannot be used in a three-hinge system.

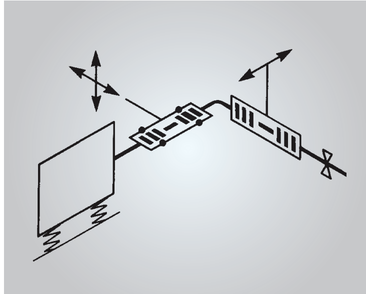


Fig. 9.26 Lateral expansion joint in an angular configuration at a vibrating aggregate

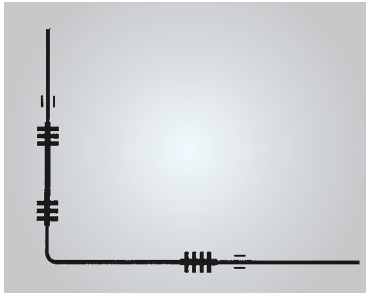


Fig. 9.27 Plane three-hinge system with lateral and angular expansion joints

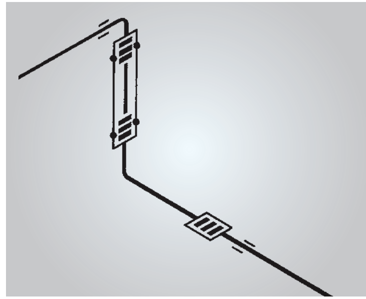


Fig. 9.28 3-dimensional three-hinge system with lateral and angular expansion joints

Installation of elbow-connected pressure balanced expansion joints

Elbow-connected pressure balanced expansion joints are restrained expansion joints in which the axial pressure thrust produced by the internal pressure is not released.

Axial and lateral movements can be absorbed simultaneously. An additional, angular flexibility on all planes can be achieved using special designs (see also Chapter 12 "Axial Pressure Thrust and Pressure-balanced Designs").

A further advantage of this construction type is its compact dimensions. These enable complex movement problems to be solved in confined spaces in combination with the advantage of small connecting forces.

The principle applications should now be apparent, namely connections for pumps, compressors and turbines in restricted spaces.

Elbow-connected pressure balanced expansion joints are normally designed specially to suit particular operating and installation conditions. The examples described below demonstrate the special advantages of this construction type and indicate points which should be noted when it is installed.

If ***elbow-connected pressure balanced expansion joints*** are used for ***pump connections*** (Fig. 9.29), it is possible to achieve low-stress machine connections, which are flexible on all planes, and low space requirements, as well as a vibration decoupling with small movable masses.

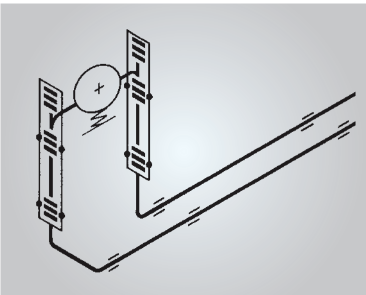


Fig. 9.29 Elbow-connected pressure balanced expansion joints used as pump connections

An ***elbow-connection pressure balanced expansion joint*** installed between a ***turbine and a condenser*** can provide a connection which requires only a relatively small vertical distance (Fig. 9.30).

The connection on the turbine side can also be made with a rectangular cross-section.

A pressure balanced expansion joint can be used in a long pipe section to absorb larger movements (Fig. 9.31).

The movement is effected by means of an extremely small pipe offset. Unlike with the three-hinge system, no lateral deflection needs to be considered. A small clearance may be left merely in the guides directly at the expansion joints for the thermal expansion resulting from the distance between the axes of the two pipe runs, in order to relieve the load on the bellows.

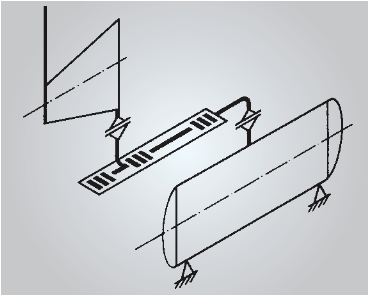


Fig. 9.30 Elbow-connected pressure balanced expansion joint between turbine and condenser

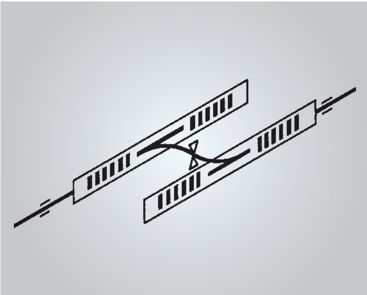


Fig. 9.31 Elbow-connected pressure balanced expansion joint in a long pipe section for absorbing large movements

PRETENSION

Pretension is often necessary in order to exploit the full movement capability of an expansion joint. Each expansion joint can effect movements of an identical magnitude in both directions from the neutral position. Accordingly the optimum presetting value would be 50 % of the total movement.

In the case of axial expansion joints, lateral expansion joints and angular expansion joints in a double-hinge system, the pretension as a proportion of the pipe expansion corresponds to the pretension of the expansion joint itself.

In three-hinge systems with angular expansion joints this is usually the case as well. In unfavourably designed systems, however, the pipe pretension should be calculated with particular care, since it is no longer necessarily proportional to the angular deflection of the individual angular expansion joints.

Since it is difficult to pretension an expansion joint directly when it is assembled, it is advisable to assemble the expansion joints in their neutral positions and to pretension the complete pipe run later on, either by displacing before securing the anchors or afterwards using an adapter which has been cut out.

It should be noted that a pretension is not always purely elastical, i.e. that the expansion joint does not necessarily move back to the nominal length after releasing the pretension.

Axial expansion joints
The expansion joint is welded at one end to the pipe (Fig. 9.35/1). This section of the pipe has already been secured, so that the expansion joint can be pretensioned subsequently without it being displaced. The pipe section to be connected is lying loose in the guides (Fig. 9.35/3). The pipe section to be connected is then pulled to the point of contact (Fig. 9.36/4) and welded to the expansion joint (Fig. 9.36/5).

After welding the loose pipe, it is pulled away from the expansion joint in an axial direction, using a wrench or other suitable device, by the magnitude of the pretension value (Fig. 9.37/6). When doing so, care must be taken to ensure that the expansion joint is not overextended (Fig. 9.37/7). This section of the pipe is now also secured, so that the expansion joint no longer draws the pipe towards it when released by the pretensioner (Fig. 9.37/8).

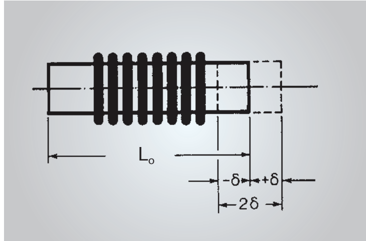


Fig. 9.32 Axial expansion joint with total length L_o (neutral position)

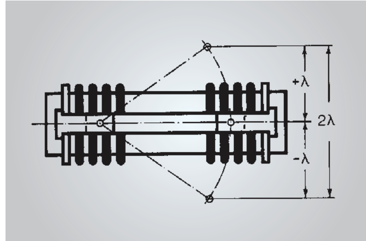


Fig. 9.33 Lateral expansion joint

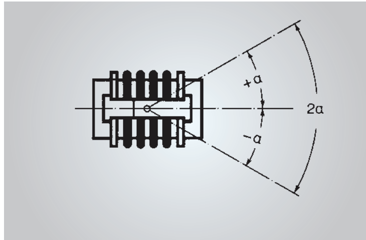


Fig. 9.34 Angular expansion joint

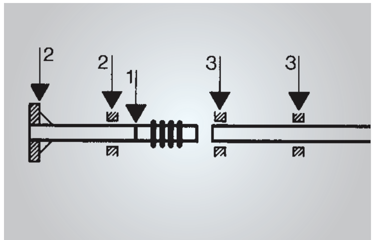


Fig. 9.35

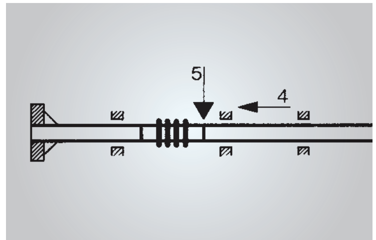


Fig. 9.36

Axial expansion joints can also be ordered already pretensioned. This ensures that they are always pretensioned to the correct value at the construction site. Of course, it is also possible to dispense with pretensioning if the movements are so minimal that the permissible deflection of the expansion joint in one direction from the neutral position is not exceeded.

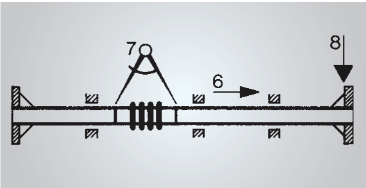


Fig. 9.37

Lateral-expansion joints

The end anchors are secured at both ends (Fig. 9.38/1). The expansion joint is welded in at a neutral position (Fig. 9.38/2). The pipe to be connected is spaced at a distance corresponding to the pretension value V (Fig. 9.38/3). This must be ensured by means of a detachable adapter or by cutting out a pipe section of the length V. The expansion joint is pulled or pushed away from its neutral position by the pretension value (Fig. 9.39/4), then connected rigidly to the pipe run (Fig. 9.39/5). For lightweight expansion joints this can be done manually, otherwise an adequate tool is necessary.

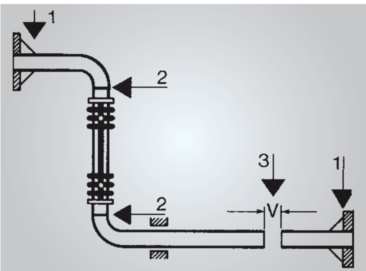


Fig. 9.38

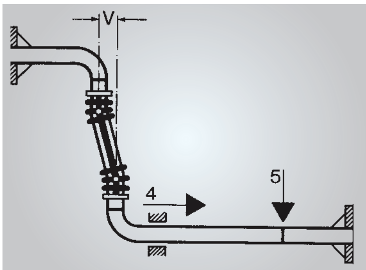


Fig. 9.39

Angular expansion joints

The end anchors are secured at both ends (Fig. 9.40/1). The angular expansion joints are welded or flanged in their neutral position, i.e. perpendicular to the incoming pipe runs (Fig. 9.40/2).
The pipes to be connected are spaced at a distance corresponding to the pretension values, or alternatively, a pipe section corresponding to the pretension value can be cut out (Fig. 9.40/3).

The expansion joints, which are already operating jointly, must then be pulled or pushed away from their neutral position by the pretensioning value (Fig. 9.41/4) and rigidly connected to the pipe runs (Fig. 9.41/5). For lightweight expansion joints this can be done manually, otherwise an adequate tool is necessary.

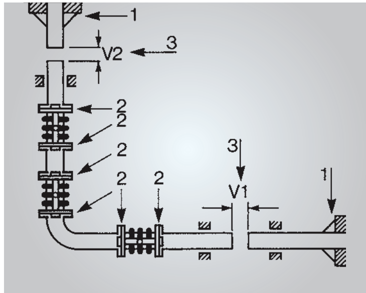


Fig. 9.40

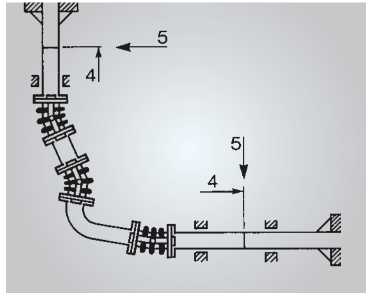
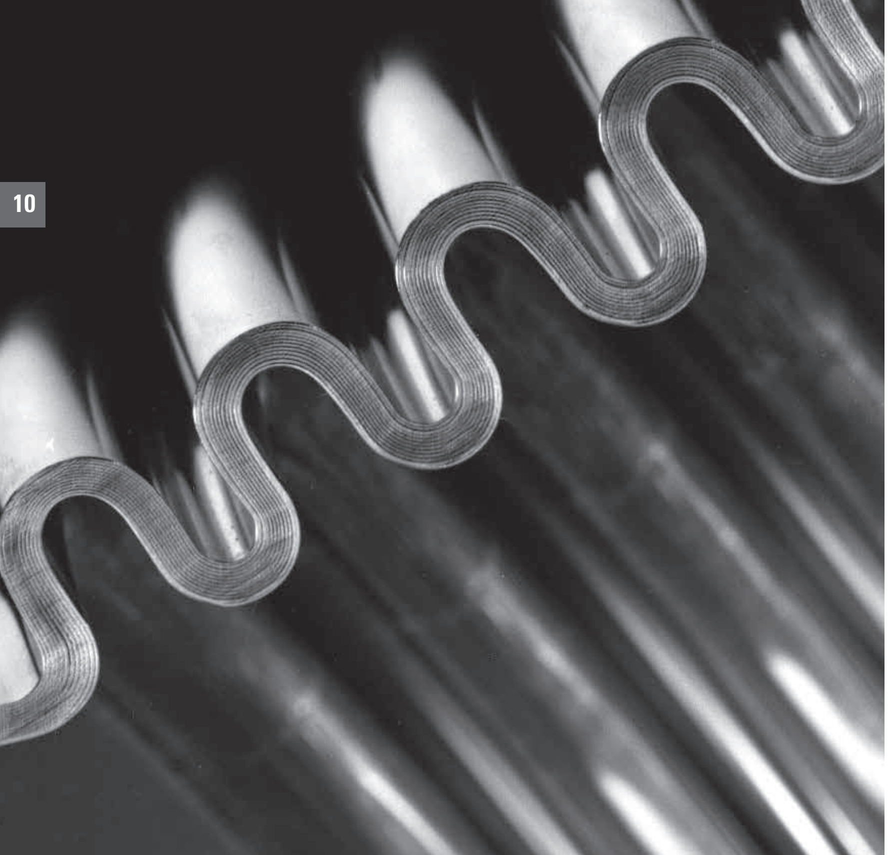


Fig. 9.41

THE MULTI-PLY PRINCIPLE

The “multi-ply” principle is based on the idea of subdividing the pressure-bearing wall into a large number of thinner, individual plies, and thereby considerably increase the flexibility, which is the most important characteristic of an expansion joint (cf. wire rope as opposed to steel rod).



Physical relationships

It becomes apparent merely by considering a simple bending beam (Fig. 10.1) that if the bending and all other dimensions remain the same whilst the beam height is halved, the bending stress is likewise halved and the adjusting force of the double-ply bending beam is reduced to just one quarter of its original value.

Similar conditions basically prevail in the corrugations of a metal bellows. The interrelationships below demonstrate how flexibility, pressure resistance and adjusting force depend on the most important geometrical parameters of the corrugation in an initial approximation (see also Chapter 11 "Design of the Bellows").

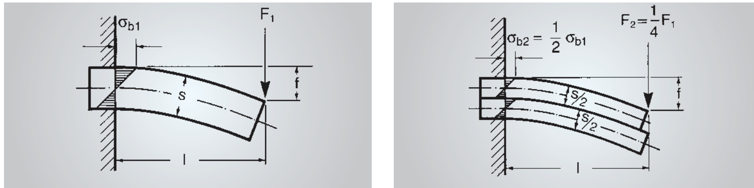


Fig. 10.1 Single and double-ply bending beam with stress profiles

Pressure

(10.1) $$p \sim n_p \left(\frac{e_p}{w}\right)^2$$

Axial movement absorption

(10.2) $$x \sim \frac{w^2}{e_p}$$

Axial spring rate

(10.3) $$k \sim n_p \left(\frac{e_p}{w}\right)^3$$

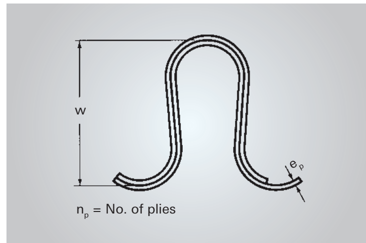


Fig. 10.2 Physical relationships for a bellows corrugation (approximation)

The relationships take into account the number of plies; this reveals the positive effect of a large number of plies on a high pressure resistance combined with good flexibility. ***Whilst increasing the number of plies causes the pressure resistance to be increased linearly, the flexibility remains unaffected.***
Although these relationships are much more complex and less easy to formulate in reality, the potential for adapting the multi-ply expansion joint optimally to specific operation conditions is readily apparent.

Bellows structure
The multi-ply bellows is made using a multi-ply cylinder package.
The multi-ply cylinder package is formed into a multi-ply bellows by pressing out circular corrugations (Fig. 10.3). The plastic stretching of the material which occurs during this process is also a reliable test of the quality of the longitudinal weld seam of the cylinders.
The individual tight cylinders may be made of different materials if desired, which opens up various economic possibilities, for example, of countering corrosion.

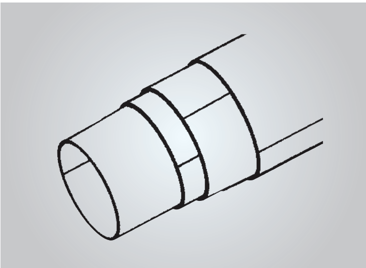


Fig. 10.3 Multi-ply cylinder package

Material quality
Using cold-rolled strip material in only a few thicknesses – it is usually the number of plies which is varied –enables the material to be procured in large quantities, in order to influence positively the characteristics of the raw material which are particularly important for manufacturing bellows, such as dimensional tolerances, surface quality, strength values and formability. The desired characteristics and data are laid down in our ordering and acceptance specifications. Our strip material is certified with the inspection certificate according to EN 10204-3.1/3.2. The most important materials are permanently available in stock.

Technical characteristics
A number of highly positive expansion joint characteristics result from structuring the bellows with a large number of individual plies:
- Ability to cope with high pressure combined with excellent flexibility
- Large movement combined with small total lengths and a guaranteed number of load cycles (usually 1000)
- Small adjusting forces in relation to other designs
- Small bellows outside diameters and consequently small effective cross-sections for reduced loads on anchors
- High burst pressures – at least three times the nominal pressure

10

BENEFITS AND SAFETY OF MULTI-PLY EXPANSION JOINTS

Economic benefits

The large movement absorption of multi-ply HYDRA expansion joints means that only ***a few expansion joints are necessary*** to compensate occuring movements, such as thermal expansion, and that the costs are reduced accordingly (fewer shaft constructions are required, for example).

The more compact dimensions of the multi-ply bellows result in shorter total lengths of the expansion joints and in reduced protrusion of the restraint hardware of hinged expansion joints as well as small outside diameters of potential outer protection covers. This again results in ***cost savings*** with regard to the shaft constructions, since these can manage with much smaller dimensions.

The smaller adjusting forces of the multi-ply HYDRA expansion joint reduce the expenditure for anchors, and thus allow effective, economical compensation in a small place, e.g. hinge systems with very short leg lengths.

If they are planned correctly and installed in accordance with our instructions, multi-ply HYDRA expansion joints protect machine connections from forces and moments and dampen vibrations. Thus, they help to maintain failure-free operation and ***reduce repair costs.***

A number of different bellows materials can be used to counter the risk of corrosion, providing they are sufficiently formable – the ***most economical method is to use the expensive corrosion-resistant material only for the ply which is in contact with the aggressive medium*** and to use our standard stainless steel 1.4541 for the remaining plies. It is however essential to ensure that the different bellows materials can be welded to one another and to the connection parts, or alternatively that loose flanges can be used.

Safety principle

In addition to the safety which is guaranteed by the reliable design and accurate manufacturing, multi-ply HYDRA expansion joints offer a notable advantage with regard to safety, namely the ***check hole for leakage monitoring*** (Fig. 10.4).

If the ply of the multi-ply expansion joint which is in contact with the medium develops a leak, for example as a result of corrosion, a weak flow of the conveyed medium gets out of the expansion joint through the ply interspaces; the onset of damage is indicated by a slight leakage at the “check holes” in the bellows cuff (covered by collars). Pressure resistance and functionality of the expansion joint are maintained in such cases for a lengthy period of time (weeks or months). It is therefore not necessary to replace it immediately. This can be left until a later date which is more convenient to the operator. A replacement expansion joint can be procured within the normal delivery period without the need for any special action.
There is no need to store spare expansion joints.

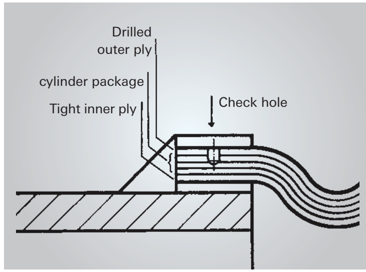


Fig. 10.4 weld seam and check hole

Based on our many years of experience, we can state that spontaneous bursting of HYDRA multi-ply bellows is not possible under any circumstances.

Permanent leak monitoring

When used in plants with toxic, flammable, explosive or other critical media, multi-ply Witzenmann expansion joints can be monitored permanently for leaks without any risk of the critical medium escaping if damage occurs.

For leak monitoring a welded measurement pipe is placed from the outer to the inner layer of the bellows tangent. An instrument can be connected to the measurement pipe (Fig. 10.5). The instrument outputs an alarm if the pressure rises, so that any onset of damage to the inner ply is indicated at absolutely no risk. Even large pipe systems, such as gas distribution systems, can be monitored completely, reliably and economically by this method.

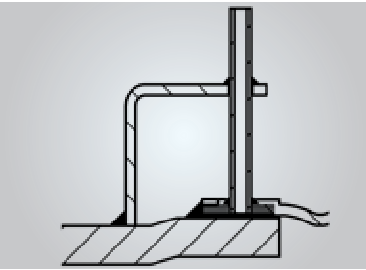


Fig. 10.5 Leak monitoring

Noise damping

Multi-ply bellows have a movement hysteresis due to mutual effect of the plies on one another and to the effect of friction (Fig. 10.6).

The damping resulting from energy consumption has an extremely positive effect on the insulation of structure-borne noise. Multi-ply bellows can reduce this noise by up to 20 dB in the same way as rubber elements.

The outstanding characteristics of multi-ply HYDRA expansion joints have proven to be a good and often the only useful solution in practical application - especially in the area of higher pressure - for many years thanks to their excellent properties.

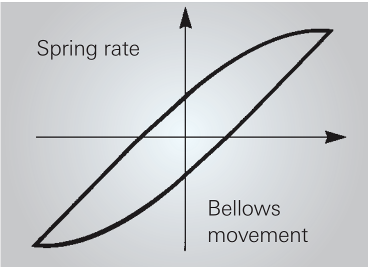
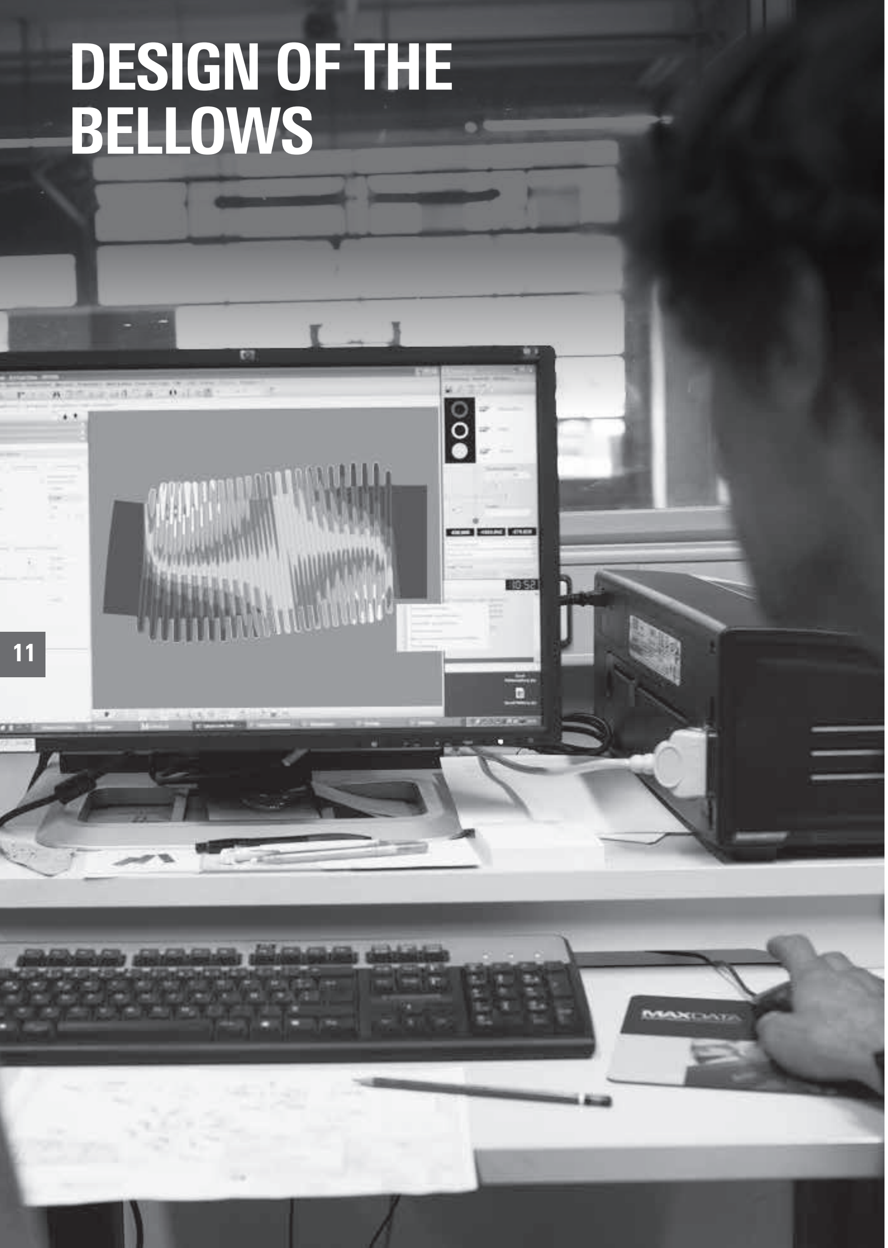


Fig. 10.6 Hysteresis loop during over-elastic cyclic load

DESIGN OF THE BELLOWS



Introduction

A corrugated metal bellows must meet two contradictory demands – namely pressure resistance on one hand and flexibility with regard to relatively large, cyclic movements on the other hand – giving almost equal priority to both. This also differentiates the metal bellows from other pressure-bearing components, such as vessels and pipes, where pressure resistance is essential, whilst other imposed cyclic loads generally play a subordinate role and are only calculated approximately as additional loads.

The aim when designing an expansion joint bellows is to establish a design which allows the two demands to be met optimally in both technical and economic terms.

According to the latest state of the art – which is based on several decades of experience – the construction principle of double and multi-ply expansion joints provides the best basis for achieving an optimised system.

On the other hand, using several plies further complicates the already difficult calculation of the lyre-shaped bellows as a doubly-curved shell. A reliable method of designing and sizing expansion joints is however indispensable, since the safety of a plant and the operating personnel may depend on it.

For this reason, we have developed an individual calculation method. This calculation method is basically founded on EN 13445-3 and EN 14917 and was complemented by supplements of operational experience and test results. The method was examined by an independent third party inspection agency (TÜV); an equivalent safety level in the sense of directive 2014/68/EU was demonstrated.

Theoretical basis

The calculation method applied in standards (EN 13445, EN 14917,...) and rules (EJMA, ASME,...) is founded on the calculation method which was developed by Anderson for the Atomic Energy Commission, USA and published in 1964/65. This method takes a flat, non-curved plate strip with a height w, corresponding to the height of the corrugations, as a simplified, substitute model for a bellows half-corrugation (Fig. 11.1). The equations required to calculate this substitute model are set up, and then corrected with factors which take into account the effect of the real shell shape of the bellows corrugation.

Anderson provides the correction factors in the form of a graph; they have been determined analytically by means of shell equations and take the laws of similarity into account. The method provides clear equations in line with the simplified, yet elegant, approach (Fig. 11.1).

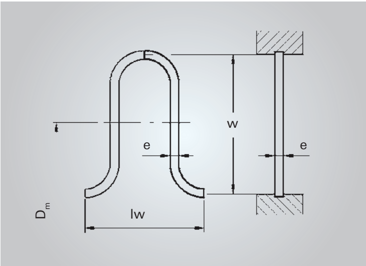


Fig. 11.1 Bellows and analogous model for the calculation according to Anderson.

The equations can principally be used as the basic equations for calculating the bellows, though strictly speaking they only apply to single-ply bellows with U-shaped corrugations (parallel side walls) and with a constant wall thickness over the entire corrugation. Bellows with more than one ply can be calculated approximately using these equations, providing the number of plies is not too high (between 2 and 5) and the overall wall thickness is small in relation to the given corrugation height.

The Witzenmann method

The essential amendments and extensions of the calculation method acc. to EN 13445 introduced by us are:

- Suspension of the limit of five plies by introducing a correction factor
- Modification of the fatigue life curve based on tests
- Modification of the equation for column instability considering the influence of movement

Service life

Based on test results and considering the correction factor, a fatigue curve specific to the manufacturer was established. The determination of this particular curve followed EN 13445-3 and EN 14917. Based on the best fit curve a S-N curve is determined, which covers at least 98 % of the test results. It is called "design curve" and is the basics for the expansion joint design (Fig. 11.2).

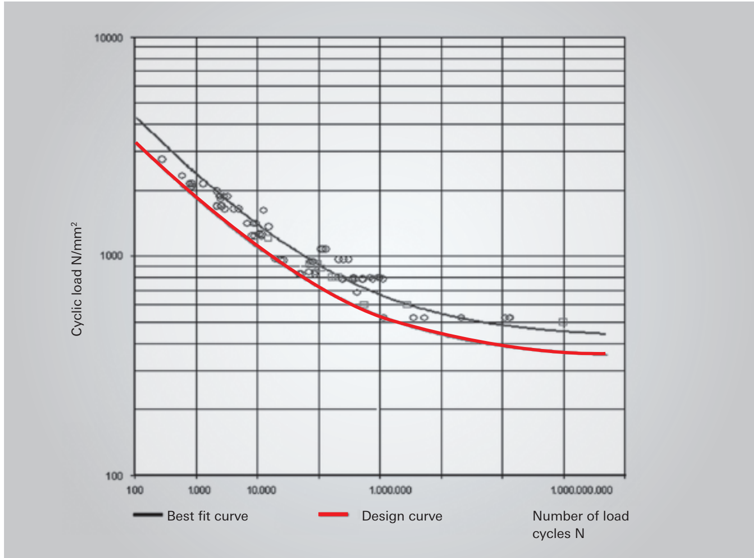


Fig. 11.2 Determining the S-N curve

Stability

The performance of a bellows (pressure resistance, fatigue life) can be decreased considerably by instability. Therefore, a reliable calculation of the critical internal pressure is very important.

There are two kinds of instability:

Column instability, which only applies to bellows with internal pressure, is defined as a strong lateral shift of the bellows median line and occurs at bellows with a relative large ratio of length to diameter (Fig. 11.3).

To determine the critical pressure we have considered both the static pressure and the effect of movement.

In-plane instability – also called local instability – occurs at small ratio of length to diameter and is defined as moving or twisting the plane of one or several corrugations against the straight axis of the bellows (Fig. 11.4).

Fig. 11.3

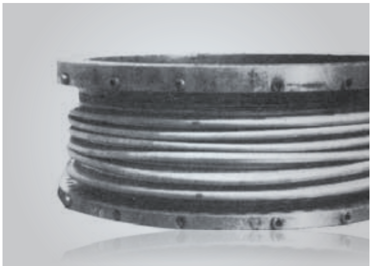


Fig. 11.4

Spring rate of bellows

The spring rate of a bellows is no explicit, linear size. It depends on the geometry (in particular wall thickness and corrugation height) and the material of the bellows.

The stiffness of a bellows can be calculated within the elastic range with sufficient accuracy (see EN 13445-3). Strictly speaking, it is valid only for small axial movements. When the axial deflection increases (plastic range, line BC in Fig. 11.5), it deviates from the linear course.
With great efforts it is possible to determine the real working spring rate by measurement.

For this reason, we formulated an equation for the working spring rate by analysis of internal measurements in combination with theoretical models. With this equation it is possible – in accordance with the results of measurement – to calculate the working spring rate in relation to the axial movement.

All supplementary influences such as pressure, friction between the plies or partly plastic deformation were taken into account in this equation.

For large movements, high pressures or high temperatures, it is recommended to apply the effective working spring rate (AC) for the calculation. We gladly calculate it individually for your specific application.

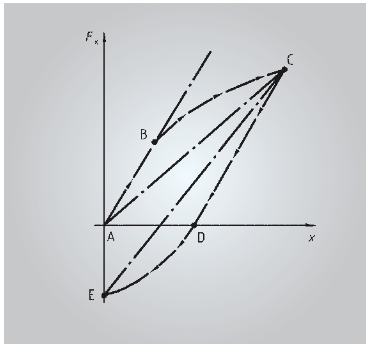


Fig. 11.5

AXIAL PRESSURE THRUST AND PRESSURE-BALANCED DESIGNS

A longitudinal force with the magnitude $F_L = a \cdot p$ generally prevails in a pressurized pipeline, where a represents the pipe cross-section and p the pressure difference (internal/external). The pressure thrust is generated by the axial pressure components, which act on a projected cross-section at the end of a pipe section (Fig. 12.1).

If a flexible, unrestrained, axial expansion joint is used, pressure thrust is released, i.e. there is no reaction in the pipeline in the form of a longitudinal force. The pressure thrust must be absorbed at both ends of the pipe section by means of anchors.

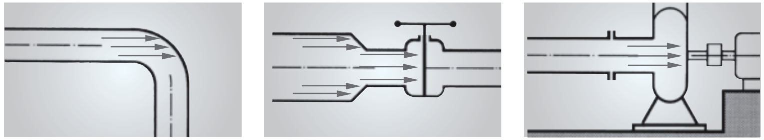


Fig. 12.1 Pipe elbow – Gate valve – Pump

Since an axial expansion joint normally has a mean bellows diameter which is larger than the inside diameter of the pipe, the force which must be taken into account when designing the anchors is slightly higher (Fig. 12.2).

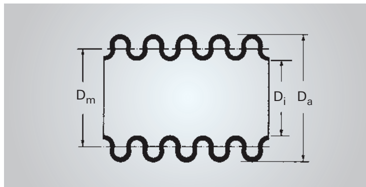


Fig. 12.2 Diameter of bellows

AXIAL PRESSURE THRUST

(12.1) $F_p = A \cdot p$

A = effective bellows cross-section
p = Over pressure

The axial pressure thrust is obtained in kN, if A is specified in cm^2 and p in kN/ cm^2 ($1 kN/cm^2$ = 100 bar; see Chapter 4, "Compensation types", Fig. 4.3). The effective bellows cross-section specified in the dimension tables for the axial expansion joints can be well approximated with the aid of the mean bellows diameter.

Effective bellows cross-section

(12.2) $$A = \frac{\pi}{4} D_m^2$$

Mean bellows diameter

(12.3) $$D_m = \frac{1}{2} (D_i + D_a)$$

The maximum over pressure which occurs must be used when designing the anchors (usually the test pressure).

From the difference between the cross-sections of bellows and pipe, $\Delta A = A - a$, a force component results which is transmitted as a longitudinal pressure thrust from the expansion joint through the pipe to the anchor (Fig. 12.3).

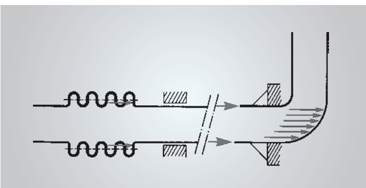


Fig. 12.3 Axial pressure thrust with axial compensation

Restrained expansion joints

Expansion joints are fitted with restraint hardware in the form of spherically pivoted tie rods or hinges, in order to guide the longitudinal force via the expansion joint from one pipe connection to the other. Thus, a pipe with restrained expansion joints behaves like a continuous pipeline regarding axial pressure thrust and longitudinal force. Anchors and guides are not loaded by the axial pressure thrust.

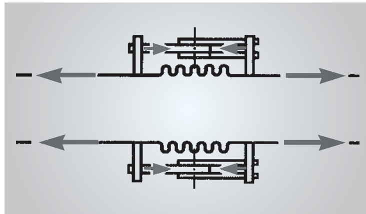


Fig. 12.4 Axial force at the angular expansion joint

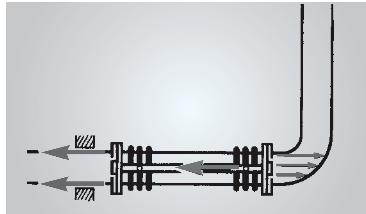


Fig. 12.5 Axial force at the lateral expansion joint

Pipe connection load

The pressure thrust acts on machines and aggregates via the pipe connectors, whereby different pipe connection loads result depending on the type of pipe connection. ***No other loads are considered here.***

Rigid pipe connection (Fig. 12.6)

- Longitudinal force equal to pressure thrust pulls at pipe connection (with internal over pressure)
- No load on foundation

Connection with restrained expansion joint or pressure-balanced expansion joint (Fig. 12.7)

- Longitudinal force equal to pressure thrust pulls at pipe connection (with internal over pressure)
- No load on foundation

Connection with axial expansion joint (Fig. 12.8)

- Connecting piece practically force-free
- Pressure thrust absorbed by supports

(12.4)
$$Q_A = Q_B = \frac{F_p}{2}$$
$$F_A = -F_B = F_p \frac{h}{c}$$

The problem which results when flexibly supported aggregates must be connected via axial expansion joints is apparent: the aggregate is tilted due to the applied force (see also Chapter 13).

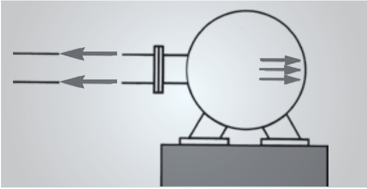


Fig. 12.6 Axial force on an aggregate with rigid pipe connection

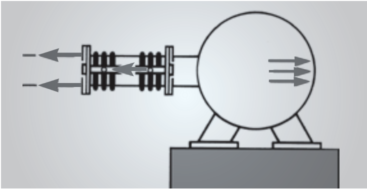


Fig. 12.7 Axial force on an aggregate with lateral expansion joint

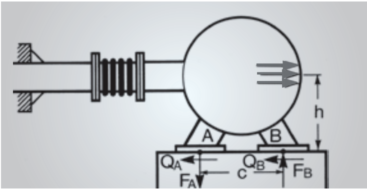


Fig. 12.8 Axial force on an aggregate with axial expansion joint

PRESSURE BALANCED DESIGNS

Since higher operating pressures and larger diameters can cause the axial pressure thrust to reach a level which makes it either uneconomical or impossible to size the anchors, restrained expansion joints (either angular or lateral expansion joints) are normally used to absorb the thermal expansion. In such cases, they always require the pipeline to be rerouted however, since their design does not permit axial movement. If it is undesirable to reroute the pipeline, or if it is impossible for reasons of space, ***straight-section tie rods*** or ***pressure balanced axial expansion joints*** can be used instead, depending on the plant-specific conditions.
Pressure balanced axial expansion joints are relatively complex designs, which should only be used if other, more economical alternatives are not viable. One possible reason for using them might be that they are designed to absorb additional, lateral movements, e.g. vibrations.
The ***elbow-connected pressure balanced expansion joint*** is a versatile variant of the pressure balanced design; in contrast with the designs described above, it requires the pipeline to be rerouted, but in exchange provides flexibility on all planes.

Straight-section tie rods

Vessels which must be connected together by a straight pipe – often at great heights – cannot absorb any significant axial pressure thrusts. An axial expansion joint and a straight-section tie rod which is adequately sized to cope with the pressure thrust may be the best answer (Fig. 12.9). The tie rods are almost always fixed and fitted by the customer. The full benefit is only obtained from the straight-section tie rod if the tie rods are located outside the insulation, in other words if they remain "cold", and if they are fitted in the centre of the vessels.
If differences in height must be compensated at the same time, hinge-supported restraint hardware and axial expansion joints which are adequately sized to cope with the total movement are necessary.

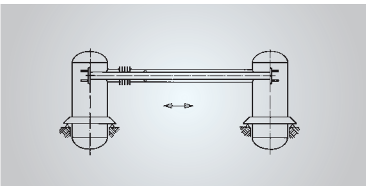


Fig. 12.9 Two containers connected together by a straight-section tie rod

Pressure balanced axial expansion joints

These designs compensate the axial pressure thrust by an additional pressure chamber, which can be either circular or toroidal and which is connected to the two diverging ends of the working bellows in opposite directions (Figs. 12.10 to 12.13).

Pressure thrust compensated via ***toroidal chamber*** with cross-section corresponding to effective cross-section A of working bellows

- Three bellows necessary
- No redirection of flow

Pressure thrust compensated via ***circular pressure chamber***

- Two identical bellows – in this case with pressure applied externally – permit full compensation of pressure thrust
- The flow is redirected

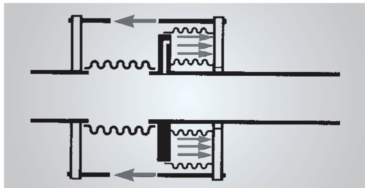


Fig. 12.10 Pressure balanced axial expansion joint. Toroidal chamber principle

Fig. 12.11 Pressure balanced axial expansion joint. Pressure chamber principle

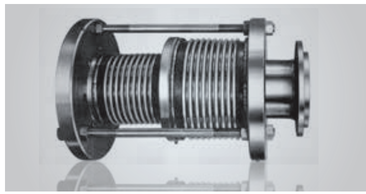


Fig. 12.12 Pressure balanced axial expansion joint, toroidal chamber principle, for chemical plant

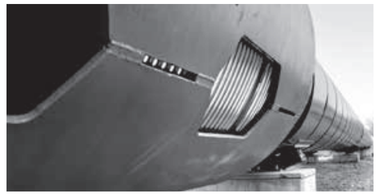


Fig. 12.13 Pressure balanced axial expansion joint, toroidal chamber principle, in district-heating pipe system DN 1000

Other designs based on the same principle are also possible, and have been implemented in numerous cases. Finally, the design is dictated by the requirements of the specific application. Our multi-ply bellows designs with their low adjusting forces have proved extremely useful, since either one or two additional bellows must now be deflected in comparison to a usual axial expansion joint. The axial adjusting force cannot be compensated in the manner of the pressure thrust and remains as a load on the anchors.

Elbow-connected pressure balanced expansion joints

This design exploits a rerouted pipeline by incorporating the expansion joint exactly at the "elbow". The axial pressure thrust is then compensated by means of an additional bellows, which is located outside the actual pipe and acts as a piston, thereby transferring its counter-force to the pipe connected via tie rods (Fig. 12.14).

The simplest type is the ***elbow-connected pressure balanced axial expansion*** joint with slight lateral flexibility (Fig. 12.14).

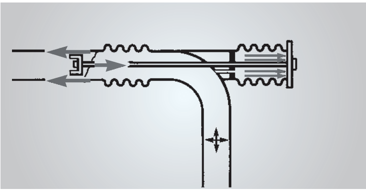


Fig. 12.14 Elbow-connected pressure balanced expansion joint (principle)

One example of how this design can be used in practice is ***to connect vessels*** if they perform only small vertical movements or if at larger vertical movements, the possibly staggered differential movement remains small enough. (Fig. 12.15).

Otherwise designs with greater lateral flexibility, provided by ***two working bellows***, must be used instead. (Fig. 12.16).

Elbow-connected pressure balanced lateral expansion joints can also be used in 3-dimensional systems if they are fitted with ***gimbal joints*** for flexibility in all planes.

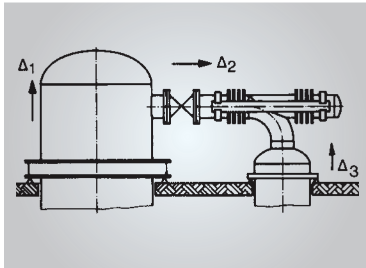


Fig. 12.15 Angle balanced axial expansion joint as vessel connection

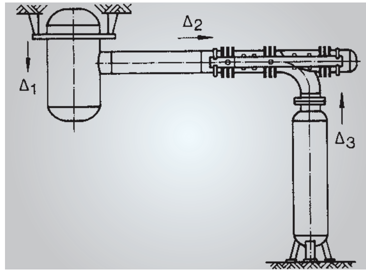
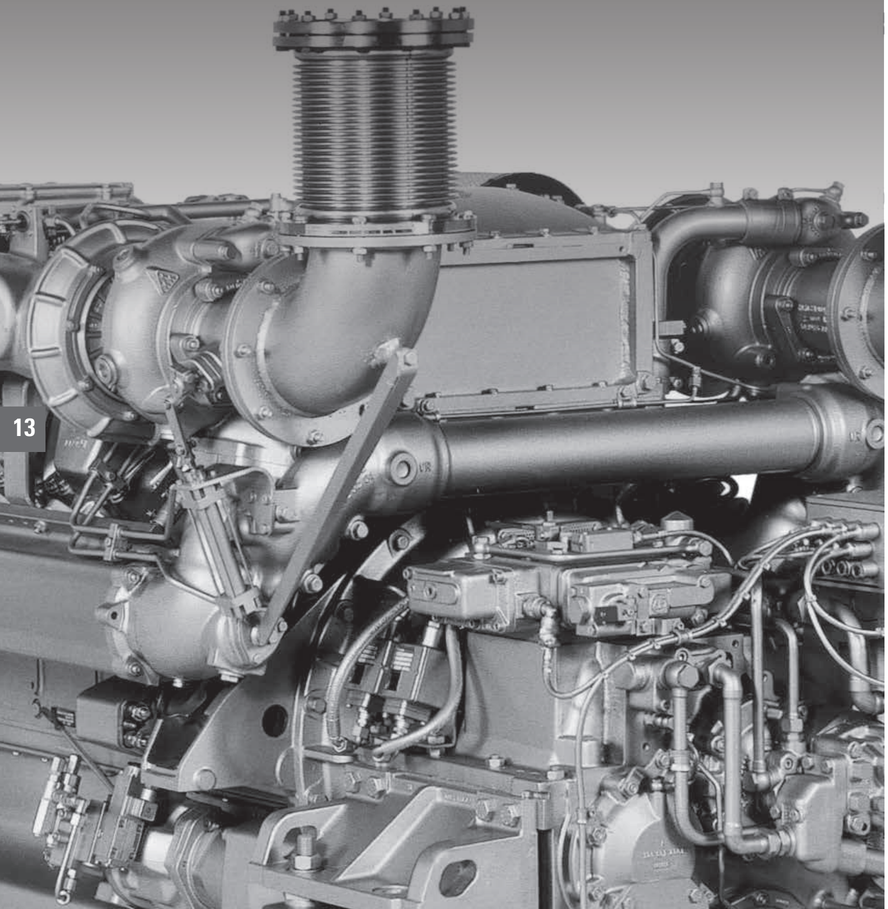


Fig. 12.16 Elbow-connected pressure balanced lateral expansion joint

VIBRATIONS AND SOUND

Hydrodynamic machines, piston engines and similar aggregates generate vibrations with differing frequencies and amplitudes according to their construction type as a result of the rotating or to-and-fro movement of their masses.



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Consequently, the pipes connected to them are also stimulated to vibrate, which can lead to material fatigue and damage. Damage is inevitable if resonance occurs in the connecting pipes. High-frequency vibrations moreover have an unpleasant side-effect in the form of noise, whilst low-frequency vibrations can be passed on via the foundations and the ground and cause damage in neighbouring constructions.
In order to prevent vibration damage and noise propagation the aggregates are flexibly supported and their connecting pipes are decoupled by means of flexible pipe elements. Metal hoses and expansion joints are used for this purpose. The most important criteria which should be considered when selecting an appropriate flexible element are as follows:

- **Dimensions of pipe connectors**
  Drilling pattern of flanges
  Diameter and thickness of weld ends
  Bolting (types and dimensions)
  Special connections
- **Operating data**
  Pressure
  Temperature
  Flow velocity
  Medium (possible impurities)
- **Permissible forces and torques**
  acting on the pipe connection
  acting on the entire aggregate (stability)
- **Thermal expansion, if this must also be absorbed**
- **Vibrations (sustained vibrations)**
- **Direction**
  Amplitude
  Frequency
- **Space available for installing flexible elements**
- **Anchors and guides for outgoing pipes**
  (possible capabilities)

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The ***connections*** used for vibration elements usually take the form of flanges according to EN 1092 or equivalent standards. Special flange designs are often necessary for engines due to the lack of space available.

The nominal pressure of the flexible pipe element can be determined from the ***operating data*** (pressure and temperature), taking the reduction factor into account. This data also effects the choice of materials for the corrugated section and for the connection parts (see Chapter 5, "Selecting an expansion joint").

The operating pressure is used additionally to calculate the axial pressure thrust which acts as a longitudinal force in all pressurized pipes. This force is released if an axial expansion joint is used, thereby placing a direct load both on the next support and on the aggregate (Fig. 13.1). This topic is discussed in more detail in Chapter 12, "Axial pressure thrust and pressure balanced designs".

It should be noted that the released ***axial pressure thrust*** acts on the interior wall of the housing which is opposite the pipe connector (Fig. 13.2), and that the flexibly supported aggregate may be tilted or displaced excessively, depending on the magnitude of the force. Since it determines the direction of the force and thus also its permissible magnitude, the position of the pipe connector is also important in addition to the weight of the machine and the elastic parameters of the support.

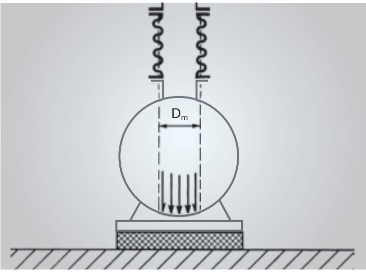


Fig. 13.1 Axial pressure thrust acting vertically on an aggregate

If lateral forces occur, the permissible ***connector loads*** should always be checked, especially if lateral expansion joints, which can only move in lateral direction, are installed. HYDRA lateral expansion joints with multi-ply bellows have relatively small lateral adjusting-force rates; however these rates may be to high for types designed for high operating pressures, due to friction, or very short total length, especially if thermal expansion must also be absorbed.

The medium which is conveyed also has an influence on the choice of materials if it is aggressive or contains aggressive components (see Chapter 5, "Selection of Expansion Joints").

Significant vibrations with amplitudes of 0.1 – 0.5 mm are generated primarily at piston engines due to the to-and-fro movement of their masses. Turbines, centrifugal pumps and turbo-compressors usually only generate vibrations with very small amplitudes –often in the audible frequency range –which are due to unbalance or to pressure differences at the blades.

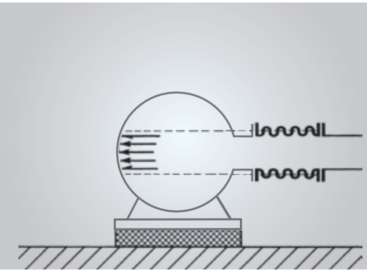


Fig. 13.2 Axial pressure thrust acting horizontally on an aggregate

In all machines the highest amplitudes are thus encountered in a plane which is perpendicular to the rotation axis. The requirements which must be met by the flexible elements, and on which the choice must be based, can therefore differ considerably according to the position of the pipe connections.

In addition to the vibration values during continuous operation, which necessitate highly durable elements, movement amplitudes which are often up to five times as high are likely during start-up, especially if the machine must pass through a critical speed range. These larger movements can generally be ignored when designing the flexible elements, since they are only allowed to occur for extremely short periods in the interests of gentle machine operation.

The first natural frequencies of the flexible elements should be higher than the excitation frequencies of the machine and sufficiently far away from them.

The elements used for ***sound insulating***, on the other hand, must have natural frequencies that are lower than the acoustic frequency, which is almost bound to be the case. Such elements can only provide insulation against structure-borne noise. Any noise conveyed in the medium (e.g. water) is normally not dampened to any significant extent by flexible connecting elements.

Braided HYDRA metal hoses and multi-ply HYDRA expansion joints, with their special design principle, have a sound insulating effect, which has been verified by means of tests. The multi-ply HYDRA axial expansion joints, for example, can provide insulation against structure-borne noise up to 20 dB. Thus, they are far superior to single-ply designs.

Pressure impulses in the medium, which may also deform the pipes or cause them to vibrate, cannot be eliminated using flexible elements. Viscous dampers must be used instead.

FLEXIBLE ELEMENTS FOR ABSORBING VIBRATIONS

Every all-metal flexible pipe element we supply for connecting to vibrating aggregates is pressure and temperature-resistant and absolutely leakproof. Our elements do not age, and if chosen and fitted correctly, have a practically unlimited service life.

Different types of flexible elements can be used, depending on specific requirements (Figs. 13.3 and 13.4). The table below lists the various possible designs and outlines the applications to which they are best suited for (Fig. 13.5). Differentiated evaluation of the individual case may allow deviations from the given reference values.

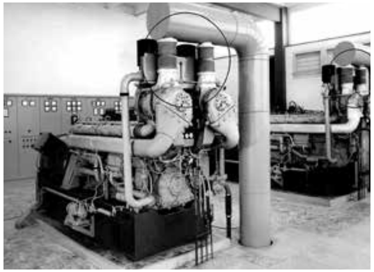


Fig. 13.3 Axial expansion joints used on superchargers of diesel engines

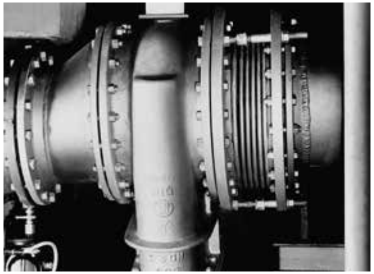
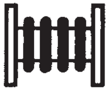
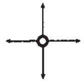
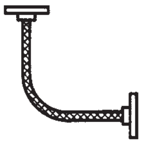
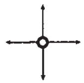
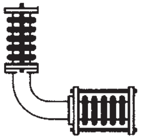
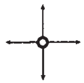
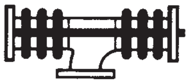
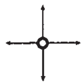


Fig. 13.4 Axial expansion joints used at pumps.

SUMMARY

Number	Flexible element		Approx. movement values		Nominal diameters DN	Pressure rating PN (max)
1		Axial expansion joint		All planes	15 – 100 150 – 1000 ≥ 1000	≤ 2.5 ≤ 1 unpressurized
2		Lateral expansion joints with braiding as restraint		Noise in all directions in circular plane	15 – 40	25
3		Lateral expansion joints with elastically supported tie rods (wire mesh cushions)		Noise in all directions in circular plane	50 – 500	25
4		Metal hose with 90° bend (See Metal Hose Manual No. 1301)		All planes	≤ 100	25
5		Lateral expansion joints with tie rods in 90° angular configuration		All planes	50 – 500	63
6		Elbow-connected balanced expansion joint (Special design on request)		All planes	50 – 500	63

Values higher than the approx. values are also possible

13

AXIAL EXPANSION JOINTS

The most economical element with the simplest design is the axial expansion joint. It can be used whenever the aggregate is able to withstand the axial pressure thrust specified in the table below for a common range (Fig. 13.6).

Nominal pressure PN	Nominal diameter DN						
	50	65	80	100	125	150	200
1	450	700	900	1350	2000	2800	4500
2.5	1100	1700	2200	3800	5000	7000	11200
6	2700	4100	5300	8100	12100	16750	66900
10	4500	6800	8800	13500	20100	27900	44800

Fig. 13.6
Axial pressure thrust in N: Values for larger dimensions and higher pressures are specified in the graph (Fig. 4.3) in Chapter 4, "Compensation types"

Vibration amplitude

The permissible vibration amplitude can be calculated from the axial movement:

Axial vibration amplitude

(13.1) $$\hat{a}_\delta = 0.03 \cdot 2\delta$$

Axial movement at temperature 2δ in mm ($2\delta = K_{\Delta\vartheta} \cdot 2\delta_N$)

Lateral vibration amplitude (one bellows)

(13.2) $$\hat{a}_\lambda = 0.01 \frac{l}{D_a} \cdot 2\delta$$

Corrugated length of bellows l in mm, outside diameter of bellows D_a in mm

The equations yield the maximum values for vibrations in one direction. Proportional values are permissible for vibrations in all planes.

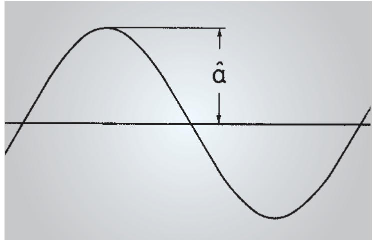


Fig. 13.7 Sinusoidal vibration

Thermal expansion

If thermal expansion must be absorbed in addition, the permissible values can be calculated in the usual way (see Chapter 5, "Selecting an expansion joint"), i.e. sustained vibrations need not be taken into account. This also applies to lateral movement, which can be calculated for axial expansion joints with single bellows according to the equation below:

Equivalent lateral movement

(13.3) $$2\lambda = 2\delta \cdot \frac{1}{3} \cdot \frac{l}{D_a}$$

Lateral spring rate

(13.4) $$c_\lambda = 1.5\, c_\delta \left(\frac{D_a}{l}\right)^2$$

Axial spring rate c_δ in N/mm (taken from dimension tables for axial expansion joints).
The expected pipe connection load can be determined on the basis of the spring rate (see Chapter 9, "Installation of expansion joints").

Guides and anchors

The diverting pipes of vibrating aggregates, which are decoupled by means of axial expansion joints, must be supported directly downstream of the expansion joint, whereby it is important for the fixture to be independent of the vibrating foundation. A support in the form of a fixed or sliding anchor must be sized so that it is capable of absorbing the axial pressure thrust in addition to the adjusting forces (Fig. 13.8). A sliding anchor should be used if lateral thermal expansions must be absorbed at the same time (Fig. 13.9).

13

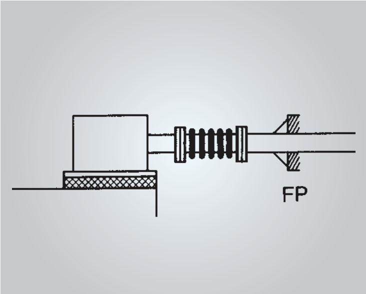


Fig. 13.8 Axial expansion joint at a vibrating aggregate, anchor

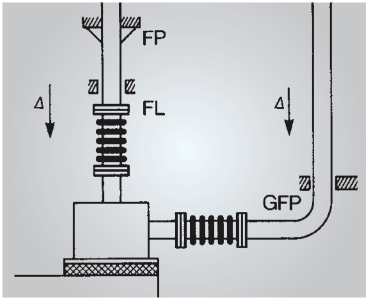


Fig. 13.9 Axial expansion joints at a vibrating aggregate, guides and anchors

Natural frequencies

The natural frequencies in the axial and radial directions are specified for the standard range of "axial expansion joints for low pressure". They only apply if the expansion joints are used for gaseous media. If other axial expansion joints are to be used to absorb vibrations, the calculation of the natural frequency must take into account whether a gas or liquid is to pass through the expansion joint, since this frequency also depends on the conveyed medium. We can calculate the natural frequencies for you on request.

Internal sleeve

The standard design of inner sleeves is not suitable for use in vibrating expansion joints, since they impede the lateral movement. If inner sleeves are necessary, e.g. in conjunction with high flow velocities (see Chapter 5, "Selection of Expansion Joints") or abrasive impurities in the flowing medium, specially designed expansion joints can be supplied with monolithic inner sleeves with a reduced diameter (Fig. 13.10).

13

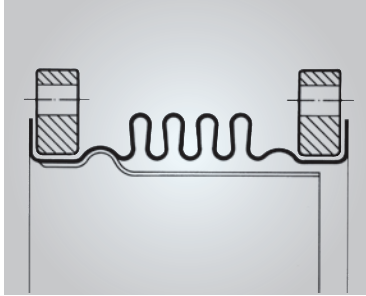


Fig. 13.10 Axial expansion joint with monolithic inner sleeve with reduced diameter

METAL HOSES

If the nominal diameters are sufficiently small at high pressures, i.e. up to approx. DN 100, braided metal hoses, where the braid absorbs the pressure thrust, provide a potential means of absorbing vibrations. If they are integrated in a 90° bend, they can absorb vibrations in all planes whilst producing only small adjusting forces.

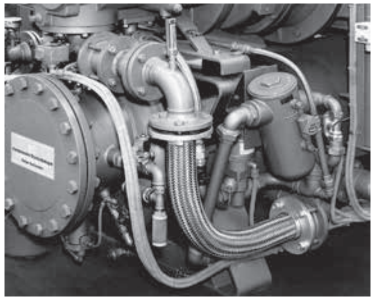


Fig. 13.11 Metal hose in 90° bend at a screw-type compressor

13

LATERAL-EXPANSION JOINTS

Lateral expansion joints are used at vibrating aggregates if the operating pressures are so high that an axial expansion joint can no longer be used due to the axial pressure thrust and a metal hose is no longer suitable because of the specified connection diameter or other parameters. If the vibrations only occur in one plane perpendicular to the axis of the pipe connector, a single expansion joint is sufficient, which has to be flexible in all directions in this plane. A design with spherically pivoted tie rods is suitable (Fig. 13.12 and 13.13).

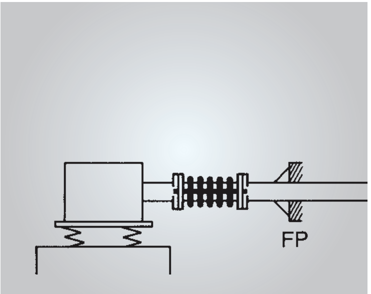


Fig. 13.12 Lateral expansion joint at vibrating aggregate

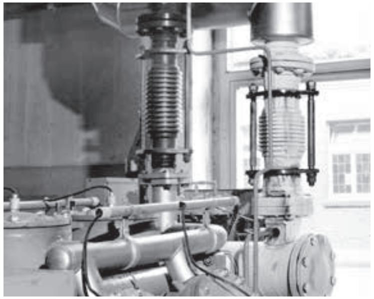


Fig. 13.13 Lateral expansion joints with tie rods at vibrating aggregate

If 3-dimensional movements occur in all directions, a second expansion joint must be installed perpendicular to the first. The additional expansion joint should be either an angular expansion joint (Fig. 13.14) or a lateral expansion joint (Fig. 13.15), depending on the magnitude of the vibration amplitudes and on potential thermal expansion which must be absorbed. If an angular expansion joint is used, it must be installed so that it can work together with the lateral expansion joint, i.e. the pipe bend must be able to execute tilting movements, and the lateral expansion joint must be designed to permit tilting movements at the associated flange.

If a second lateral expansion joint is used as the additional joint, the restraint hardware of the two expansion joints must be arranged at 90° against each other (Fig. 13.15).

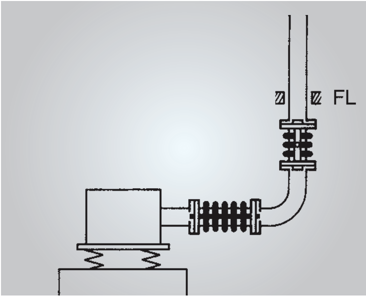


Fig. 13.14 Lateral and angular expansion joints at vibrating aggregate

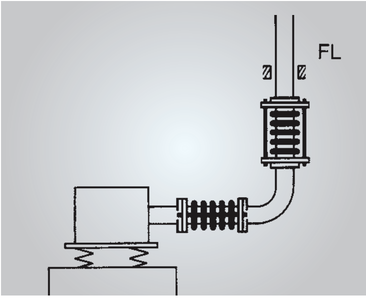


Fig. 13.15 Lateral expansion joints at vibrating aggregate

13

ELBOW-CONNECTED PRESSURE BALANCED EXPANSION JOINTS

Where appropriate elbow-connected pressure balanced expansion joints may be the best answer, since they can effect 3-dimensional vibrations in all planes with a small vibrating mass (Fig. 13.16).

This adapted special design is generally somewhat more expensive than the arrangement shown in Fig. 13.15.

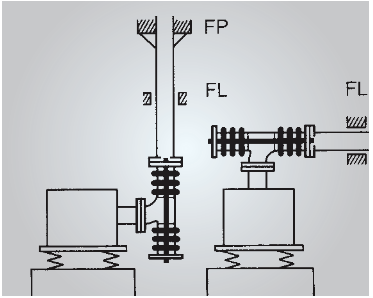


Fig. 13.16 Elbow-connected pressure balanced expansion joints at vibrating aggregate

SOUND INSULATING EXPANSION JOINTS

If lateral expansion joints must be used on account of the operating conditions as described above, the insulation does not necessarily prevent transmission of structure-borne noise, since the restraint hardware still transmits the sound despite the use of multi-ply bellows.

For small nominal diameters lateral expansion joints with braiding as restraint (Fig. 13.17) can be used, for large diameters specially developed HYDRA lateral expansion joints (LBS and LRS types); with sound insulating pivoted tie rods which ensure that the machine connection has the necessary noise isolation. The insulating cushions made of stainless-steel wire mesh which are used to support the tie rods are resistant to ageing and temperature, and are therefore able to maintain their technical characteristics almost entirely throughout the operating time, even at high temperatures (Fig. 13.18).

The permissible vibration amplitude for sustained vibrations is approximately 5 % of the movement values in one plane specified in the dimension tables for 1000 load cycles (δ, α, λ) for all expansion joints.
The flexible element should always be assembled as close as possible to the vibrating aggregate in order to prevent additional movements.

An anchor or a guide support, which is independent of the vibration bed, should be installed directly after the compensating element in order to reduce the free-swinging mass to a minimum. This largely prevents the risk of self oscillation.

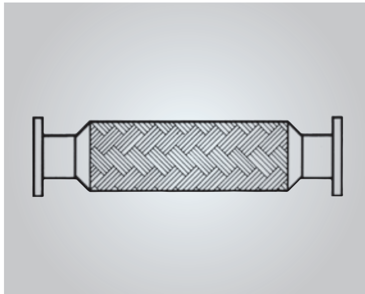


Fig. 13.17 Lateral expansion joints with small nominal diameters with braiding for absorbing vibrations (sound insulated)

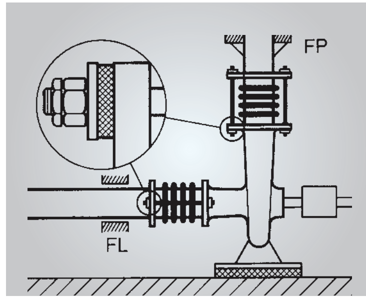
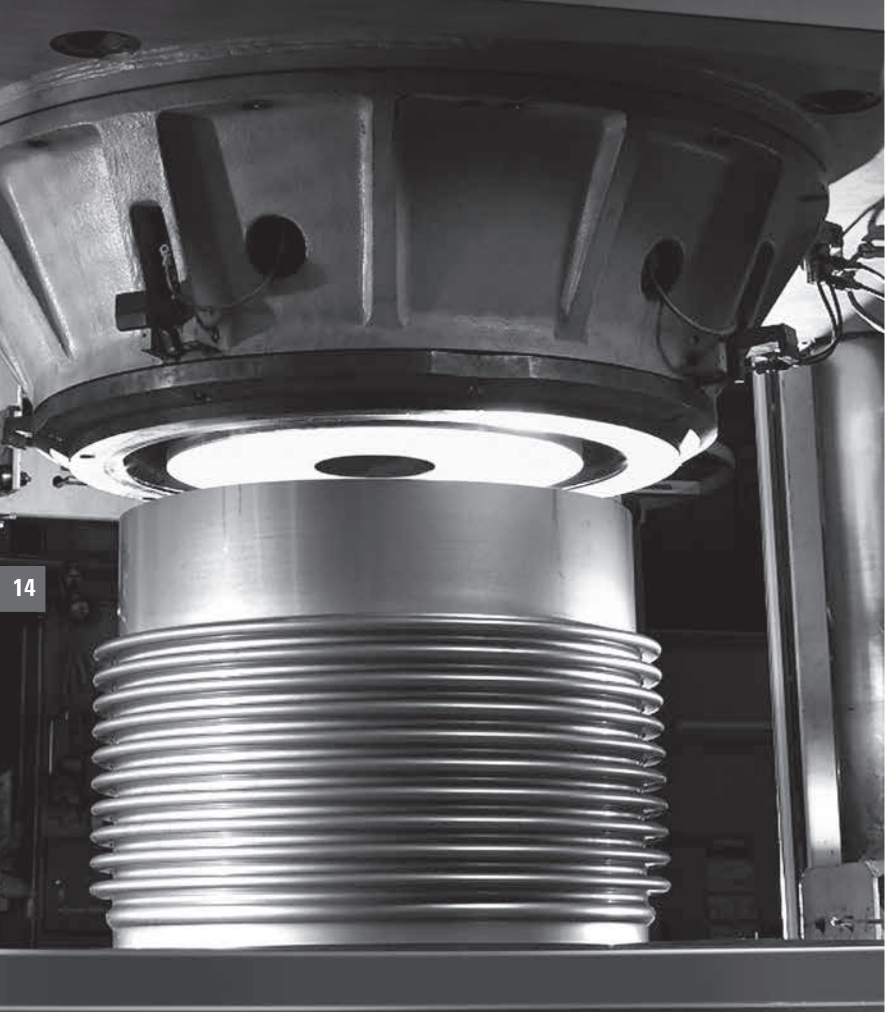


Fig. 13.18 Lateral expansion joints (sound insulating)

MANUFACTURING AND TESTING

Expansion joint manufacturing necessitates a mastery of two crucial procedures - bellows forming and welding engineering.



14

MANUFACTURING

Bellows forming

The bellows manufacturing process starts with the production of single or multi-ply cylinders, or cylinder packages using a readily formable material, predominantly austenitic stainless steel 1.4541.

To this end thin strips (0.3 to 2 mm) or sheets are firstly cut, then formed to a pre-rounded cylinder and in the last step longitudinal seam welded into a single cylinder. Multi-ply bellows are manufactured from several individual cylinders inserted into each other (cylinder packages)(Fig. 14.1).

During the forming of the cylinders or cylinder packages into bellows, circular corrugations are formed. The used forming procedures can be categorized into two basic procedures. Depending on the bellows geometry and the Nominal diameter either hydraulic or mechanical forming is used.

The hydraulic method applies a special forming emulsion under high pressure from the inside to a cylinder section which is divided up by means of external and internal tools. A corrugation is produced when the cylindrical section is formed in the circumferential direction as a result of the internal pressure. The material undergoes only the geometrical changes in the process and requires no follow-up treatment. This method is very gentle on the material.

Fig. 14.1 Cylinder packages

14

Elastomer forming is a variation of the hydraulic bellows-forming method, whereby the elastomer pad performs the task of the hydraulic fluid. The pad is pressed outwards by a movable tool, thereby forming the corrugation, which is then final-formed by recompression. This method is especially suitable for thick walls, and is used up to DN 1200. Automatic Presses with capacities up to 1000 tons are available.

Types of mechanical methods are roll forming and punching. Both are used primarily for medium and large diameter. For roll forming, several roll forming tools simultaneously form the bellows in a single process. For punching, corrugation after corrugation is radially shaped with segment tools. All bellows for expansion joints produced by Witzenmann are formed automatically. Circumferential weld seams on the corrugations are not necessary.

Beside the mentioned austenitic stainless steel 1.4541 other sufficiently formable materials, for which we have accumulated comprehensive know-how, can also be used to manufacture bellows, if the application so demands.

Welding engineering

Welding engineering is just as crucial to us as bellows forming. The above-mentioned longitudinal seam of the cylinder, which must survive the forming process without damage, is particularly important, together with the connection weld seam, which must join the bellows and the connection parts together pressure-tight. The nature of the connection weld seams differs according to the expansion joint design, the dimensions and the combination of materials. It is essential for the connection seam to be designed so that the expansion joint remains absolutely leakproof throughout its long operating time. The most suitable economic method should always be used to make weld seams. Methods such as Laser, TIG, MIG, MAG and submerged-arc welding, which are automated to a large extent, are also employed. These methods have been well tried and tested and are comprehensively backed up by welding procedures. Welding work is always performed by qualified welders based on predefined parameters. We apply the same care to the other weld seams, e.g. at the restraint hardware of the hinged expansion joints, some of which are located in the force flow and are therefore required to be of a correspondingly high quality.

INSPECTING AND MONITORING

Inspections are carried out to back up the quality of our expansion joints, parallel to the manufacturing process and independently of the manufacturing personnel. The most important test steps and inspections which we perform in standard cases are described below.

Standard incoming inspections

Stip and sheet metal material are subjected to an incoming inspection when they arrive at our factory, whose scope may differ according to the intended application. We check whether the requirements set out in our order specifications have been met.

- Certification
- Marking
- Material analysis
- Physical material values
- Dimensions / tolerances
- Surface finish

Accordingly the strip material is documented by an official inspection certificate according to EN 10204 - 3.1.

Production monitoring

The production process is constantly monitored by the company supervisory staff. In addition, the following random checks are performed by the quality department:

- Valid work instructions at workplace
- Up-to-date forming parameters for bellows production
- Valid welding parameters for longitudinal cylinder weld seams and connection seams
- Correct welding fillers
- Preheating temperatures
- Dimensional accuracy of components and assemblies

If any special requirements must be met, accompanying inspections may be performed by the quality department parallel to the manufacturing process.

14

Standard final inspections

The final inspections described below are performed for the finished expansion joints before they are delivered. These can be considered as part of the production process and do not entail any additional costs. They are documented internally.
Certification for these inspections can be provided in return for a refund of the purchase price if this is agreed when the order is placed.

Leak test

All expansion joints are usually tested for leaktightness. Different methods are used depending on the construction type, size and application of the expansion joint.

- **Nitrogen under water**
  The expansion joint is clamped in a test tank between two sealing plates and filled with nitrogen, pressure 2-4 bar. The tank is then flooded with water. After a suitably defined hold time, bubbling must not be detected (leakage rate less than 10^{-3} mbar l/s).

- **He sniffing method**
  A gas mixture comprising nitrogen and helium is applied to the sealed, clamped expansion joint (pressure approx. 2 bar), and it is sniffed at all critical points with an He sensor (leakage rate less than 10^{-5} mbar l/s).

- **Helium leakage test under vacuum**
  As a special inspection a Helium leakage test can be performed if required. The expansion joint is vacuumed from the inside and is expoused with Helium athmosphere from the outside. Helium can diffuse through smalles leakages to the inside and can be detacted (Leakage less than 10^{-9} mbar l/s)

Pressure test

Expansion joints are subjected to a pressure test in a test press if required.
The test pressure is calculated according to the following formula in Chapter 5 “Selection of Expansion Joints” as specified in the official regulations.

$$P_T = \max \begin{cases} 1.25 \cdot PS \cdot \frac{f_0}{f} \\ 1.43 \cdot PS \end{cases} \quad (5.11)$$

To reduce the axial forces in case of greater dimensions and higher pressures a stable inner pipe is clamped pressure-tight during the pressure test. If the available standard testing facilities are inadequate due to an extremely high pressure thrust, we recommend performing the pressure test for the expansion joint together with that of the plant. The expansion joint must not have any leaks or deformations which could give rise to doubts regarding safety.

Dimensional check

This checks the dimensional accuracy, in particular with regard to the installation and connection dimensions.

Visual inspection

This checks for visible defects or damage, especially to the corrugations of the bellows.

Tests and inspections, including the associated documentation, over and above the scope of those described here are possible. The necessary facilities are available. The scope of the tests should always be the subject of very careful thought and restricted to the necessary minimum for the particular application, since the costs of such tests may be extremely high and may easily exceed the value of the expansion joint.

MARKING, CORROSION PROTECTION, PACKAGING

15

MARKING

Our expansion joints are usually supplied with a permanent identification plate made of stainless steel, which contains the following information as a minimum:

- Witzenmann
- Pforzheim
- Serial number
- Type, PN, DN, movement
- Year of production

Expansion joints without connection parts (compensation bellows) are supplied with a sticker, tag or other marking instead of an identification plate.

Flanges and weld ends are marked separately, the data being embossed:

- **Flange**
  DN / PN / material / manufacturer’s identification mark
- **Weld ends**
  DN / material / manufacturer’s identification mark

Expansion joints in the low-pressure series do not normally have any identification plates and their flanges and weld ends are not marked. In the case of expansion joints requiring approval, the used parts and expansion joints are marked (identification plates) as agreed in the specification. Pretensioners and transportation fixtures, which must be removed after the expansion joint has been installed, are specially marked (indicated by additional stickers in a contrasting colour).

15

CORROSION PROTECTION

Standard designs
The bellows of our expansion joints, with the exception of a few special designs, are made exclusively of corrosion-resistant steels, mainly of austenitic stainless steel 1.4541 and do not normally require any type of corrosion protection.
The same applies to connection parts made of stainless steel. The ferrite steel parts of the expansion joints, such as flanges and restraint hardware (not weld ends) are protected externally with an anti-rust coating for transportation and short-term storage on the building site. Weld ends are either likewise painted or spray-oiled, depending on the construction type of the expansion joint. If they are painted, the welded area is masked. All ferrite steel parts are oiled from the inside where possible.

Custom-built designs
For special applications, or if requested by the customer the corrosion protection of the steel sections can be extended by agreement. Either a special paint, a plastic coating or galvanization may be used.

PACKAGING

Standard packaging
Unless otherwise agreed, the expansion joints are supplied with shock-proof packaging, in a box on a pallet or clamped on a pallet, depending on their size and weight. Only hinged expansion joints, whose bellows are protected by a cover, are normally clamped directly on pallets. The bellows protection, comprising corrugated cardboard and sheet metal, prevents damage from minor shocks and weld splatters. Large expansion joints are packed depending on the transportation route.

Transportation Fixtures
If, because of heavy connection parts, it is necessary transportation fixtures are attached, which maintain the size and form of the expansion joints and prevent them from vibrating during transportation. If metal parts are welded or bolted on for this purpose, they are identified by means of separate paint. These must be removed after installation.

Special packaging
Special packaging can be provided after arrangement either by Witzenmann or by specialised subcontractors instructed by us.

15

INSTALLATION INSTRUCTIONS

INSTRUCTIONS FOR THE INSTALLATION OF WITZENMANN EXPANSION JOINTS WITH FIXED OR LOOSE FLANGES

HYDRA expansion joints are maintenance-free. They are designed exclusively for the agreed conditions specified in the order. Long-term reliable operation is only guaranteed when they are properly incorporated and installed in systems and when they can operate without being damaged or hindered. See also „Installation of expansion joints“ in our manual.
Note: even restrained expansion joints can slightly expand or shorten elastically as a result of pressure thrust. This does not limit their function, as in a multi-hinge system the change in length can be absorbed by pipe bending or other expansion joints. Witzenmann can provide further information if necessary.

General installation instructions

- Check the expansion joint for any damage before installation.
- Handle the expansion joint with care – no harsh knocks or impacts – do not throw
- Do not attach chains or ropes to the bellows
- Protect the bellows against weld spatter and abrasion – cover with non-conductive material
- Prevent an electrical short-circuit by welding electrodes, earthing cables, etc. – the bellows may suffer irreparable damage
- Keep the bellows corrugations inside and outside free from foreign matter (dirt, cement, insulation material) – check before and after installation
- Before insulating with mineral wool, cover with sheet metal all around
- Do not use any insulation material
- containing corrosive substances
- Avoid excessive movements and torsion (twisting) at all, during installation and operation (Figure 16.1)

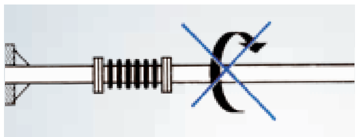


Fig. 16.1 Pipe with axial expansion joint

- Remove the marked pretensioning bracket and transport fixtures after installation – not before
- Before start-up, remove any protection and packaging materials, such as cardboard packaging, tape or plastic foil, which are not explicitly shown as being part of the expansion joint
- Make sure that the fixed points at the ends of pipeline sections containing an expansion joint are of adequate size. These must be able to withstand not only the axial pressure thrust (in unrestrained expansion joints), but also the adjustment force of the expansion joint and the friction forces of the pipe guides and supports - in particular the axial pressure thrust can be very large (Fig. 16.2).

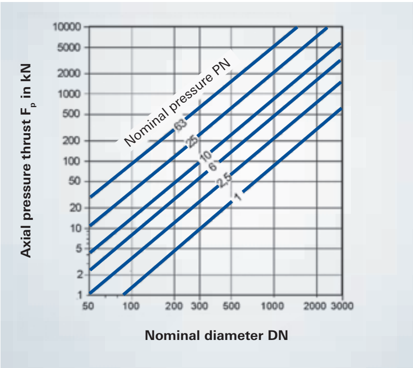


Fig. 16.2 Axial pressure thrust in a pipe with axial expansion joints

- Preload axial expansion joints and hinge systems after installation (when necessary and when agreed with Witzenmann) – usually 50 % of total movement – taking into account the direction of movement and the temperature during installation
- Before pressurising the pipeline, check that flange connections, guides, fixed and loose bearings have been installed correctly and are functioning properly
- A pressure test outside the system or a pressure test on expansion joints sealed with blind flanges is only permitted after consultation with Witzenmann
- The permissible test pressure and permissible deflection must not be exceeded under any circumstances

- Consider flow direction in expansion joints with internal sleeves
- After the pressure test remove liquid residues in the corrugations if necessary - these can lead to corrosion or steam explosions when increasing temperature rapidly

Installation instructions for axial and universal expansion joints

- Install only one axial expansion joint between two fixed points
- If several axial expansion joints are installed in a straight pipe section, subdivide the section by using (light) intermediate anchors
- Pipes with axial expansion joints must be guided. Guides are required on both sides of the axial expansion joint; a fixed point fulfils the guiding function. (See Fig. 16.3 and Fig. 16.4 and related codes for maximum distances)

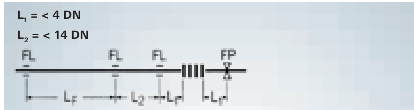


Fig. 16.3 Guide spacing of pipelines with axial expansion joints

- The incoming ends of the pipeline must be aligned at the position where the expansion joint is to be installed. Compensation of assembly tolerances by expansion joint deflection is only permitted after consultation with Witzenmann.
- When connected to vibrating equipment, secure the pipeline directly after the expansion joint

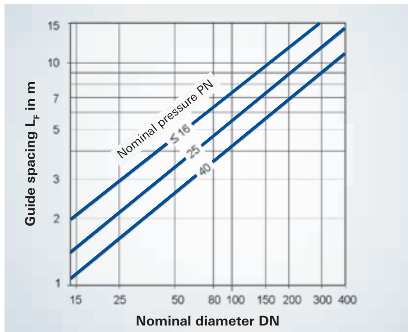


Fig. 16.4 Recommended spacing for pipe guides in pipelines with axial expansion joints

Installation instructions for restrained expansion joints

- Provide suitable pipe guides or supports close to the expansion joint system – take lateral movements in the pipes into account
- Make sure the rotation axes are correctly oriented during installation: parallel to each other and perpendicular to the direction of movement
- Make sure the orientation of the tie rods is appropriate for the function when installing lateral expansion joints (see „Installation of expansion joints“ in our manual!)
- The factory settings of tie rods with nuts must not be changed
- The weight of the pipeline must not be absorbed by expansion joints – no sagging pipes, no additional loads on the restraint hardware

General installation instructions

- Upon installing expansion joints with flanged connections it is essential to use the proper bolt torque when tightening the flange connection. Applying the proper torque will prevent the flanges from being subjected to critical stresses and at the same time guarantee the tightness of the flanged connection. Several national and international standards provide calculation schemes in order to obtain the proper bolt torque, which is a function of flange geometry, gasket properties and bolt tightening method.

Bolt tightening

- Calculate proper bolt torque acc. to appropriate standard
- Tighten the bolts in a „criss-cross“ sequence using the bolt tightening method that was taken into account in the calculation of the bolt torque

Installation of loose flanges

- For expansion joints with loose flanges, the bellows tangent is bended around the flange to form a rim. For technical reasons, there may be a small gap between the bended tangent and the flange, which however will neither compromise function nor tightness of the flanged connection. The elastic tangent will exert a uniform contact pressure on the gasket, pushing it against the counter flange. During bolt tightening, any remaining gap between the tangent and flange will vanish.
- For technical reasons, the sealing ridge diameter of expansion joints with loose flanges is limited and might therefor deviate from sealing ridge diameters as given in national or international standards for flanged connections. Accordingly, a standard gasket might overlap the sealing ridge diameter of the expansion joint. This is non-critical, even if the sharp-edged bellows tangent damages the rim of the gasket (only the inner part of the gasket is essential for the sealing effect). Cutting or grinding of the bellows tangent must be omitted in order to guarantee the function of the sealing surface.

Gasket

- Gaskets need to be replaced after each disassembly

MATERIALS

In chapter 17 you find the basic characteristics and properties of the materials used. Apart from the respective delivery form, this includes the limiting temperatures as well as strength values at ambient temperature.

The chemical composition of the materials as well as their strength at elevated temperatures are described afterwards. Finally, you will find a list of the material descriptions according to international specifications.

All information is supplied without guarantee.

DESIGNATION, FORMS OF DELIVERY, LIMITING TEMPERATURES

Material group	Material no. according to DIN EN 10027	Steel name according to DIN EN 10027	Steel name according to DIN (old)	Semi-finished	Documentation	Upper limiting tempera-ture °C
Non-alloy steel	1.0254	P235TR1	St 37.0	Welded tubes	DIN EN 10217-1	300
				seamless tubes	DIN EN 10216-1	
	1.0255	P235TR2	St 37.4	Welded tubes	DIN EN 10217-1	
				seamless tubes	DIN EN 10216-1	
	1.0427	C22G1	C 22.3	Flange	VdTÜV-WB 364	350
General construction steel	1.0038	S235JRG2	RSt 37-2	Steel bars, flat products, wire rod profiles	DIN EN 10025 AD W1	300
	1.0050	E295	St 50-2			
	1.0570	S355J2G3	St 52-3			
Heat resisting non-alloy steel	1.0460	C22G2	C 22.8	Flange	VdTÜV-WB 350	450
Heat-resisting steel	1.0345	P235GH	HI	Sheet metal	DIN EN 10028-2	480
				Seamless tube	DIN EN 10216	450
	1.0425	P265GH	HII	Sheet metal	DIN EN 10028-2	480
	1.0481	P295GH	17 Mn 4	Sheet metal	DIN EN 10028-2	500
	1.5415	16Mo3	15 Mo 3	Sheet metal	DIN EN 10028-2	530
				Seamless tube	DIN EN 10216-2	
	1.7335	13CrMo4-5	13CrMo4-4	Sheet metal	DIN EN 10028-2	570
				Seamless tube	DIN EN 10216-2	
	1.7380	10CrMo9-10	10 CrMo 9 10	Sheet metal	DIN EN 10028-2	600
				Seamless tube	DIN EN 10216-2	
Fine grain construction steel						
Normal	1.0562	P355N	StE 355	Sheet metal, metal strip, Steel bars	DIN EN 10028-3	
Heat resisting	1.0565	P355NH	WStE 355			400
Tough when cold	1.0566	P355NL1	TStE 355			(-50) [1]
Special	1.1106	P355NL2	EStE 355			(-60) [1]

[1] Lower limiting temperature

17

STRENGTH VALUES AT AMBIENT TEMPERATURE (MINIMUM VALUES [2])

Material no. according to DIN EN 10027	Yield strength min. R_{eH} MPa	Tensile strength R_m MPa	Elongation at break min. A_5 %	A_{80} %	Impact work min. KV [3] J	Remarks
1.0254	235	360 - 500	23			s ≤ 16
1.0255	235	360 - 500	23		at 0 °C: 27	s ≤ 16
1.0427	240	410 - 540	20 (transverse)		at 20 °C: 31	s ≤ 70
1.0038	235	340 - 470	21 - 26 [4]	17 - 21 [4]	at 20 °C: 27	3 ≤ s ≤ 100 (R_m)
1.0050	295	470 - 610	16 - 20 [4]	12 - 16 [4]		10 ≤ s ≤ 150 (KV)
1.0570	355	490 - 630	18 - 22 [4]	14 - 18 [4]	at -20 °C: 27	s < 16 (R_{eH})
1.0460	240	410 - 540	20		at 20 °C: 31	s ≤ 70
1.0345	235	360-480	25		at 0 °C: 27	s ≤ 16
	235	360-500	23		at 0 °C: 27	s ≤ 16
1.0425	265	410-530	23		at 0 °C: 27	s ≤ 16
1.0481	295	460-580	22		at 0 °C: 27	s ≤ 16
1.5415	275	440 - 590	22		at 20 °C: 31	s ≤ 16
	280	450 - 600	20		at 20 °C: 27	
1.7335	300	440 - 600	20		at 20 °C: 31	s ≤ 16
	290	440 - 590			at 20 °C: 27	
1.7380	310	480 - 630	18		at 20 °C: 31	s ≤ 16
	280		20		at 20 °C: 27	
1.0562	355	490-630	22		at 0 °C: 47	s ≤ 16
1.0565					at 0 °C: 47	s ≤ 16
1.0566					at 0 °C: 55	s ≤ 16
1.1106					at 0 °C: 90	s ≤ 16

[2] Smallest value from lateral and transverse test piece
[3] according to DIN EN 10045; average of 3 tests with DIN EN standards
[4] depending on product thickness

17

DESIGNATION, FORMS OF DELIVERY, LIMITING TEMPERATURES

Material group	Material no. according to DIN EN 10027	Steel name according to DIN EN 10027	Semi-finished	Documentation	Upper limiting temperature °C
Stainless ferritic steel	1.4511	X3CrNb17	Metal strip, sheet metal	DIN EN 10088	
				VdTÜV-WB 422	200
	1.4512	X2CrTi12	Metal strip, sheet metal	DIN EN 10088	350
				SEW 400	
Stainless austenitic steel	1.4301	X5CrNi18-10	Metal strip, sheet metal	DIN EN 10088-2	550 / 300 [5]
	1.4306	X2CrNi19-11	Metal strip, sheet metal	DIN EN 10088-2	550 / 350 [5]
	1.4541	X6CrNiTi18-10	Metal strip, sheet metal	DIN EN 10088-2	550 / 400 [5]
	1.4571	X6CrNiMoTi17-12-2	Metal strip, sheet metal	DIN EN 10088-2	550 / 400 [5]
	1.4404	X2CrNiMo17-12-2	Metal strip, sheet metal	DIN EN 10088-2	550 / 400 [5]
	1.4435	X2CrNiMo18-14-3	Metal strip, sheet metal	DIN EN 10088-2	550 / 400 [5]
	1.4565	X2CrNiMnMoNbN25-18-5-4	Metal strip, sheet metal	SEW 400	550 / 400 [5]
	1.4539	X1NiCrMoCu25-20-5	Sheet metal, metal strip,	DIN EN 10088-2	550 / 400 [5]
			Seamless tube	VdTÜV-WB 421	400
	1.4529	X1NiCrMoCuN25-20-7	Sheet metal, metal strip	DIN EN 10088-2	400
			Seamless tube	VdTÜV-WB 502	
Highly heat-resistant austenitic steel	1.4948	X6CrNi18-10	Sheet metal, metal strip	DIN EN 10028-7	600
			Forging	DIN EN 10222-5	
			Seamless tube	DIN EN 10216-5	400 [5]
	1.4958	X5NiCrAlTi31-20	Sheet metal, metal strip	DIN EN 10028-7	600
			Seamless tube	DIN EN 10216-5	400 [5]

[5] Limiting temperature at risk of intercrystalline corrosion

STRENGTH VALUES AT AMBIENT TEMPERATURE (MINIMUM VALUES [2])

Material no. according to DIN EN 10027		Yield strength min.		Tensile strength	Elongation at break min.		Impact work > 10 mm thickness, transverse min.	Remarks
					> 3 mm	< 3mm		
		$R_{p0.2}$	$R_{p1.0}$	R_m	Thickness A_5	Thickness A_{80}	KV	
		MPa	MPa	MPa	%	%	J	
1.4511		230		420 - 600		23		s ≤ 6
1.4512		210		380 - 560		25		s ≤ 6
1.4301	t	230	260	540 - 750	45	45	at 20 °C: 60	s ≤ 6
	l	215	245		43	40		
1.4306	t	220	250	520 - 670	45	45	at 20 °C: 60	s ≤ 6
	l	205	235		43	40		
1.4541	t	220	250	520 - 720	40	40	at 20 °C: 60	s ≤ 6
	l	205	235		38	35		
1.4571	t	240	270	540 - 690	40	40	at 20 °C: 60	s ≤ 6
	l	225	255		38	35		
1.4404	t	240	270	530 - 680	40	40	at 20 °C: 60	s ≤ 6
	l	225	255		38	35		
1.4435	t	240	270	550 - 700	40	40	at 20 °C: 60	s ≤ 6
	l	225	255		38	35		
1.4565	t	420	460	800 - 1000	30	25	at 20 °C: 55	s ≤ 30
1.4539	t	240	270	530 - 730	35	35	at 20 °C: 60	s ≤ 6
	l	225	255		33	30		
		220	250	520 - 720	40	40		
1.4529	t	300	340	650 - 850	40	40	at 20 °C: 60	s ≤ 50
	l	285	325		38	35		
		300	340	600 - 800	40	40	at 20 °C: 84	
1.4948	t	230	260	530 - 740	45	45	at 20 °C: 60	s ≤ 6
	t	195	230	490 - 690	35		at 20 °C: 60	s ≤ 250
	t	185	225	500 - 700	30		at 20 °C: 60	
1.4958	t	170	200	500 - 750	30	30	at 20 °C: 80	s ≤ 75
	t	170	200	500 - 750	30		at 20 °C: 80	

[2] Smallest value from lateral and transverse test piece
t = Test piece, transverse
l = Test piece, longitudinal

DESIGNATION, FORMS OF DELIVERY, LIMITING TEMPERATURES

Material group	Material no. according to DIN EN 10027[6]	Steel name according to DIN EN 10027	Trade name	Semi-finished	Documentation	Upper limiting temperature °C
Heat resistant steel	1.4828	X15CrNiSi20-12		Sheet metal, metal strip	DIN EN 10095 (SEW470)	900
	1.4876	X10NiCrAlTi32-20	INCOLOY 800	Metal strip, sheet metal, rod, seamless Tube, forging	SEW470	600
					VdTÜV-WB 412	
		X10NiCrAlTi32-20 H	INCOLOY 800 H		VdTÜV-WB 434	950
					DIN EN 10095	900
Nickel-base alloys	2.4858	NICr21Mo	INCOLOY 825	Metal strip, sheet metal	DIN 17750	
					VdTüV-WB 432	450
					DIN 17744 [7]	
	2.4816	NiCR15Fe	INCONEL 600	Metal strip, sheet metal	DIN EN 10095	1000
					VdTÜV-WB 305	450
			INCONEL 600 H		DIN 17750	
					VdTÜV-WB 305	450
					DIN 17742 [7]	
	2.4819	NiMo16Cr15W	HASTELLOY C-276	Metal strip, sheet metal	DIN 17750	
					VdTÜV-WB 400	450
					DIN 17744 [7]	
	2.4856	NiCr22Mo9Nb	INCONEL 625	Flat products, Metal strip, sheet metal	DIN EN 10095	900
					VdTÜV-WB 499	450
			INCONEL 625 H		DIN 17750	
					DIN 17744 [7]	
	2.4610	NiMo16Cr16Ti	HASTELLOY-C4	Metal strip, sheet metal	DIN 17750	
					VdTÜV-WB 424	400
					DIN 17744 [7]	
	2.4360	NiCu30Fe	MONEL	Metal strip, sheet metal	DIN 17750	
				Metal strip, sheet metal, Seamless tube, Forging	VdTÜV-WB 263	425
					DIN 17743 [7]	

[6] The material number DIN 17007 is valid for nickel-base alloys
[7] chemical composition

STRENGTH VALUES AT AMBIENT TEMPERATURE (MINIMUM VALUES [2])

Material no. according to DIN EN 10027[6]	Yield strength min.		Tensile strength	Elongation at break min.		Impact work min.	Remarks
	$R_{p0.2}$	$R_{p1.0}$	R_m	A_5	A_{80}	KV	
	MPa	MPa	MPa	%	%	J	
1.4828	230	270	500 - 750		28		Solution-annealed (+AT), s ≤ 3 mm
1.4876	210		500 - 750	22			soft-annealed (+A)
	210	240	500 - 750	30		at 20 °C: 150 [8]	
	170	200	450 -700	30			solution-annealed (+AT)
	170	210	450 - 680		28		
2.4858	240	270	≥ 550	30			soft-annealed (+A), F55, s ≤ 30 mm
	235	265	550 - 750		30	at 20 °C: 80	
2.4816	240		500 - 850		30		soft-annealed (+A), F55
	200	230	550 - 750	30		at 20 °C: 150 [8]	
	180	210	≥ 550		30		solution-annealed (+AT), (+AT), F50
	180	210	500 - 700	35		at 20 °C: 150 [8]	
2.4819	310	330	≥ 690	30			solution-annealed (+AT), F69, s ≤ 5 mm
	310	330	730 - 1000	30		at 20 °C: 96	
2.4856	415		820 - 1050		30		soft-annealed (+A), s ≤ 3 mm
	400	440	830 - 1000	30			soft-annealed (+A)
	275	305	≥ 690		30	at 20 °C: 100	solution annealed (+AT), F69
2.4610	305	340	≥ 690	40		at 20 °C: 96	solution-annealed (+AT), s ≤ 5
	280	315	700 - 900	40		at 20 °C: 96	5 < s ≤ 30
2.4360	175	205	≥ 450	30			soft-annealed (+A), F45, s ≤ 50
	175		450 - 600	30		at 20 °C: 120	soft-annealed (+A), F45

[2] Smallest value from lateral and transverse test piece
[6] The material number DIN 17007 is valid for nickel-base alloys
[8] Value a_k in J/cm^2

DESIGNATION, FORMS OF DELIVERY, LIMITING TEMPERATURES

Material group	Material no.	Designation according to	Semi-finished	Documentation	Upper limiting temperature
	according to DIN EN 1652				°C
Copper-based alloys	CW354H	CuNi30Mn1Fe	Metal strip, sheet metal	DIN-EN 1652 AD-W 6/2	350
Copper	CW024A	Cu-DHP	Metal strip, sheet metal	DIN-EN 1652 AD-W 6/2	250
Copper-tin alloys	CW452K	CuSn6	Metal strip, sheet metal	DIN-EN 1652	
Copper-zinc alloys	CW503L	CuZn20	Metal strip, sheet metal	DIN-EN 1652	
	CW508L	CuZn37	Metal strip, sheet metal	DIN-EN 1652	
	2.0402[9] (CW617N)	CuZn40Pb2	Metal strip, sheet metal	DIN 17670 DIN 17660	
	according to DIN EN 485-2				
Wrought aluminium alloys	EN AW-5754	EN AW-Al Mg3	Metal strip, sheet metal	DIN EN 485-2	
				DIN EN 575-3	
				AD-W 6/1	150 (AD-W)
	EN AW-6082	EN AW-Al Si1MgMn	Metal strip, sheet metal	DIN-EN 485-2 DIN-EN 573-3	
	according to DIN 17007				
Pure nickel	2.4068	LC-Ni 99	Metal strip, sheet metal	VdTÜV-WB 345	600
titanium	3.7025	Ti 1	Metal strip, sheet metal	DIN 17 850 DIN 17 860 VdTÜV-WB 230	250
Tantalum		Ta	Metal strip, sheet metal	VdTÜV-WB 382	250

[9] according to DIN 17670

STRENGTH VALUES AT AMBIENT TEMPERATURE (MINIMUM VALUES [2])

Material no.	Yield strength min.		Tensile strength	Elongation at break min.	Impact work min.	Remarks
	$R_{p0.2}$	$R_{p1.0}$	R_m	A_5	KV	
	MPa	MPa	MPa	%	J	
CW354H	≥ 120		350 - 420	35 [13]		R350 (F35) [11] 0.3 ≤ s ≤ 15
CW024A	≤ 100		200 - 250	42 [13]		R200 (F20) [11] s > 5 mm
	≤ 140		220 - 260	33 [14] / 42 [13]		R220 (F22) [11] 0.2 ≤ s ≤ 5 mm
CW452K	≤ 300		350 - 420	45 [14] 55 [13]		R350 (F35) [11] 0.1 ≤ s ≤ 5 mm
CW503L	≤ 150		270 - 320	38 [14] 48 [13]		R270 (F27) [11] 0.2 ≤ s ≤ 5 mm
CW508L	≤ 180		300 - 370	38 [14] 48 [13]		R300 (F30) [11] 0.2 ≤ s ≤ 5 mm
2.0402	≤ 300		≥ 380	35		- (F38) [12] 0.3 ≤ s ≤ 5 mm
EN AW-5754	≥ 80		190 - 240	14 (A50)		0.5 < s ≤ 1.5 mm Status: O / H111 DIN EN values
EN AW-6082	≤ 85		≤ 150	14 (A50)		0.4 ≤ s ≤ 1.5 mm Status: O ; DIN EN values
2.4068	≥ 80	≥ 105	340 - 540	40		
3.7025	≥ 180	≥ 200	290 - 410	30 / 24 [15]	62	0.4 < s ≤ 8 mm
TANTAL-ES	≥ 140		≥225	35 [10]		0.1 ≤ s ≤ 5.0, smelted with electronic beam
TANTALUM-GS	≥ 200		≥ 280	30 [10]		0.1 ≤ s ≤ 5.0, sintered in vacuum

[2] Smallest value from lateral and transverse test piece
[10] Gauge length lo = 25 mm
[11] Status description according to DIN EN 1652 or. (--) according to DIN 17670
[12] According to DIN, material not contained in the DIN EN 1652
[13] Details in DIN EN for s > 2.5 mm
[14] Elongation at break A50, details in DIN EN for s ≤ 2.5 mm
[15] A50 for thicknesses ≤ 5 mm

CHEMICAL COMPOSITION (PERCENTAGE BY MASS)

Material group	Material no.	Designation	C [16]	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other Elements
Non-alloy steel	1.0254	P235TR1	≤ 0.16	0.35	≤ 1.20	0.025	0.020	≤ 0.30	≤ 0.08	≤ 0.30	Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70
	1.0255	P235TR2	≤ 0.16	0.35	≤ 1.20	0.025	0.020	≤ 0.30	≤ 0.08	≤ 0.30	Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70 Al_{ges} ≥ 0.02
	1.0427	C22G1	0.18 - 0.23	0.15 - 0.35	0.4 - 0.9	0.035	0.03	≤ 0.30			Alges ≥ 0.015
General construction steel	1.0038	S235JRG2	≤ 0.17		≤ 1.40	0.045	0.045				N ≤ 0.009
	1.0050	E295				0.045	0.045				N ≤ 0.009
	1.0570	S355J2G3	≤ 0.20	0.55	≤ 1.6	0.035	0.035				Al_{ges} ≥ 0.015
Heat resisting non-alloy steel	1.0460	C22G2	0.18 - 0.23	0.15 - 0.35	0.4 - 0.90	0.035	0.030	≤ 0.30			
Heat-resisting steel	1.0345	P236GH	≤ 0.16	0.35	0.4 - 1.20	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	Nb,Ti,V Alges ≥ 0.020 Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70
	1.0425	P265GH	≤ 0.20	0.4	≤ 0.5	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	
	1.0481	P295GH	0.08 - 0.20	0.40	0.9 - 1.50	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	
	1.5415	16Mo3	0.12 - 0.20	0.35	0.4 - 0.90	0.03	0.025	≤ 0.30	0.25 - 0.35	≤ 0.30	Cu ≤ 0.3
	1.7335	13CrMo4-5	0.08 - 0.18	0.35	0.4 - 1.00	0.030	0.025	0.7 - 1.15	0.4 - 0.6		Cu ≤ 0.3
	1.7380	10 CrMo9-10	0.08 - 0.14	0.5	0.4 - 0.80	0.03	0.025	2 - 2.50	0.9 - 1.10		Cu ≤ 0.3
	1.0305	P235G1TH	≤ 0.17	0.1 - 0.35	0.4 - 0.80	0.040	0.040				

[16] The C content is dependent on the thickness. The values are for a thickness of ≤ 16 mm.

CHEMICAL COMPOSITION (PERCENTAGE BY MASS)

Material group	Material no.	Designation	C max.	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other Elements
Fine grain construction steel	1.0562	P355N	0.2	0.50	0.9 - 1.70	0.03	0.025	≤ 0.3	≤ 0.8	≤ 0.5	Al_{ges} ≥ 0,020 (s, DIN EN 10028-3) Cu, N, Nb, Ti, V Nb + Ti + V ≤ 0.12
	1.0565	P355NH	0.2	0.50	0.9 - 1.70	0.03	0.025	≤ 0.3	≤ 0.8	≤ 0.5	
	1.0566	P355NL1	0.18	0.50	0.90 - 1.70	0.030	0.020	≤ 0.3	≤ 0.8	≤ 0.5	
	1.1106	P355NL2	0.18	0.50	0.9 - 1.70	0.025	0.015	≤ 0.3	≤ 0.8	≤ 0.5	
Stainless ferritic steel	1.4511	X3CrNb17	0.05	1.00	≤ 1.0	0.040	0.015	16.0 - 18			Nb: 12 x %C - 1.00
	1.4512	X2CrTi12	0.03	1.00	≤ 1.0	0.04	0.015	10.5 - 12.5			Ti: 6 x (C+N) - 0.65
Stainless austenitic steel	1.4301	X5CrNi18-10	0.07	1.00	≤ 2.0	0.045	0.015	17.0 - 19.5		8.0 - 10.5	
	1.4306	X2CrNi19-11	0.03	1.00	≤ 2.0	0.045	0.015	18.0 - 20.0		10.0 - 12.0	
	1.4541	X6CrNiTi18-10	0.08	1.00	≤ 2.0	0.045	0.015	17.0 - 19.0		9.0 - 12.0	Ti: 5 x % C - 0.7
	1.4571	X6CrNiMoTi 17 12 2	0.08	1.00	≤ 2.0	0.045	0.015	16.5 - 18.5	2 - 2.5	10.5 - 13.5	Ti: 5 x % C - 0.7
	1.4404	X2CrNiMo 17 12 2	0.03	1.00	≤ 2.0	0.045	0.015	16.5 - 18.5	2.0 - 2.5	10.0 - 13.0	N ≤ 0.11
	1.4435	X2CrNiMo 18 14 3	0.03	1.00	≤ 2.0	0.045	0.015	17.0 - 19.0	2.5 - 3.0	12.5 - 15.0	
	1.4565	X2CrNiMnMoNbN2 5-18-5-4	0.04	1.00	4.50 - 6.5	0.030	0.015	21.0 - 25	3.0 - 4.5	15.0 - 18	Nb ≤ 0.30, N: 0.04 - 0.15
	1.4539	X1NiCrMoCu 25-20-5	0.02	0.70	≤ 2.0	0.030	0.010	19.00 - 21	4.0 - 5.0	24.0 - 26.0	Cu: 1.20- 2.00 N: ≤ 0.15
	1.4529	X2NiCrMoCuN 25-20-7	0.02	0.50	≤ 1.0	0.03	0.01	19.0 - 21.0	6.0 - 7.0	24 - 26	Cu: 0.5 - 1 N: 0.15 - 0.25

CHEMICAL COMPOSITION (PERCENTAGE BY MASS)

Material group	Material no.	Designation	C	Si	Mn	P max.	S max.	Cr	Mo	Ni	Other Elements
Highly heat-resistant austenitic steel	1.4948	X6CrNi18-10	0.04 - 0.08	≤ 1.00	≤ 2.0	0.035	0.015	17.0 - 19.0		8.0 - 11.0	
	1.4919	X6CrNiMo 17-13	0.04 - 0.08	≤ 0.75	≤ 2.0	0.035	0.015	16.0 - 18.0	2.0 - 2.5	12.0 - 14.0	
Heat-resistant steel	1.4828	X15CrNiSi 20-12	≤ 0.2	1.50 -2.00	≤ 2.0	0.045	0.015	19.0 - 21.0		11.0 - 13.0	N: ≤ 0.11
	1.4876 (DIN EN 10095)	X10NiCrAlTi32-21 INCOLOY 800H	≤ 0.12	≤ 1.0	≤ 2.0	0.030	0.015	19.0 - 23.0		30.0 - 34.0	Al: 0.15 - 0.60 Ti: 0.15 - 0.60
Nickel-base alloy	2.4858	NiCr21Mo INCOLOY 825	≤ 0.025	≤ 0.5	≤ 1.0	0.02	0.015	19.5 - 23.5	2.5 - 3.5	38.0 - 46.0	Ti, Cu, Al, Co ≤ 1.0
	2.4816	NiCr15Fe INCONEL 600 INCONEL 600 H	0.05 - 0.1	≤ 0.5	≤ 1.0	0.02	0.015	14.0 - 17.0		> 72	Ti, Cu, Al
	2.4819	NiMo16Cr15W HASTELLOY C-276	≤ 0.01	0.08	≤ 1.0	0.02	0.015	14.5 - 16.5	15 - 17	Residue	V, Co, Cu, Fe
	2.4856	NiCr22Mo9Nb INCONEL 625 INCONEL 625 H	0.03 - 0.1	≤ 0.5	≤ 0.5	0.02	0.015	20.0 - 23.0	8.0 - 10.0	> 58	Ti, Cu, Al Nb/Ta: 3.15 - 4.15 Co ≤ 1.0
	2.4610	NiMo16Cr16Ti HASTELLOY C4	≤ 0.015	≤ 0.08	≤ 1.0	0.025	0.015	14.0 - 18.0	14.0 - 17.0	Residue	Ti, Cu, Co ≤ 2.0
	2.4360	NiCu30Fe MONEL	≤ 0.15	≤ 0.5	≤ 2.0		0.02			> 63	Cu: 28 - 34 Ti, Al, Co ≤ 1.0
Cop-per-based alloy	CW354H	CuNi 30 Mn1 Fe CUNIFER 30	≤ 0.05		0.5 - 1.50		0.050			30.0 -32.0	Cu: residue, Pb, Zn

CHEMICAL COMPOSITION (PERCENTAGE BY MASS)

Material group	Material no.	Designation	Cu	Al	Zn	Sn	Pb	Ni	Ti	Ta	Other Elements
Copper	CW024A	Cu DHP	≥ 99.9								P: 0.015 - 0.04
Copper-tin alloy	CW452K	CuSn 6	Residue		≤ 0.2	5.5 - 7.0	≤ 0.2	≤ 0.2			P: 0.01 - 0.4, Fe: ≤ 0.1
Copper-Zinc alloy	CW503L	CuZn 20	79.0 - 81.0	≤ 0.02	Residue	≤ 0.1	≤ 0.05				
	CW508L	CuZn 37 Brass	62.0 - 64.0	≤ 0.05	Residue	≤ 0.1	≤ 0.1	≤ 0.3			
	2.0402	CuZn 40 Pb 2	57.0 - 59.0	≤ 0.1	Residue	≤ 0.3	1.5 - 2.5	≤ 0.4			
Wrought aluminium alloy	EN AW-5754	EN AW-Al Mg3	≤ 0.1	Residue	≤ 0.1				≤ 0.15		Si, Mn, Mg
	EN AW-6082	EN AW-Al Si1MgMn	≤ 0.1	Residue	≤ 0.2				≤ 0.1		Si, Mn, Mg
Pure nickel	2.4068	LC-Ni 99	≤ 0.025					≥ 99	≤ 0.1		C ≤ 0.02 Mg ≤ 0.15 S ≤ 0.01 Si ≤ 0.2
titanium	3.7025	Ti							Residue		N ≤ 0.05 H ≤ 0.013 C ≤ 0.06 Fe ≤ 0.15
Tantalum	-	Ta						≤ 0.01	≤ 0.01	Residue	

STRENGTH VALUES AT ELEVATED TEMPERATURES

Material no. according to DIN	Strength values in MPa															
	Type of value	Temperatures in °C														
		RT [17]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
1.0254	$R_{p\,0,2}$	235														
1.0255	$R_{p\,0,2}$	235														
1.0427	$R_{p\,0,2}$	220	210	190	170	150	130	110								
1.0038	$R_{p\,0,2}$	205	187		161	143	122						(values according to AD W1)			
1.0570	$R_{p\,0,2}$	315	254		226	206	186						(values according to AD W1)			
1.0460	$R_{p\,0,2}$	240	230	210	185	165	145	125	100	80						
	$R_{p\,1/10000}$								136	80	(53)					
	$R_{p\,1/100000}$								95	49	(30)		( ) = values at 480 °C			
	$R_{m\,10000}$								191	113	(75)					
	$R_{m\,100000}$								132	69	(42)					
1.0345	$R_{p\,0,2}$	206	190	180	170	150	130	120	110							
	$R_{p\,1/10000}$								136	80	(53)					
	$R_{p\,1/100000}$								95	49	(30)		( ) = values at 480 °C			
	$R_{m\,10000}$								191	113	(75)					
	$R_{m\,100000}$								132	69	(42)					
	$R_{m\,200000}$								115	57	(33)					
1.0425	$R_{p\,0,2}$	234	215	205	195	175	155	140	130							
	$R_{p\,1/10000}$								136	80	(53)					
	$R_{p\,1/100000}$								95	49	(30)		( ) = values at 480 °C			
	$R_{m\,10000}$								191	113	(75)					
	$R_{m\,100000}$								132	69	(42)					
	$R_{m\,200000}$								115	57	(33)					
1.0481	$R_{p\,0,2}$	272	250	235	225	205	185	170	155							
	$R_{p\,1/10000}$								167	93	49					
	$R_{p\,1/100000}$								118	59	29					
	$R_{m\,10000}$								243	143	74					
	$R_{m\,100000}$								179	85	41					
	$R_{m\,200000}$								157	70	30					
1.5415	$R_{p\,0,2}$	275	264	250	233	213	194	175	159	147	141					
	$R_{p\,1/10000}$									216	132	(84)				
	$R_{p\,1/100000}$									167	73	(36)	( ) = values at 530 °C			
	$R_{m\,10000}$									298	171	(102)				
	$R_{m\,100000}$									239	101	(53)				
	$R_{m\,200000}$									217	84	(45)				
1.7335	$R_{p\,0,2}$				230	220	205	190	180	170	165					
	$R_{p\,1/10000}$									245	157	(53)				
	$R_{p\,1/100000}$									191	98	(24)				
	$R_{m\,10000}$									370	239	(76)	( ) = values at 570 °C			
	$R_{m\,100000}$									285	137	(33)				
	$R_{m\,200000}$									260	115	(26)				

17) Ambient temperature values valid to 50 °C

17

STRENGTH VALUES AT ELEVATED TEMPERATURES

Material no. according to DIN	Strength values in MPa															
	Type of value	Temperatures in °C														
		RT [17]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
1.7380	$R_{p\,0,2}$				245	230	220	210	200	190	180					
	$R_{p\,1/10000}$									240	147	83	44			
	$R_{p\,1/100000}$									166	103	49	22			
	$R_{m\,10000}$									306	196	108	61			
	$R_{m\,100000}$									221	135	68	34			
	$R_{m\,200000}$									201	120	58	28			
1.0305	$R_{p\,0,2}$	235			185	165	140	120	110	105						
	$R_{p\,1/10000}$								136	80	(53)					
	$R_{p\,1/100000}$								95	49	(30)					
	$R_{m\,10000}$								191	113	(75)		( ) = values at 480 °C			
	$R_{m\,100000}$								132	69	(42)					
	$R_{m\,200000}$								115	57	(33)					
1.0565	$R_{p\,0,2}$	336	304	284	245	226	216	196	167							
1.4511	$R_{p\,0,2}$	230	230	220	205	190	180	165								
1.4512	$R_{p\,0,2}$	210	200	195	190	186	180	160								
1.4301	$R_{p\,0,2}$	215	157	142	127	118	110	104	98	95	92	90				
	$R_{p\,1}$		191	172	157	145	135	129	125	122	120	120				
1.4306	$R_{p\,0,2}$	205	147	132	118	108	100	94	89	85	81	80				
	$R_{p\,1}$		181	162	147	137	127	121	116	112	109	108				
1.4541	$R_{p\,0,2}$	205	176	167	157	147	136	130	125	121	119	118				
	$R_{p\,1}$		208	196	186	177	167	161	156	152	149	147				
1.4571	$R_{p\,0,2}$	225	185	177	167	157	145	140	135	131	129	127				
	$R_{p\,1}$		218	206	196	186	175	169	164	160	158	157				
1.4404	$R_{p\,0,2}$	225	166	152	137	127	118	113	108	103	100	98				
	$R_{p\,1}$		199	181	167	157	145	139	135	130	128	127				
1.4435	$R_{p\,0,2}$	225	165	150	137	127	119	113	108	103	100	98				
	$R_{p\,1}$		200	180	165	153	145	139	135	130	128	127				
1.4565	$R_{p\,0,2}$	420	350	310	270	255	240	225	210	210	210	200				
	$R_{p\,1}$	460	400	355	310	290	270	255	240	240	240	230				
1.4539	$R_{p\,0,2}$	220	205	190	175	160	145	135	125	115	110	105				
	$R_{p\,1}$		235	220	205	190	175	165	155	145	140	135				
	$R_{m\,(VdTÜV)}$	520	440	420	400	390	380	370	360							
1.4529	$R_{p\,0,2}$	300	230	210	190	180	170	165	160							
	$R_{p\,1}$	340	270	245	225	215	205	195	190							

17) Ambient temperature values valid to 50 °C

17

STRENGTH VALUES AT ELEVATED TEMPERATURES

Material no. according to DIN	Type of value	Strength values in MPa – Temperatures in °C														
		RT [17]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
1.4948	$R_{p\,0,2}$	230	157	142	127	117	108	103	98	93	88	83	78			
	$R_{p\,1}$	260	191	172	157	147	137	132	127	122	118	113	108			
	R_m	530	440	410	390	385	375	375	375	370	360	330	300			
	$R_{p\,1/10000}$										147	121	94	35		
	$R_{p\,1/100000}$										114	96	74	22		
	$R_{m\,10000}$										250	191	132	55		
	$R_{m\,100000}$										192	140	89	28		
	$R_{m\,200000}$										176	125	78	22		
1.4919	$R_{p\,0,2}$	205	177		147		127		118		108	103	98			
	$R_{p\,1}$	245	211		177		157		147		137	132	128			
	$R_{p\,1/10000}$											180	125	46		
	$R_{p\,1/100000}$											125	85	25		
	$R_{m\,10000}$											250	175	65		
	$R_{m\,100000}$											175	120	34		
1.4958	$R_{p\,0,2}$	170	140	127	115	105	95	90	85	82	80	75	75			
	$R_{p\,1}$	200	160	147	135	125	115	110	105	102	100	95	95			
	R_m	500	465	445	435	425	420	418	415	415	415					
	$R_{p\,1/10000}$												115	58		
	$R_{p\,1/100000}$	Values in brackets were determined by enhanced extrapolation											(85)	(40)		
	$R_{m\,10000}$										290	225	140	69		
	$R_{m\,100000}$										215	160	95	44		
	$R_{m\,200000}$										(196)	(143)	(83)	(38)		
1.4828	$R_{p\,0,2}$	230	205		180		160		150		140		130	DIN EN 14917		
	$R_{p\,1}$	270	245		220		205		190		180		170			
	R_m	550	470		430		410		400		370		320			
	$R_{p\,1/1000}$	DIN EN 10095											120	50	20	8
	$R_{p\,1/10000}$												80	25	10	4
	$R_{m\,1000}$												190	75	35	15
	$R_{m\,100000}$												120	36	18	8.5
	$R_{m\,100000}$												65	16	7.5	3.0
1.4876 solution-annealed (+AT)	$R_{p\,0,2}$	170	140		115		95		85		80		75	DIN EN 14917		
	$R_{p\,1}$	200	160		135		115		105		100		95			
	R_m	450	425		400		390		380		360		300			
	$R_{p\,1/1000}$	DIN EN 10095											130	70	30	13
	$R_{p\,1/10000}$												90	40	15	5
	$R_{m\,1000}$												200	90	45	20
	$R_{m\,100000}$												152	68	30	10
	$R_{m\,100000}$	DIN EN 14917											114	47	19	4
2.4858	$R_{p\,0,2}$	235	205	190	180	175	170	165	160	155						
	$R_{p\,1}$	265	235	220	205	200	195	190	185	180						
	R_m	550	530		515		500		490	485						

17) Ambient temperature values valid to 50 °C

STRENGTH VALUES AT ELEVATED TEMPERATURES

Material no. according to DIN	Type of value	Strength values in MPa – Temperatures in °C														
		RT [17]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
2.4816 DIN EN 10095	$R_{p\,0,2}$	200	180		165		155		150	145			soft-annealed (+A)			
	R_m	550	520		500		485		480	475						
		-750														
	$R_{p\,0,2}$	180	170		160		150		150	145			solution-annealed (+AT)			
	R_m	500	480		460		445		440	435						
		-700														
	$R_{p\,1/10000}$	soft-annealed (+A)									153		91	43	18	8
	$R_{p\,1/100000}$										126		66	28	12	4
	$R_{m\,1000}$												160	96	38	22
	$R_{m\,10000}$										297		138	63	29	13
	$R_{m\,100000}$										215		97	42	17	7
2.4819 VdTÜV-WB 400	$R_{p0,2}$	310	280		240		220		195							
	R_{p1}	330	305		275		215		200							
2.4856	$R_{p\,0,2}$	400	350		320		300		280	270		soft-annealed (+A), VdTÜV-WB 499				
	$R_{p\,1/100000}$	solution-annealed (+AT), manufacturer's figures for Inconel 625 H											250	90	30	10
	$R_{m\,100000}$												290	135	45	18
	$R_{m\,1000}$	soft-annealed (+A), DIN EN 10095												260	107	34
	$R_{m\,10000}$													190	63	20
2.4610	$R_{p\,0,2}$	305	285		255		245		225					s ≤ 5		
	$R_{p\,1}$	340	315		285		270		260							
2.4360	$R_{p\,0,2}$	175	150	140	135	132	130	130	130	(130)			( ) = values for 425 °C			
	R_m	450	420	400	390	385	380	375	370	(370)						
CW354H	$R_{p\,1}$	140	130	126	123	120	117	112								
	$R_{p\,1/10000}$				107	99	92	84								
	$R_{p\,1/100000}$				102	94	86	78								
	K/S [18]		93	87	84	82	80	78	75							
CW024A AD-W 6/2	$R_{p\,1}$	60	55	55									State R200			
	R_m	200	200	175	150	125										
	K/S [18]	57	57	50	43	36										
	$R_{p\,1}$	65	58	58									State R220			
	R_m	220	220	195	170	145										
	K/S [18]	63	63	56	49	41										
	$R_{p\,2/10000}$		58	53	46	37							State R200 + R220			
	$R_{p\,2/100000}$		56	49	40	30										
EN-AW 5754	$R_{p\,0,2}$	80	70													
	$R_{m\,100000}$		(80)	45												

17) Ambient temperature values valid to 50 °C
18) K/S = Permissible tension in accordance with AD-W 6/2 for 10^5 h

STRENGTH VALUES AT ELEVATED TEMPERATURES

Material no. according to DIN	Strength values in MPa															
	Type of value	Temperatures in °C														
		RT [17]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
2.4068 Nickel	$R_{p\,0,2}$	80	70		65		60		55		50		40			
	$R_{p\,1}$	105	95		90		85		80		75		65			
	R_m	340	290		275		260		240		210		150			
	$R_{p\,1/10000}$								75	55	35	19	10			
	$R_{p\,1/100000}$							85	60	40	23	11	6			
3.7025 titanium	$R_{p\,1}$	200	180	150	110	90										
	$R_{m\,10000}$	220	160	150	130	110										
	$R_{m\,100000}$	200	145	130	120	90										
Tantalum	$R_{p\,0,2}$	140	100	90	80	70							Tantalum-ES melted by electron beam			
	R_m	225	200	185	175	160	150									
	$A_{\,30[\%]}$	35														
	$R_{p\,0,2}$	200	160	150	140	130							Tantalum-GS Sintered in vacuum			
	R_m	280	270	260	240	230										
	$A_{\,30[\%]}$	25														

[17] Ambient temperature values valid to 50 °C

17

17

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	USA			Japan		
	Standard	UNS designation	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.0254	ASTM A 53	K02504 Grade A, type S	Welded and seamless black-oxidised and hot-dip galvanised steel pipes	JIS G 3445	STKM12A	Pipe for mechanical engineering
	ASTM A 519	K02504 Grade 1020	Seamless pipe	JIS G 3454	STPG370	Pipe for pressure vessels
	ASTM A 523	K02504 Grade B	Seamless, resistance welded pipe	JIS G 3457	STPY400	Welded pipe
1.0255	ASTM A106	Grade A	Seamless heat resisting pipe	JIS G 3455	STS 370	Pipe for pressure vessels
1.0038	ASTM A 500	K03000	Welded and seamless molded parts made of cold-formed steel			
1.0050	ASTM A 573	Grade 70	Sheet metal with improved toughness	JIS G 3101	SS490	General construction steels
1.0570	ASTM A105		Forging for pipelines	JIS G 3106	SM490YB	Steels for welded structures
	ASTM A 662	Grade C	Sheet metal for pressure vessels	JIS G 3106	SM520B	Steels for welded structures
1.0345	ASTM A 414	K02201 Grade A	Sheet metal for pressure vessels	JIS G 3115	SPV450	Sheet metal for pressure vessels
1.0425	ASTM A 414	K02505 Grade D	Sheet metal for pressure vessels	JIS G 3115	SPV355	Sheet metal for pressure vessels
1.0481	ASTM A 414	K02704 Grade F	Sheet metal for pressure vessels	JIS G 3118	SGV410	Sheet metal for pressure vessels
1.5415	ASTM A 204	K12320 Grade A	Sheet metal for pressure vessels	JIS G 3458	STPA12	pipes
1.7335	ASTM A 387	K11789 Grade 12	Sheet metal made of Cr-Mo alloy steel for pressure tanks	JIS G 3462	STBA22	Boiler and heat exchanger pipes
1.7380	ASTM A 387	K21590 Grade 22	Sheet metal made of Cr-Mo alloy steel for pressure tanks	JIS G 4109	SCMV4	Sheet metal for pressure vessels
1.0305	ASTM A 106	K02501 Grade A	Seamless heat resisting pipe	JIS G 3461	STB340	Pipe, boiler pipe
1.0562	ASTM A 299	K02803 Grade A	Sheet metal for pressure vessels	JIS G 3106	SM490 A;B;C	Steels for welded structures
	ASTM A 714	K12609 Grade II	Welded and seamless pipes made of high tensile, low-alloy steel	JIS G 3444	STK490	Pipes for general use
1.0565	ASTM A 633	K12037 Grade D	Sheet, high-strength			
	ASTM A 662	K12037 Grade C	Sheet metal for pressure vessels			
1.0566	ASTM A 662	K02701 Grade C	Sheet metal for pressure vessels	JIS G 3126	SLA365	Sheet for pressure vessels, low temperature

17

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	Korea			China		
	Standard	Designation	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.0254	KS D 3583	SPW 400	Welded pipes made of carbon steel			
1.0255	KS D 3562	SPPS 410	Carbon steel, pipelines for high-pressure applications	GB/T 5312	410	Seamless pipe for shipbuilding
1.0038				GB/T 700	Q235B U12355	(non-alloy construction steels)
1.0050	KS D 3503	SS 490	General construction steels	GB/T 700	Q275 U12752	(non-alloy construction steels)
1.0570	KS D 3517	STKM 16C	Non-alloy steel pipes for general mechanical engineering	GB 6654	16MnR L20162	Sheet metal for pressure vessels
				GB/T 8164	16Mn L20166	Metal strip for welded pipes
1.0345	KS D 3521	SPPV 450	Steel plates for pressure vessels for medium working temperatures	GB 6654	20R	Sheet metal for pressure vessels
1.0425	KS D 3521	SPPV 315	Steel plates for pressure vessels for medium working temperatures	GB/T 713	22Mng	Steel sheets for boilers and pressure vessels
1.0481						
1.5415	KS D 3572	STHA 12	Pipes for boilers and heat exchangers	GB 5310	15MoG A65158	Seamless pipes for pressure tanks
1.7335	KS D 3572	STHA 22	Pipes for boilers and heat exchangers	YB/T 5132	12CrMo A30122	Sheet metal for alloy construction steels
1.7380	KS D 3543	SCMV 4	Cr-Mo steel for pressure vessels	GB 5310	12Cr2MoG A30138	Seamless pipes for pressure tanks
1.0305				GB/T 5312	360	Seamless pipe for shipbuilding
1.0562						
1.0565						
1.0566	KS D 3541	SLA 1 360	Steel plates for pressure vessels (low temperature)	GB/T 714	Q420q-D L14204	Steels for bridge building

17

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	USA			Japan		
	Standard	UNS designation	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.1106	ASTM A 707	K12510 Grade L3	Forged flanges made of alloy and non-alloy steel for use at low temperatures	JIS G 3444	STK490	Pipes for general use
1.4511				JIS G 4305	SUS430LX	Cold-rolled sheet metal, steel plates and metal strip
1.4512	ASTM A 240	S40900 409	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4312	SUH409L	Sheet metal, rust-resistant, heat resistant
1.4301	ASTM A 240	S30400 304	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS304	Cold-rolled sheet metal, steel plates and metal strip
1.4306	ASTM A 240	S30403 304L	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS304L	Cold-rolled sheet metal, steel plates and metal strip
1.4541	ASTM A 240	S32100 321	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS321	Cold-rolled sheet metal, steel plates and metal strip
1.4571	ASTM A 240	S31635 316Ti	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS316Ti	Cold-rolled sheet metal, steel plates and metal strip
1.4404	ASTM A 240	S31603 316L	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS316L	Cold-rolled sheet metal, steel plates and metal strip
1.4435	ASTM A 240	S31603 316L	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS316L	Cold-rolled sheet metal, steel plates and metal strip
1.4565	ASTM A 240	S34565	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks			
1.4539	ASTM A 240	N08904 904L	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks	JIS G 4305	SUS890L	Cold-rolled sheet metal, steel plates and metal strip
1.4529	ASTM A 240	N08925	Sheet metal and metal strip made of heat-resistant, stainless steel Cr and Cr-Ni steel for pressure tanks			

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	Korea			China		
	Standard	Designa-tion	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.1106				GB 6654	16MnR L20163	Sheet metal for pressure vessels
1.4511	KS D 3698	STS 430LX	Cold-rolled sheet metal, steel plates and metal strip			
1.4512				GB /T 3280	022Cr11NbTi S11168	Hot-rolled sheet metal made of heat-resistant steel, ferritic
1.4301	KS D 3698	STS 304	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	06Cr19Ni10 S30408	Cold-rolled sheet metal and metal strips, austenitic
1.4306	KS D 3698	STS 304L	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	022Cr19Ni10 S30403	Cold-rolled sheet metal and metal strips, austenitic
1.4541	KS D 3698	STS 321	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	06Cr18Ni11Ti S32168	Cold-rolled sheet metal and metal strips, austenitic
1.4571	KS D 3698	STS 316Ti	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	06Cr17Ni12Mo2Ti S31668	Cold-rolled sheet metal and metal strips, austenitic
1.4404	KS D 3698	STS 316L	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	022Cr17Ni12Mo2 S31603	Cold-rolled sheet metal and metal strip, austenitic
1.4435	KS D 3698	STS 316L	Cold-rolled sheet metal, steel plates and metal strip	GB /T 3280	022Cr17Ni12Mo2 S31603	Cold-rolled sheet metal and metal strips, austenitic
1.4565				GB /T 3280	022Cr24Ni-17Mo5Mn6NbN	Cold-rolled sheet metal and metal strips, austenitic
1.4539				GB /T 3280	015Cr21Ni-26Mo5Cu2	Cold-rolled sheet metal and metal strips, austenitic
1.4529	KS D 3698	STS 317J5L	Cold-rolled sheet metal, steel plates and metal strip			

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	USA			Japan		
	Standard	UNS designation	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.4948	ASTM A 240	S30409 304H	Sheet metal and metal strip made of heat-resistant, non-rusting Cr and Cr-Ni steel for pressure tanks			
1.4919	ASTM A 240	S31609 316H	Sheet metal and metal strip made of heat-resistant, non-rusting Cr and Cr-Ni steel for pressure tanks			
1.4958	ASTM A 240	N08810	Sheet metal and metal strip made of heat-resistant, non-rusting Cr and Cr-Ni steel for pressure tanks			
1.4828	ASTM A 167	S30900 309	Sheet metal and metal strip made of non-rusting, heat-resistant Cr-Ni steel	JIS G 4312	SUH309	Heat-resistant sheet metals and steel plates
1.4876	ASTM A 240	N08800 800H	Sheet metal and metal strip made of heat-resistant, non-rusting Cr and Cr-Ni steel for pressure tanks	JIS G 4902	NCF800	Special alloys in sheet metals
2.4858	ASTM B 424	N08825	Sheet metal and metal strips made of Ni-Fe-Cr-Mo-Cu alloys (UNS N08825 and N08221)	JIS G 4902	NCF825	Special alloys in sheet metals
2.4816	ASTM B 168	N06600	Sheet metal and metal strips made of Ni-Cr-Fe, and Ni-Cr-Co-Mo alloys (UNS N06600 and N06690)			
2.4819	ASTM B 575	N10276	Sheet metal and metal strips made of low Ni-Mo-Cr alloys			
2.4856	ASTM B 443	N06625	Sheet metal and metal strips made of Ni-Cr-Mo-Nb alloy (UNS N06625)	JIS G 4902	NCF625	Special alloys in sheet metals
2.4610	ASTM B 575	N06455	Sheet metal and metal strips made of low Ni-Mo-Cr alloys			
2.4360	ASTM B 127	N04400	Sheet metal and metal strips made of Ni-Cu alloy (UNS N04400)	JIS H 4551	NW4400	Sheet metals and metal strips made of nickel and nickel alloy

MATERIAL DESCRIPTIONS ACCORDING TO INTERNATIONAL SPECIFICATIONS

Material no. according to DIN EN	Korea			China		
	Standard	Designation	Semi-finished product/ application/title	Standard	Designation	Semi-finished product/ application/title
1.4948				GB /T 3280	07Cr19Ni10	Cold-rolled sheet metal and metal strips, austenitic
1.4919						
1.4958						
1.4828	KS D 3732	STR 309	Heat-resistant sheet metals and steel plates	GB/T 4238	16Cr23Ni13 S38210	Heat-resistant steels; austenitic
1.4876	KS D 3532	NCF 800	Special alloys in sheet metal and steel plates	GB/T 15007	NS 111 H01110	Rustproof alloys
2.4858	KS D 3532	NCF 825	Special alloys in sheet metal and steel plates	GB/T 15007	NS 142 H01402	Rustproof alloys
2.4816				GB/T 15007	NS 3102 H06600	Rustproof alloys
2.4819				GB/T 15007	NS 3304 H10276	Rustproof alloys
2.4856	KS D 3532	NCF 625	Special alloys in sheet metal and steel plates	GB/T 15007	NS 3306 H06625	Rustproof alloys
2.4610				GB/T 15007	NS 3305 H06455	Rustproof alloys
2.4360				GB/T 15007	NS6400 H04400	Rustproof alloys

CORROSION RESISTANCE

Basic principles
Flexible metal elements are basically suitable for the transport of critical fluids if a sufficient resistance is ensured against all corrosive media that may occur during the entire lifetime. The flexibility of the corrugated elements like bellows or corrugated hoses generally require their wall thickness to be considerably smaller than that of all other parts of the system in which they are installed. As therefore increasing the wall thickness to prevent damages caused by corrosion is not reasonable, it becomes essential to select a suitable material for the flexible elements which is sufficiently resistant. Special attention must be paid to all possible kinds of corrosion, especially pitting corrosion, intercrystalline corrosion, crevice corrosion, and stress corrosion cracking, (see Types of corrosion). This leads to the fact that in many cases at least the ply of the flexible element that is exposed to the corrosive fluid has to be chosen of a material with even higher corrosion resistance than those of the system parts it is connected to (see Resistance table).

Types of corrosion
According to EN ISO 8044, corrosion is the "physicochemical interaction between a metal and its environment that results in changes in the properties of the metal, and which may lead to significant impairment of the function of the metal, the environment, or the technical system, of which these form a part. This interaction is often of an electrochemical nature". Different types of corrosion may occur, depending on the material and on the corrosion conditions. The most important corrosion types of ferrous and non-ferrous metals are briefly described below.

Uniform surface corrosion
A general corrosion proceeding at almost the same rate over the whole surface. The loss in weight which occurs is generally specified either in g/m^2h or as the reduction in the wall thickness in mm/year. This type of corrosion includes the corrosion which commonly is found on unalloyed steel (e. g. caused by oxidation in the presence of water). Stainless steels can only be affect by uniform corrosion under extremely unfavourable conditions, e.g. caused by liquids, such as acids, bases and salt solutions.

Pitting corrosion

Under certain conditions, attacks in limited areas can be described as pitting corrosion due to their appearance. The attack occurs from the effect of chlorine, bromine or iodine ions, particularly when present in watery solutions. This form of corrosion or the resulting selective attack is not calculable in comparison with surface corrosion and for that reason it can only be mastered using an appropriate selection of materials. With stainless steels, the resistants relating to pitting corrosion increases with rising molybdenum content in the chemical composition of the material. The so-called pitting resistant equivalent (PRE = Cr % + 3.3 · Mo % + 30 N %) can be used to compare roughly the resistants of the materials in relation to pitting corrosion; the higher the cumulated
reaction value, the greater the resistants.

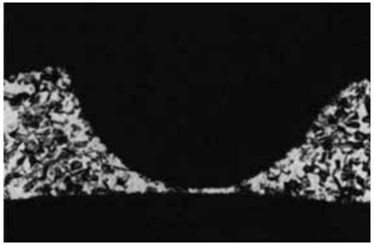


Fig. 18.1 Pitting corrosion on a cold strip made of austenitic steel. Sectional view (50-fold enlargement).

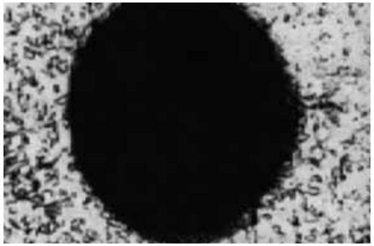


Figure 18.2 Sectional view (50-fold enlargement).

Intergranular corrosion

Intergranular corrosion is a localised, selective corrosion, which primarily attacks the grain boundaries. This type of corrosion is caused by separation in the material structure, which leads to a reduction in corrosion resistance in the areas near to the grain boundaries. This form of corrosion can lead in stainless steels to complete disinte gration of the grain bond (intergranular attack).

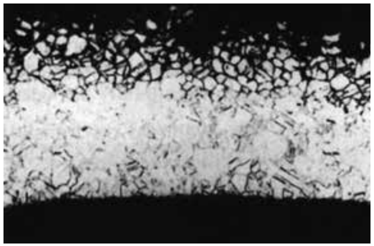


Figure 18.3 Intercrystalline corrosion (intergranular attack) in material 1.4828. Sectional view (100-fold enlargement).

These sensitization processes are dependent on temperature and time in CrNi alloys, whereby the critical temperature range is between 550 and 650 °C and the period up to the onset of the sensitization processes differs according to the type of steel. This must be taken into account, for example, when welding thick-walled parts with a high thermal capacity. These deposit-related changes in the structure can be reversed by means of solution annealing (1000 – 1050 °C). This type of corrosion can be avoided by using stainless steels with low carbon content (≤ 0.03 % C) or containing elements, such as titanium or niobium. For our products made of stainless steels this may be stabilized material qualities like 1.4541, 1.4571 or low-carbon qualities like 1.4404, 1.4306. The resistance of materials to intergranular corrosion can be verified by a standardized test (Monypenny - Strauss test according to ISO 3651-2). Certificates to be delivered by the material supplier, proving resistant to intergranular corrosion according to this test are therefore asked for in order and acceptance test specifications.

Stress corrosion cracking

This type of corrosion is observed most frequently in austenitic materials, subjected to tensile stresses and exposed to a corrosive agent. The most important agents are alkaline solutions and those containing chloride. The crack configuration can be transgranular or intergranular. Whereas the transgranular form only occurs at temperatures higher than 50 °C (especially in solutions containing chloride), the intergranular form can be observed already at room temperature in austenitic materials in a neutral solutions containing chloride.

At temperatures above 100 °C stress corrosion cracking (SCC) can already be caused by very small concentrations of chloride or lye – the latter always leads to the transgranular form. Stress corrosion cracking takes the same forms in non-ferrous metals as in austenitic materials. Damage caused by intergranular stress corrosion cracking can occur in nickel and nickel alloys in highly concentrated alkalis at temperatures above 400 °C, and in solutions or water vapour containing hydrogen sulphide at temperatures above 250 °C. A careful choice of materials based on a detailed knowledge of the existing operating conditions is necessary to prevent from this type of corrosion damage.

Crevice corrosion

Owing to the risk of crevice corrosion design and applications should be avoided which represent crevice or encourage deposits.

The resistance of high-alloy steels and Ni-based alloys to this type of corrosion increases in line with the molybdenum content of the materials. Again pitting resistance equivalent (PRE) (see Pitting corrosion) can be taken as criteria for assessing the resistance to crevice corrosion.

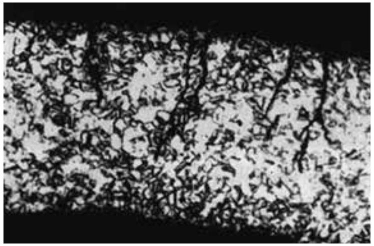


Figure 18.4 Transgranular stress corrosion cracking on a cold strip made of austenitic steel. Sectional view (50-fold enlargement).

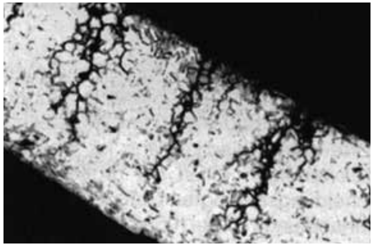


Figure 18.5 Intergranular stress corrosion cracking on a cold strip made of austenitic steel. Sectional view (50-fold enlargement).

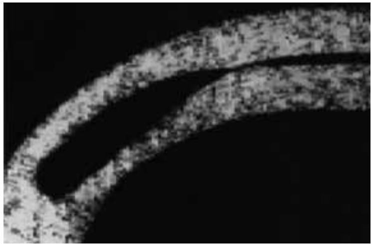


Figure 18.6 Crevice corrosion on a cold strip made from austenitic steel. Sectional view (50-fold enlargement).

Dezincification

A type of corrosion which occurs primarily in copper-zinc alloys with more than 20 % zinc. During the corrosion process the copper is separated from the brass, usually in the form of a spongy mass. The zinc either remains in solution or is separated in the form of basic salts above the point of corrosion. The dezincification can be either of the surface type or locally restricted, and can also be found deeper inside Conditions. Which encourage this type of corrosion include thick coatings from corrosion products, lime deposits from the water or other deposits of foreign bodies on the metal surface. Water with high chloride content at elevated temperature in conjunction with low flow velocities favor the occurrence of dezincification.

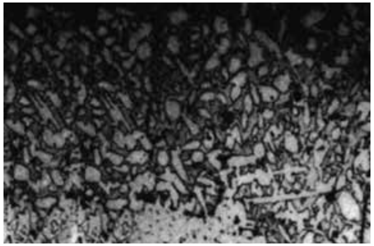


Figure 18.7 Dezincification on a Copper-Zinc alloy (CuZn37). Sectional view (100-fold enlargement).

Contact corrosion

A type of corrosion which may result from a combination of different materials. In practice, so-called "practical galvanic potentials" are used, for example in seawater, to assess the risk of contact corrosion corrosion. Metals which are close together on this graph are mutually compatible; the anodic metal corrodes increasingly in line with the distance between two metals.

Materials which can be encountered in both the active and passive state must also be taken into account. A CrNi alloy, for example, can be activated by mechanical damage to the surface, by deposits (diffusion of oxygen made more difficult) or by corrosion products on the surface of the material. This may result in a potential difference between the active and passive surfaces of the metal, and in material erosion (corrosion) if an electrolyte is present.

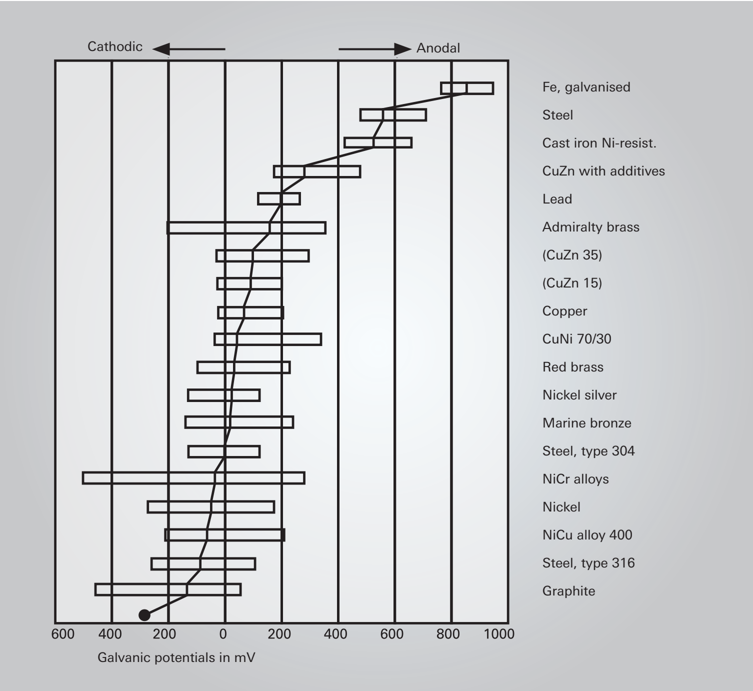


Figure 18.9 Galvanic potential in seawater
Source: DECHEMA material tables.

RESISTANCE TABLES

The table below provides a summery of the resistance to different media for metal materials most commonly used for flexible elements.

The table has been drawn up on the basis of relevant sources in accordance with the state of the art; it makes no claims to completeness. The data constitutes recommendations only, for which no liability can be accepted.

The main function of the table is to provide the user with an indication of which materials are suitable or of restricted suitability for the projected application, and which can be rejected right from the start. The exact composition of the working medium, varying operating states and other boundary operating conditions must be taken into consideration when choosing the material.

Table keys

Assessment	Corrosion behaviour	Suitability
0	resistant	suitable
1	uniform corrosion with reduction in thickness of up to 1 mm/year	restricted suitability
P	risk of pitting corrosion	
S	risk of stress corrosion cracking	
2	hardly resistant, uniform corrosion with reduction in thickness of more than 1 mm/year up to 10 mm/year	not recommended
3	not resistant (different forms of corrosion)	unsuitable

Meanings of abbreviations

adp: acid dew point
bp: boiling point
cs: cold-saturated (at room temperature)
dr: dry condition
hy: hydrous solution
me: melted
mo: moist condition
sa: saturated (at boiling point)

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
1,3 Butadiene								0	0	0		0				0	0			0	
$CH_2=CHCH=CH_2$																					
Acetaldehyde		100	bp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH_3 - CHO																					
Acetanilide			<114	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
= Antifebrin																					
Acetic acid		5	20	3	0	0	0	0	1	0	0	1				0	3	0	0	0	
CH_3-COOH		5	bp	3	3	0	0	0	1	0	0	1						0	0		
		50	20	3	3	0	0	0	1	0	0	1				0	3	1	0	0	0
		50	bp	3	3	3	0	0	1	0	0	1				3	3	0	0	3	1
		80	20	3	3	P	P	0	1	0	0	1					3	0	0	0	0
		96	20	3	3	3	P	0	1	0	0	1					3	0	0		
		98	bp	3	3	3	3	0	1	0	0	1						0	0		
Acetic acid alumina																					
s. Aluminium acetate																					
Acetic acid butyl ether																					
s. Butyl acetate																					
Acetic acid vapour		33	20		3	1	1														
		100	>50		3	3	3	0	1		0	1	3			3	3	0		1	
		100	<bp		3	3	3	0	3		0	3	3			3	3	0		3	
Acetic anhydride		All	20	1	0	0	0	0	1	0	0	1	1	3	0	0	1	0	0	0	0
$(CH_3\text{-}CO)_2O$		100	60	3		0	0				0				1	1	1	0	0	1	0
		100	bp	3		0	0		3		0						1	0	0	3	0
Acetone		100	bp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH_3COCH_3																					
Acetyl chloride			20	1	1	1	1	1	1	0	0	1	1		1	1	1		0	1	0
CH_3COCl																					
Acetylene	dr		20	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	3
H-C≡C-H	dr		200	1	0	0	0	0	0	0	0	0	3	3	3	3	3	0	0	1	3
Acetylene dichloride	hy	5	20																	1	
$H_2C=CCl_2$	dr	100	20	0	P	P	P	0	0	0		0					0			0	
Acetylene tetrachloride																					
$CHCL_2$ - $CHCL_2$																					
s. Tetrachloroethane																					

18

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Adipine acid		All	200	0	0	0	0	0	0	0	0	0					0	0	0	0	0
$HOOC(CH_2)_4COOH$																					
Alcohol																					
s. Ethylene alcohol																					
Allyl alcohol		100	bp			0	0	0	0	0	1	0					0				
CH_2CHCH_2OH																					
Allyl chloride		100	25				0	0	0	0		0					0				
$CH_2=CHCH_2Cl$																					
Alum		100	20	1	1	0	0	0	1	0	0		1			1			0	1	
$KAl(SO_4)_2$	hy	10	20	1	0	0	0				1		1	1	1	1		0	0	1	
	hy	10	<80	1	1	0	0				1		1					0	0		
		sa			3	3	1				3		3								
Aluminium	me		750	3	3	3	3					3					3	3			
Al																					
Aluminium acetate	hy	3	20	3	0	0	0				0						0	0			
$(CH_3\text{-}COO)_2Al(OH)$	hy	sa		3	0	0	0				1							0	1		
Aluminium chloride	hy	5	20	3	3	3	P	1	1	0	0	1	3	3	1	3	1	0	0	3	1
$AlCl_3$																					
Aluminium fluoride	hy	10	25	3	3	3	3				1	1				1	1	0	3	1	1
AlF_3																					
Aluminium formate				1	0	0	0	0	0	0	0				0	1	0	0	0	0	
$Al(HCOO)_3$																					
Aluminium hydroxide	hy	10	20	1	3	0	0	0		0	0	1	0			0		0	0	1	
$Al(OH)_3$																					
Aluminium nitrate				0	0	0	0	0	0	0	0	0						0	0	1	
$Al(NO_3)_3$																					
Aluminium oxide			20	1	1	0	0	0		0	0	3	0	0	0	0			0	3	
Al_2O_3																					
Aluminium sulphate	hy	10	<bp	3	3	3	0	0	1	0	1	3	3	3	3	3	1	0	0	3	
$Al_2(SO_4)_3$	hy	15	50	3	3	3	1		1	1	1	1	1	1	1	1	1	0	0	3	

18

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Ammonia	dr	10	20	0	0	0	0		0	0	0	1	0	S	S	0	3	0	0	0	0
NH_3	hy	2	20	0	0	0	0		0	0	0	0	3	S	S	3	3	0	0	1	0
	hy	20	40	0	0	0	0	0	1	1	1	3				3	3	0	0		
	hy	hs	bp	0	0	0	0	0	3	1	1	3						0	0		
Ammonium acetate				1	0	0	0												0	0	
CH_3-$COONH_4$																					
Ammonium alum	hy	cs	20			0	0											3	0		
$NH_4Al(SO_4)_2$																					
Ammonium bicarbonate	hy			0	0	0	0	1	3			3	3			3			0	0	
$(NH_4)HCO_3$																					
Ammonium bifluoride	hy	10	25	3	3	3	3				0							3	0		
NH_4HF_2	hy	100	20	3	3	0	0				0							3	0		
Ammonium bromide	hy	10	25	3	P	P	P	0		0	1								0	1	
NH_4Br																					
Ammonium carbonate	hy	1	20	0	0	0	0	0	0	0	1	0	1			1			0	0	0
$(NH_4)_2CO_3$		50	bp	0	0	0	0	0	0	0	1	0	1			1	1		0	0	0
Ammonium chloride	hy	1	20	1	P	P	P	0	0	0	0	0	1	S	S	1	1	0	0	1	1
NH_4Cl	hy	10	100	1	P	P	P	0	0	0	0	1	1	S	S	1	1	0	1	1	1
	hy	50	bp	1	P	P	P	0	1	0	1	1	1			1	1	0	1	1	1
Ammonium fluoride		10	25	1	1	0	0				0							1	0		
NH_4F	hy	hg	70	3																	
	hy	20	80	3		3	3				0			3	3	3			0		
Ammonium fluorosilicate	hy	20	40	3		1	0	0	0	0	0	0					0				
$(NH_4)_2SiF_6$																					
Ammonium formate	hy	10	20	1	0	0	0	0	0	0	0	0						0	0	0	
$HCOONH_4$		10	70																0	0	
Ammonium hydroxide		100	20		0	0	0	0	0	0	0	3	3			3	0	0	0	1	
NH_4OH																					
Ammonium nitrate	hy	5	20	3	0	0	0	0	1	0	0	3	3			3			0	0	
NH_4NO_3	hy	100	bp	3	0	0	0	0			0	3		3	3	3			0	0	
Ammonium oxalate	hy	10	20	1	1	0	0		1	0	0	1	1			1		0	0		
$(COONH_4)_2$	hy	10	bp	3	3	1	0		1	0		1	1			1		1	0		
Ammonium perchlorate	hy	10	20		P	P	P				1							0			
NH_4ClO_4																					

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Ammonium persulphate	hy	5	20		0	0	0	0	1	0	0	3	3			3	3	0	0	3	
$(NH_4)S_2O_8$	hy	10	25	3	1	1	1				0	3	3	3	3	3	3	0			3
Ammonium phosphate	hy	5	25	0	1	1	0	0	1	0	0	1	1			3	1	0	0	1	
$NH_4H_2PO_4$																					
Ammonium rhodanide			70		0	0	0											0		0	
NH_4CNS																					
Ammonium saltpetre																					
s. Ammonium nitrate																					
Ammonium sulphate	hy	1	20	0	0	0	0	0	1	0	0	1	3			3	1	0	0	P	
$(NH_4)_2SO_4$	hy	10	20	0	1	1	0	0	3		1	1	3	3	1	3	1	3	0	P	1
	hy	sa	bp	1		0					3	2	3					0	0		
Ammonium sulphite		cs	20		1	0	0	3	3			3	3			3	3	0	0		
$(NH4)_2SO_3$		sa	bp		3	1	1	3	3			3	3			3	3	0	0		
Ammonium sulphocyanide s. Ammonium rhodanide																					
Amyl acetate		All	20					1	1	1	1	1	1			1	1		1	1	
CH_3-$COOC_5H_{11}$		100	bp	1		1	1		0	1	1	0	0				0			0	
Amyl alcohol		100	20	0	0	0	0		0	0	0	0	0	0	0	0	0		0		
$C_5H_{11}OH$ Pentanole		100	bp	1	0	0	0											0		1	
Amyl chloride		100	bp	1		P	P	0	1	0	0	1	0			0	1	0	0	3	
$CH_3(CH_2)_3CH_2Cl$																					
Amyl mercaptan		100	160			0	0				0										
Anilin		100	20			0	0	0	1	0	0	3	3	3	3	3	3	0		0	0
$C_6H_5NH_2$		100	180			1	1					1								3	0
Anilin chloride	hy	5	20		P	P	P				0		3			3	3	0	0	3	
$C_6H_5NH_2HCl$	hy	5	100		P	P	P				0							0			
Anilin hydrochloride																					
s. Anilin chloride																					
Anilin sulphate			20				0				0									1	
Aniline sulphite	hy	10	20				0		1		0										
	hy	cs	20				0				0										

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration	Temperature	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
		%	°C																		
Antifreeze			20		0	0	0	0	0	0	0	0					0	0	0	0	
Glysantine																					
Antimony	me	100	650	3						0	0							3		3	
Sb																					
Antimony tric hloride	dr		20	0	3	3	3										0			3	
$SbCl_3$	hy		100	1	3	3	3										0			3	
Aqua regia			20	3	3	3	3		3		3		3	3	3	3		0	0		1
$3HCl+HNO_3$																					
Arsenic			65			0	0														
As			110			1	1														
Arsenious acid	hy		20	3		0	0														
H_3AsO_4	hy	90	110		3	3	3		3				3			3				3	
Asphalt			20	0	0	0	0						0	0	0	0	0			0	
Azobenzene			20		0	0	0	0	0	0	0	0						0	0	0	
C_6H_5-N=N-C_6H_5																					
Baking powder	mo			1	0	0	0	0	0	0	0	0				1				0	
Barium carbonate			20	3	0	0	0	0		0	0	0	0	0	0	0		0	0	1	
$BaCO_3$																					
Barium chloride	hy	5	20		P	P	P	1	1	0	0	1	3			3	1	0	0	3	
$BaCl_2$	hy	25	bp		P	P	P	1	1	0	0	1					1	0	0	L	
Barium hydroxide	solid	100	20	0	0	0	0	0	1		0	1	0	1	0	0	0	0		3	
$Ba(OH)_2$	hy	All	20	0	0	0	0	0	1		0	1	0	1	0	0	1	0		3	
	hy	All	bp	0	0	0	0				1		0					0			
	hy	100	815	0	0	0	0	0	1								1	0			
		cs	20	0	0	0	0				1		0	1	0	0	0	0		0	
	hy	sa	bp	0	0	0	0				1						0	0		3	
		50	100	0	0	0	0	0	1			1					0	0			
Barium nitrate	hy	All	bp		0	0	0	0	1	0			3			3		0	0	0	
$Ba(NO_3)_2$																					
Barium sulphate			25	0	0	0	0	0		0		0	0	0	0	0	1	0	0	0	
$BaSO_4$																					
Barium sulphide			25		0	0	0						3	1	3	3					
BaS																					

18

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration	Temperature	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
		%	°C																		
Beer		100	20	3	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	
		100	bp	3	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	
Benzaldehyde	dr		bp		0	0	0											1	0	0	0
C_6H_5-CHO																					
Benzene[1]		100	20	1	1	1	1	0	1	1	1	2		1	1	1	1	0	0	1	0
		100	bp	1	2	1	1		1	1	1	2	0	1	1	1	1	0	0	1	0
Benzenesulfonic acid	hy	5	40	3	0	0	0														
C_6H_5-SO_3H	hy	5	60	3	3	1	1														
Benzoic acid	hy	All	20	1	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	
C_6H_5COOH	hy	All	bp	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	
Benzyl alcohol		All	20	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
C_6H_5-CH_2OH																					
Blood			20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Borax	hy	cs		1	0	0	0						0	0	0	0		0	0	0	
$Na_2B_4O_7$	hy	sa		3	0	0	0											0	0	1	
Boric acid	hy	50	100	3	0	0	0	0	1	0	0	1		1		1	1	0	0	1	1
H_3BO_3	hy	50	150	3	1	0	0	0	1	0	0	1		1		1	1	0	0	1	0
	hy	70	150	3	1	1	1	0	1	0	0	1	0	1	1	1	1	0	0	1	0
Boron			20	0	0	0	0														
OM			900	0																	
Brandy			20	1	0	0	0	0	0	0	0	0									
			bp	3	0	0	0	0	0	0	0	0									
Bromine	dr	100	20	P	P	P	P	1	0	0	0	0		0	0	0	0	3		3	0
Br	mo	100	20	P	P	P	P		3		3	0	1	3	1	3	0	0		3	0
Bromine water		0.03	20		P	P	P														
		1	20		P	P	P														
Bromoform	dr		20	0	0	0	0	0	0	0	0	0			0	0				3	
$CHBr_3$	mo		3	0	0	0	0	0	0	0	0			0	0				3		
Butane		100	20	0	0	0	0	0	0	0	0	0	0	0	0	1	0			1	
C_4H_{10}		100	120		1	0	0				1										
Butter			20	3	0	0	0	0	0	0	0					3				0	
Buttermilk			20	3	0	0	0	0		0	0	3			3	3				0	
Butyl acetate			20	1	0	0	0	0		0	0	1	0	0	0	0		0	0	0	0
$CH_3COOC_4H_9$			bp	1	0	0	0	0		0	0	0	0			0		0	0	0	

1) Worst rating from "Corrosion Data Survey"(NACE, 1967) and "Compass Corrosion Guide II" (Kenneth M. Pruett, 1983)

18

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Butyl alcohol		100	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH_3-CH_2-CH_2-CH_2OH		100	bp	0	0	0	0		0		0	0						0	0	0	
Butyric acid	hy	cs	20	3	0	0	0	1	3	0	0	1					3			0	
CH_3-CH_2-CH_2-$COOH$	hy		bp	3	3	3	0	1	3	0	0	1					3			1	
		sa																			
Cadmium	me					3	3														
Cd																					
Calcium			850	3		3	3														
Ca																					
Calcium bisulphite		cs	20	3	3	0	0						1	3	1	0		0			
$CaSO_3$			bp	3	3	3	0											0			
		sa																			
Calcium carbonate			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
$CaCO_3$																					
Calcium chlorate	hy	10	20		P	P	P	1	1	1	1	1	3			1	1		0		
$Ca(ClO_3)_2$	hy	10	100		3	3	P	1	1	1	1	1	3			1	1		0		
Calcium chloride	hy	5	100	3	P	P	P				0							0	0	3	
$CaCl_2$	hy	10	20	3	P	P	P	0	0	0	0	0	0	3	1	1	0	0	0	3	
		cs		3	P	P	P	0	0	0	0	1	0	3		0	1	0	0	3	
				3	3	P	P	0	0	0	0	3	0	3				P	0	3	
		sa																			
Calcium hydroxide				0	0	0	0	1	1	0	0	1	0	0	0	1	1	0	0	3	
Ca(OH)2																					
Calcium hypochlorite	hy	2	20	3	3	3	P	0	3	0	0	3	3			3	3	0	0	3	
$Ca(OCl)_2$	hy	cs		3	3	3	P				1								0	3	
Calcium nitrate			20	3	0	0	0	0	0	0	0	0						0		0	
$Ca(NO_3)_2$		All	100	3	0	0	0	0		0	0	0						0		0	
Calcium oxalate	mo		20	1	0	0	0	0	0	0	0	0	0	0	0			0	0	3	
$(COO)_2Ca$																					
Calcium oxide			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	
CaO																					
Calcium sulphate	mo		20	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	1	
$CaSO_4$	mo		bp	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	1	
Calcium sulphite	hy	cs		0	0	0	0									1		0	0	1	
$CaSO_3$	hy			0	0	0	0									1		0	0	1	
		sa																			

18

Medium				Materials																	
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Carbolic acid			20	0	0	0	0	0	1	0	0	1	0			0	1	0	0	0	
$C_6H_5(OH)$			bp	3	3	3	0				1	0					0	0	0	3	
	hy	90	bp	3	3	3	0				1	0					0	0	0	3	
Carbon dioxide	dr	100	<540	0	1	0	0	0	0	0	0	0				3	0		0		
CO_2	dr	100	1000	3					3										0		
	mo	20	25	1	1	0	0	0	0	0	0	0	0	3	1	1			0	3	
	mo	100	25	3	1	0	0	0	1	0	0	1	0			0	1	0	0	3	
Carbon monoxide		100	20	0	0	0	0		0	0	0	0				0	0	0	0	0	0
CO		100	<540	3	0	0	0		3		0	1				3	3	0	0	1	3
Carbon tetrachloride	dr		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
CCl_4	dr		bp	1	0	0	0				0	0		0	0	0	0	0		3	
	mo		25	1	1	1	1	0	0	0	0	0	0			1	0	0		3	
	mo		bp	3			1													3	
Carbonic acid																					
CO_2																					
s. Carbon dioxide																					
Caustic potash																					
s. Potassium hydroxide																					
Caustic soda lye																					
s. Sodium hydroxide																					
Chloral			20								0								0	3	
CCl_3-CHO																					
Chloramines				3	3	1	0	0		0	0	0									
Chloric acid	hy		20	3	3	3	3	0			0							0	0	3	3
$HClO_3$																					
Chloride of lime																					
s. Calcium hypochlorite																					
Chlorine	dr	100	200	0	0	0	0		0	0	0	0	0	0	0	0	0	1	0	0	0
Cl_2	dr	100	300	3	3	3	0		0	0	0	0									
	dr	100	400	3	3	3	3		0	0	0	0									
	mo		20	3	3	3	3	0			0							0	0	3	
	mo		150	3	3	3	3				0							0	0	3	
Chlorine dioxide	hy	0.5	20	3	3	3	3				1				3			0	0		
ClO_2																					

18

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Chloroacetic acid		All	20	3	3	3	P	3		1	1	3	3			3		0	0	3	
CH_2-Cl-COOH	hy	30	80	3	3	3	3		3		0			3	3	3	1	0	0	3	
Chlorobenzene	dr			0	0	0	0				0										
C_6H_5Cl	mo	100	20	0	P	P	P	0	0	0	0	0	0	0	0	1	1	0	0	1	
Chloroethane	dr		20	0	0	0	0				0				0					0	
CH_2=CHCl			<400	0	0	0	0				0						0	0			
Chloroethylene																					
C_2H_5Cl																					
s. Ethyl chloride																					
Chloroform	dr			1	1	1	1	0	0	0	0	0	0	0	0	0	0	0		0	
$CHCl_3$	mo			3	P	P	P	0	0	0		0						0		3	
Chloromethane	dr		20	0	P	P	P						0					0		0	
CH_2Cl_2	mo		20		P	P	P	0		1	1	1	0			0	1	0		3	
	mo		bp		P	P	P	1		1	1	1	1			0	1	0		3	
Chloromethane	dr	100	20	0	0	0	0		0	0	0	0		0	0	0	0	0		0	
CH_3Cl	mo		20	3	P	P	P		0	0								0		3	
	mo		100		P	P	P		0	0						1		0		3	
Chloronaphthalene				0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	
$C_{10}H_7Cl$																					
Chlorophenol				1	0	0	0				0										
$C_6H_4(OH)Cl$																					
Chlorosulphonic acid	dr	100	20	0	0	0	0	0	0	0	0	0				0	0	0	0	0	3
HSO_3Cl	mo		20	3	3	3	1	1	1	1						3	3	3	0	3	3
Chrome alum	hy	1	20	3	3	0	0					1						0		1	
$KCr(SO_4)_2$		cs		3	3	1	0		0			0		3			1	0		3	
		sa		3	3	3	3		0			1		3			3	0		3	
Chromic acid	hy	5	20	3	3	0	0	1	3	0	0	3	3	3	3	3	3	0	0	1	0
Cr_2O_3 (H_2CrO_4)	hy	5	90	3	3	3	3				1	3	3	3	3	3	3	0	0		
	hy	10	20	3	0	0	0	1	3		0	3	3	3	3	3	3	0	0	1	
	hy	10	65	3	3	3	3				0	3	3	3	3	3	3	0	0		
	hy	10	bp	3	3	3	3	1	3		0	3	3	3	3	3	3	0	0	3	
	hy	50	bp	3	3	3	3	3	3		3	3	3	3	3	3	3	0	0	3	
	hy	60	20	3	3	3	3	1	3			3	3	3	3	3	3	0	0	3	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Chromic acid anhydride																					
CrO_3																					
s. Chromium oxide																					
Chromium oxide				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
CrO_3																					
Chromium sulphate		cs		3	0	0	0		0	0	0	0					0				
$Cr_2(SO_4)_3$		sa		3	0	1	1		1	0	0	0					0				
Cider			20	3	0	0	0	0	0	0	0	0					0	0	0	1	0
			bp	3	0	0	0	0	0	0	0	0					0	0	0	1	0
Citric acid	hy	All	bp	3	3	3	0		0		0										
$CH_2COOH(COH)$	hy																				
COOH CH_2 COOH																					
Combustion gases																					
free of S or																					
H_2SO_4 and Cl			≤400	0	0	0	0				0										
with S or			>adp																		
H_2SO_4 and Cl			and																		
			≤400	0	0	0	0				0										
Copper (II)-chloride	hy	1	20	3	3	P	P	0	3		1	3	3			3	3	0	0	3	
$CuCl_2$	hy	cs		3	3	3	3	3	3		0	3				3	3	0	0	3	
Copper (II)-nitrate	hy	1	20		0	0	0	0	3		0	3	3			3	3	0	0	3	
$Cu(NO_3)_2$	hy	50	bp		0	0	0		3		1	3					0	0	3		
	hy	cs			0	0	0	0	3		1	3	3			3	3	0	0	3	
Copper (II)-sulphate	hy	cs		3	0	0	0	0	3		0	3	3			3	3	0	0	3	
$CuSO_4$	hy	sa		3	1	0	0	0	3		0	3				3	3	0	0	3	0
Copper acetate	hy		20	3	0	0	0	0	1	0	0	1	3		3	3	1	0	0	3	1
(CH_3-COO)$_2$	hy		bp	3	0	0	0								3			0		3	
Cresols		All	20	3	1	0	0		0	0		0					0	0		0	0
$C_6H_4(CH_3)OH$		All	bp	3	1	1	0		0	0	1	0					0	0		3	0
Crotonaldehyde			20	3		0	0	0	0	0	0	0	0	0		0				0	
CH_3-CH=CH-CHO			bp			1	0	0	0	0	0	0	0	0						0	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Cyclohexane				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
$(CH_2)_6$																					
Diammonium phosphate																					
s. Ammonium phosphate																					
Dibromethane																					
s. Ethylene bromide																					
Dichlorethylene																					
$C_2H_2Cl_2$																					
s. Acetylene dichloride																					
Dichloroethane																					
$CH_2Cl\text{-}CH_2Cl$																					
s. Ethylene chloride																					
Difluorodichloromethane	dr		bp			0	0	0	0	0	0	0							0	0	
CF_2Cl_2	dr		20			0	0	0	0	0	0	0							0	0	
	mo		20			0	0	0	0	0	0	0							0	0	
Diphenyl		100	20	0	0	S	S	0	0	0	0	0	0	0	0	0	0	0	0	0	
$C_6H_5\text{-}C_6H_5$		100	400	0	0	S	S	0	0	0	0	0				0	0	0	0	0	
Ethane			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH_3 - CH_3																					
Ether																					
$(C_2H_5)_2O$																					
s. Ethyl ether																					
Ethereal oils			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl alcohol		All	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_2H_5OH		All	bp	1	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
Ethyl benzene				1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_6H_5 - C_2H_5																					
Ethyl chloride			0	S	S	S	0	0	0	1	0	0	1	1	1	0		0	1	0	
C_2H_5Cl																					
Ethyl ether			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
$(C_2H_5)_2O$																					
Ethylene																					
$CH_2{=}CH_2$			20	0	0	0	0													0	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Ethylene bromide																					
$CH_2Br\text{-}CH_2Br$				1		0	0										0			3	
Ethylene chloride	dr	100	20	0	P	P	P	1	0				0	1		1		0	0	0	1
CH_2ClCH_2CL	mo	100	20		P	P	P												0		1
Ethylene glycol		100	20	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	
$CH_2OH\text{-}CH_2OH$																					
Exhaust gases																					
s. Combustion gases																					
Fats				0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	
Fatty acid		100	20	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0
$C_{17}H_{33}COOH$		100	60	3	0	0	0	0	0	0	0	0		1	1	1	0	0	0	1	0
		100	150	3	3	0	0	0	0	0	0	1		1	1	3	0	0	0	3	0
		100	180	3	3	3	0	0	0	0	0	1		1	3	3	0	0	0	3	0
		100	300	3	3	3	0	0	0	0	0			3	3	3	0	0	0	3	0
Ferric (II) chloride	hy	10	20	0		P	P				1		1	3	1	1		0	0	3	
$FeCl_2$	hy	cs						3	3		0	3	3			3	3	0	0	3	
Ferric (II) sulphate	hy	All	bp	0	0	0	0				0	0					3	0		3	
$FeSO_4$																					
Ferric (III) chloride	dr	100	20	0	P	P	P	1	3		0	3	3	3	3	3	3	0	0	3	
$FeCl_3$	hy	5	25	3	3	3	3	3	3		0	3	3	3	3	3	3	0	0	3	
	hy	10	65	3	1	1	1				3						0	0			
	hy	50	20	3	3	3	3		3		1		3	3	3	3		0	0		
Ferric (III) chloride	hy	10	20	3	0	0	0				0							0			
$Fe(NO_3)_3$	hy	All	bp	3	0	0	0	3	3	3	3	3				3	0				
Ferric (III) sulphate	hy	<30	20	3	0	0	0	0	3		0	1	3	3	3	3	3	0	0	3	
$Fe(SO_4)_3$	hy	All	bp	3	1	0	0				0							0	0	3	
Fixing salt																					
s. Sodium thiosulphate																					
Flue gases																					
s. Combustion gases																					
Fluoride	mo		20	3	3	3	3				0	0	3	3	3	3	0	3		3	0
F	dr	100	20	0	0	0	0				0	0	0	0	0	0	0	0		3	0
	dr	100	200	0	0	P	P				0	0				3	0	0		3	
	dr	100	500	3							0									3	

18

18

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Fluosilicic acid																					
s. Hexafluorosilicic acid																					
Formaldehyde	hy	10	20	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0		1	0
CH_2O	hy	40	20	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0		1	0
	hy	All	bp	3	0	0	0				0							0		3	
Formic acid		10	20	3	3	1	0	0	1	0	0	1		0		0	1	0	0	0	1
HCOOH		10	bp	3	3	3	1	0	1	0	0	1		0			3	0		3	3
		80	bp	3	3	3	3	0	1	0	0	3		0		0	1	3		3	3
		85	65	3	3	3	3	0	1	0	0	2		0		1	1	3		3	
Frigene																					
CF_2Cl_2																					
s. Dichlorodifluo-romethane																					
Fuel																					
s. Petrol																					
Fuels																					
s. Petrol																					
s. Benzene																					
Petrol-alcohol mixture			20		0	0	0	0	0	0	0	0		0	0	0	0			0	
Diesel oil			20		0	0	0	0	0	0	0	0		0	0	0	0			0	
Furfural		100	25	1	1	1	1				0		0	3	0	0			0	0	
		100	bp	3	1	1	1				0					3			0	0	
Gallic acid	hy	1	20	1	0	0	0				0								0		
$C_6H_2(OH)_3COOH$		100	20	3	0	0	0												0		
		100	bp	3	0	0	0		3										0		
Gelatine			20	0	0	0	0		0		0								0		0
			80	1	0	0	0		0			0	0	1	0	0	0	0		0	0
Glacial acetic acid																					
CH_3CO_2H																					
s. Acetic acid																					
Glas	me		1200	1		1	1														
Glauber salt																					
s. Sodium sulphate																					
Gluconic acid		100	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
$CH_2OH(CHOH)_4\text{-}COOH$																					

18

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Glucose	hy		20		0	0	0						0	1	0	0		0		0	
$C_6H_{12}O_6$																					
Glutamic acid			20	1	P	P	0	0	1	0	0	1					1				
$HOOC\text{-}CH_2\text{-}CH_2\text{-}$			80	3	P	P	0		1		1										
$CHNH_2\text{-}COOH$																					
Glycerine		100	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
$CH_2OH\text{-}CHOH\text{-}CH_2OH$		100	bp	1	1	0	0		0	0	0			1		0	0		0	0	
Glycol																					
$CH_2OH\text{-}CH_2OH$																					
s. Ethylene glycol																					
Glycolic acid			20	3	1	1	1				0							0		1	
$CH_2OH\text{-}COOH$			bp	3	3	3	3				0							0		1	
		98	bp	3	3	3	3	0	1	0	0	1						0	0		
Glysantine																					
s. Antifreeze																					
Hexachloroethane																					
$CCl_3\text{-}CCl_3$	dr		20			0	0	0	0		0	0						0		0	
= Perchloroethane	mo		20			0	0	0	0		0	0						0		0	
Hexafluorosilicic acid																					
s. hexafluorosilic																					
hydrogen acid																					
Hexamethylenete-tramine	hy	20	60	1		0	0				0										1
$(CH_2)_6N_4$	hy	80	60	3		0	0				0										
Hydrazine			20	0		0		3	3			3					3			1	
$H_2N\text{-}NH_2$																					
Hydrazine sulphate	hy	10	bp	3		3	3														
$(N_2H_6)SO_4$																					
Hydrobromic acid			20	3	3	3	3	3	3	3	3	3	3	3	3	3			0	3	3
HBr																					

18

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Hydrochloric acid		0.2	20	3	3	P	P				0						P	0	0		
HCl		0.5	20	3	3	3	P				0							0	0		
		0.5	bp	3	3	3	3				3							1	0		
		1	20	3	3	3	P	3	3		0	1	3	3	3	3	1	0	0	3	
		2	65	3	3	3	3				0							0	0	3	
		5	20	3	3	3	3	3	3		0	1	3		1	3	3		3		
		15	20	3	3	3	3	3	3		0	3	3			3	3	3	0	3	0
		32	20	3	3	3	3				0					3		3	0	3	1
		32	bp	3	3	3	3				3							3	0	3	
Hydrochloric acid gas																					
s. Hydrochloric																					
Hydrofluoric acid		10	20	3	3	3	3	1	1	0	0	1		3	3	3	1	3	3	3	
HF		80	20	1				1	1	1	1	1				1	1	3	3	3	
		80	bp								1	1						3	3	3	
		90	30					1	1			0					1	3	3	3	
Hydrofluoro-		100	20	3	3	P	P				1		1	3	1	1				3	
Hydrogen acid		25	20	3	3	3	3	1	1	1	1	3		3	1	1	1	3		3	
$H_2(SiF_6)$		70	20	3	3	3	3				1									3	
	Vapour			3	3	3	3				1							2		3	
Hydrogen*			<300	0		0	0				0			0		0				0	
H			>300	3		0	0				0									0	
Hydrogen bromide	dr	100	20	0	0	0	0														
HBr	mo	30	20	3	3	3	3											0			
Hydrogen chloride	dr		20	0	3	1	1	0	0	0	0			3	3	3				1	0
HCl	dr		100	0	3	3	3	0	0	0	0			3		3				1	
	dr		250	1	3	3	3	0	0	0	0			3		3				3	3
	dr		500	3	3	3	3		1		0			3		3				3	3
Hydrogen cyanide	dr		20	3	0	0	0	0	1	0	0	1	3	3	3	1	0	0	0	0	
HCN	hy	20	20	3	1	0	0	0	1	0	0	1	3	3	3	1	0	0	0	0	
	hy	cs	20	3	1	0	0	0	0	0	0	3	3	3	3	1	0	0	0	0	
Hydrogen fluoride		5	20		3	3	3	3	0	0	0	0				3	0	3	3	3	
HF		100	500	3	3	3	3	3	3		0	3		3		3	0	3	3	3	
Hydrogen iodide	dr		20	0	0	0	0														
/ acid	mo		20	3	3	3	3														
Hydrogen peroxide		All	20	3	3	0	0	0	1	0	0	1	3	3	3		3	1	3	0	0
H_2O_2																					

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Hydrogen sulphide	dr	100	20	1	S	0	0	0	1		0	1	0	0	0	0	0	0	0	0	1
H_2S	dr	100	100	3	S	0	0									0				0	
	dr	100	200	3	3	0	0												0		
	mo		20	3	3	0	0		0	0	0	0	3	3	3	3	1	0		0	3
Hydroquinone				3		0	0	0	0	0		1					1			0	
$HO\text{-}C_6H_4\text{-}OH$																					
Hypochlorus acid			20	3	3	3	3											0		3	
HOCl																					
Illuminating gas				0	0	0	0	0	0	0	0	1	1	0	0	1	1				
Indole			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Ink																					
s. Gallic acid																					
Iodine	dr	100	20	0	P	P	P				0	0	3	3	3	3		3		0	
J_2	mo		20	3	3	3	3				1	3					3	0		3	3
	mo		bp	3	3	3	3				1	3					3			3	3
Iodoform	dr		60	0	0	0	0													0	
CHJ_3	mo		20	3	3	P	P														
Isatin			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
$C_8H_5NO_2$																					
Kalinite																					
s. Alum																					
Ketene			20		0	0	0	0	0	0	0						0	0	0	0	
$(CnH_2n+1)_2C=C=O$			bp		0	0	0	0	0	0	0						0	0	0	0	
Lactic acid	hy	1	20	3	3	0	0	0		0	0		0	3	1	0		0	0	0	
$C_3H_6O_3$	hy	All	20	3	3	1	0				0							0	0	3	
	hy	10	bp	3	3	3	3	0	3		0	3	1			1	3	0	0	3	
	hy	All	bp	3	3	3	1				0							0	0	3	
Lactose	hy		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
$C_{12}H_{22}O_{11}$																					
Lead	me		388	3	1	1	1		0			3				3		0	0		
Pb			900	3	3	3	3				0										
Lead acetate	me			3	0	0	0				0	0			3	3				3	
$(CH_3\text{-}COO)_2Pb$																					
Lead acid		<20	<30					0	0	0		1					1				
$Pb(N_3)_2$																					

*All materials tend to become brittle under hydrogen atmosphere. For components with cyclic loads the materials 1.4404 oder 1.4435 should be selected.

18

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Lead nitrate	hy		100	1	0	0	0	0	0	0	0	0						0	0	0	
Pb(NO$_3$)$_2$																					
Lime CaO s. Calcium oxide																					
Lime milk			20	0	1	0	0													0	
Ca(OH)$_2$			bp	0	1	0	0													0	
Liquid ammonia s. Ammonium hydroxide																					
Lithium	me		300	0	0	0	0	0	0	0	0	3	3	3	3	3		0		3	
Li																					
Lithium chloride	hy	cs		3	3	3	L	0	0	0	0	1					0	0			
LiCl																					
Lithium hydroxide	hy	All	20	1	0	0	0	0	0	0		0					0	0			
LiOH																					
Magnesium	me		650		1	3	3	3	3		3	3	3	3	3	3	3	0	0	3	
Mg																					
Magnesium carbonate	hy		20	0	0	0	0	0	0	0	0	0	0			0	0	0	0	1	
MgCO$_3$	hy		bp	0	0	0	0	0	0	0	0	0	0			0	0	0	0	1	
Magnesium chloride	hy	5	20	3	3	P	P	0	0	0	0	0	3			3	0	0	0	3	
MgCl$_2$	hy	5	bp	3	3	3	3	0	0	0	0	0	3			3	0	0	0	3	
	hy	50	bp	3	3	3	3				0							0	0	3	
Magnesium hydroxide	hy	cs		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Mg(OH)$_2$	hy			0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
		sa																			
Magnesium nitrate		cs		0	0	0	0	3	3		3	0	3	0	0	3	3	0	0	1	
Mg(NO$_3$)$_2$																					
Magnesium oxide MgO s. Magnesium hydroxide																					
Magnesium sulphate	hy	0.1	20	0	1	0	0				0							0	0	3	
MgSO$_4$	hy	5	20	3	1	0	0	0	1	0	0	1	0	3	0	0	1	0	0	0	
	hy	50	bp	3	1	0	0				1							0	0	0	
Maleic acid	hy	5	20	3	0	0	0	0	1	0	0	1	0				1			0	
HOOC-HC=CH-COOH	hy	50	100	3	0	0	0		1											0	

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Maleic acid hydride		100	285								0										
Malic acid	hy		20	3	3	0	0	0	1	0	0	1	3			3	3	0	0	0	
	hy	50	100	3	3	0	0	0	1	0	0	1	3	3	3	3	3	0	0	0	
Malonic acid			20			1	1	1	1	1	1	1					1	1		1	
CH$_2$(COOH)$_2$			50					1	1	1	1	1					1	1			
			100					3	3		3	3					3	3			
Manganese(II)-chloride	hy	5	100	3	P	P	P	1	1	1		1	3			3	1	0	0		
MnCl$_2$	hy	50	20	1	3	P	P	1	1	1		1	3			3	1	0	0		
Manganese(II)-sulphate MnSO$_4$		cs			0	0	0	0	0	0	0	0				0	0	0			
Maritime climate	mo			2P	1P	1P	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1
Mercury	dr	All	<500	1	1	1	0		0	0	0	3	3	3	3	3		0	0	3	
Hs																					
Menthol					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
C$_{10}$H$_{19}$OH																					
Methane			200	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
CH$_4$			600								0						0				
Methanol s. Methyl alcohol																					
Methyl acetate		60	20	0		0	0				0							0	0		
CH$_3$COOCH$_3$		60	bp	0		0	0				0							0	0		
Methyl alcohol		<100	20		0	0	0	0	0	0	0	0				0	0	0	1		
CH$_3$OH		100	bp	1	3	1	1		0	0	0	0		0	0	0	0	0	0	1	0
Methylamine	hy	25	20	1	0	0	0	0		0	0	3	3	3	3	3		0		0	
CH$_3$-NH$_2$																					
Methyldehyde s. Formaldehyde																					

Medium: Designation / Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Mixed acids																				
HNO_3 % / H_2SO_4 % / H_2O %																				
90 / 10 / –		20	0		0	0					3		3	3	3	3	0		1	3
50 / 50 / –		20			0	0											0		3	
50 / 50 / –		90		3	1	1														
50 / 50 / –		120		3	3	3														
38 / 60 / 2		50		3	0	0														
25 / 75 / –		50		3	1	0														
25 / 75 / –		90		3	3	1														
25 / 75 / –		157		3	3	3														
15 / 20 / 65		20	3	3	0	0														
15 / 20 / 65		80		3	1	0														
10 / 70 / 20		50		3	0	0														
10 / 70 / 20		90		3	1	0														
5 / 30 / 65		20	3	3	0	0														
5 / 30 / 65		90	3	3	0	0														
5 / 30 / 65		bp	3	3	3	1														
5 / 15 / 80		134		3	1	1														
Molasses		0	0	0	0	0	0	0	0					0	0	0	0			
Monochloroacetic acid																				
s. Acetic acid																				
Naphthalene	100	20	0	0	0	0											0		1	
$C_{10}H_8$	100	390	0	0	0	0														
Naphthalene chloride	100	45								0										
	100	200								0										
Naphthalene sulphonic acid	100	20	0		0	0				0										
$C_{10}H_7SO_3H$	100	bp		3	3	3				0										
Naphthenic acid	100	20		P	P	P	0	0	0		0					1			0	
Nickel (II) chloride hy	10	20	3	P	P	P	0	1	0	0	1	1	3	1	3	1	0			0
$NiCl_2$ hy	10	bp	3	3	P	P				0							0			
	total	70				0				1										
Nickel (II) nitrate hy	10	25	3	0	0	0	0	0	0	0	3	3			3	3	0	0	3	
$Ni(NO_3)_2$ hy	<100	25	3	0	0	0	0	3		1	3				3	3	0	0	3	

18

Medium: Designation / Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Nickel (II) sulphate hy		20	3	0	0	0	0	1	1	1	1					3	0			
$NiSO_4$ hy		bp	3	0	0	0		0		1	1					3	0			
Nitric acid	1	20	3	0	0	0				0	0	1	3	3	3	0	0	0		
HNO_3	1	bp	3	0	0	0				1	3					3	0	0		
	5	20	3	0	0	0	0	3		0	3	3			3	3	0	0	3	
	5	bp	3	1	0	0				1							0	0		
	10	bp	3	1	0	0				1	3					3	0	0		
	15	bp	3	1	0	0				3							0	0		
	25	bp	3	3	0	0				3							1	0		
	50	bp	3	3	3	1	0	3		3	3	3			3	3	1	0	3	
	65	20	3	0	0	0		0		0							0	0	1	
	65	bp	3	3	3	3	0	3		3	3	3			3	3	0	0	3	
	99	bp	3	3	3	3	0	3		3	3	3			3	3	0	3		
	20	290	3	3	3	3				3							3	0		
	40	200	3	3	3	3				3							3	0		
Nitrobenzene			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	
$C_6Hx(NO_2)y$																				
Nitrobenzoic acid hy		20	1	0	0	0	0	0	0	0	0	0	0	0		0			0	
$C_6H_4(NO_2)COOH$																				
Nitrogen	100	20	0		0	0		0	0	0	0	0	0	0	0	0	0		0	0
N	100	900	1													3				
Nitroglycerine		20	0	0	0	0													0	
$C_3H_5(ONO_2)_3$																				
Nitrous acid																				
HNO_2																				
similar to Nitric acid																				
Oil of turpentine	100	20	3	0	0	0						0	1	0	0		0		0	
	100	bp	3	0	0	0						0	1	0	0		0		0	
Oleic acid																				
s. Fatty acid																				
Oleum																				
s. Sulphur trioxide																				
Oxalic acid hy	All	20	3	3	0	0	1	1	0	0	1					3	0	0	0	
$C_2H_2O_4$ hy	10	bp	3	3	3	3	0	1	0	0	1	1			1	3	3	0	3	
hy	sa		3	3	3	3	1	1	1	1	1									

18

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Oxygen			500	1	0	0	0					0			3	3				0	3
O																					
Ozone					0	0	0	0	0	0	0	0				1		0		0	
Paraffin			20	0	0	0	0											0		0	
C_nH_{2n+2}	me		120	0	0	0	0						0	0	0	0		0		0	
Perchloric acid		10	20	3	3	3	3											0		3	
$HClO_4$		100	20	3	3	3	3											0			
Perchloroethylene			20	0	0	0	0							0	0	0	0			0	
C_2Cl_4			bp	0	1	1	1							1	1	0	0			3	
	mo			3	P	P	P														
Perhydrol																					
s. Hydrogen peroxide																					
Petrol[1)]		100	25	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1		1	
		100	bp	1			0	0			0	1						1		1	
Petroleum			20	0	0	0	0		0	0	0	0	0	1	0	0	0	0		0	
			bp	0	0	0	0		0	0	0	0		1	0	0	3	0		0	
Phenol																					
s. Carbolic acid																					
Phloroglucinol																					
$C_6H_3(OH)_3$			20		0	0	0	0	0	0	0	0						0	0	0	
Phosgene	dr																				
$COCl_2$			20		0	0	0	0	0	0	0	0						0	0	0	
Phosphoric acid	hy	1	20	3	0	0	0	0	0	0	0	1	3			3	0	0	0	3	
H_3PO_4	hy	10	20	3	3	0	0				0							0	0		
	hy	30	bp	3	3	1	1				1	1	1	2	1	3	3	3	0	3	
	hy	60	bp	3	3	3	3				1							3	0		
	hy	80	20	3	3	1	0		0	0	0				0	1		3	0		0
	hy	80	bp	3	3	3	3		0		3				1		3	3	0		1
Phosphorous	dr																				
P			20	0	0	0	0														
Phosphorous pentachloride	dr																				
PCl_5		100	20	0	0	0					0					0	1				
Phthalic acid and			20	0		0	0				0	0		0	0	0	0			0	0
phthalic anhydride			200		0	3	0				0	0				0	0				0
$C_6H_4(COOH)_2$	dr		bp			0	0	0								0			0	0	

1) Worst rating from "Corrosion Data Survey"(NACE, 1967) and "Compass Corrosion Guide II" (Kenneth M. Pruett, 1983)

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Picric acid	hy	3	20	3	0	0	0											0		1	0
$C_6H_2(OH)(NO_2)_3$	hy	cs		3	0	0	0	3	3		0	3	3	3	3	3	3	0		0	
	me		150	3	0	0	0											0		3	
Plaster																					
see Calcium sulphate																					
Potassium	me		604	0		0	0				1							0		0	
K			80			0	0				1							0	1	0	
Potassium acetate	me	100	292	1		0	0									1		0			
CH_3-COOK	hy		20	1	0	0	0		0	0	0	0			1	1	0	0			
Potassium aluminium sulphate																					
s. Alum																					
Potassium bisulphate	hy	5	20	3	3	2	0											0			
$KHSO_4$	hy	5	90	3	3	3	3											3			
Potassium bitartrate	hy	cs		3	3	0	0										0	0		0	
$KC_4H_5O_6$	hy	sa		3	3	3	1										1	0		0	
Potassium bromide	hy	5	30	3	P	P	P	0	1	0	0	1	0	0		0	0	0	0	3	
KBr																					
Potassium carbonate	hy	50	20	1	0	0	0	0	0	0	0	0	1	3	1	1	0	0	0	3	0
K_2CO_3	hy	50	bp	3	3	0	0	0	0	0	0	0		3			0	0	0	3	0
Potassium chlorate	hy	5	20	3	0	0	0	0	1	0		1	3	1	1	1	1	0		0	
KClO3	hy	sa		3	0	0	0	0	3	0	0	3	3			1	3	0	0	1	
Potassium chloride	hy	10	20	3	3	P	P	0	0	0	0	0	0							1	
KCl	hy	10	<bp	3	3	P	P				1		3							1	
	hy	30	bp	3	3	P	P				1	0		3	1	3		0		0	0
	hy	cs		3	P	P	P				1										
	hy	sa		3	3	P	P				1										
Potassium chromate	hy	10	20	0		0	0	0	0	0	0	1	0	0	0	0	0	0		0	
K_2CrO_4	hy	10	bp	1		0	0											0		0	
Potassium cyanide	hy	10	20	3	0	0	0	0	3		0	1	3			3	3		0	3	
KCN	hy	10	bp	3	0	0	0						3	3	3	3				3	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Potassium dichromate	hy	10	40	3	0	0	0	1	1	1	1	1	0			3	1	0	0	0	
$K_2Cr_2O_7$	hy	25	40	3	3	0	0	1	1	1	1	1	3	3	3	3	1	0	0	0	0
	hy	25	bp	3	3	0	0				1		3	3	3	3		0	0	0	
Potassium ferricyanide	hy	1	20		0	0	0	1	1	0	0	0			0	0	1	0	0		
$K_3(Fe(CN)_6)$	hy	cs	20		0	0	0		0		0	0			0		0	0	0	0	3
	hy	sa	bp	3	0	0	0		0		0						0	0	0	0	3
Potassium ferrocyanide	hy	1	20		0	0	0	1	1	0	0	0	0			0	1	0	0	0	
$K_4(Fe(CN)_6)$	hy	25	20		0	0	0	0	0	0	0	0	0		0		0	0	0	0	3
	hy	25	bp		1	1	0	0	0	0	0	0	0				0	0	0	0	3
Potassium fluoride	hy	cs		0	0	0	0				0									3	
KF	hy	sa		1	0	0	0				0										
Potassium hydroxide	hy	10	20		0	S	S	1	1	1	1	0	0			3	0	0	3	3	
KOH	hy	20	bp		0	S	S	1	1	1	1	0	3				0	0	3	3	
	hy	30	bp		3	S	S	1	3		1	0				3	0	3	3	3	
	hy	50	20	S	0	S	S	1	1	1	0	0	3				0	0	3	3	
	hy	50	bp	S	3	3	3	1	3		1	0	3			3	0	3	3	3	
	hy	sa		S	3	S	S				1		0						3	3	0
	me	100	360	S	3	3	3		3		3						0	3	3	3	
Potassium hypochlorite	hy	All	20		P	P	P	3	3		0	3	3				3	0		3	
KClO	hy	All	bp		P	P	P	3	3		1	3	3				3	0		3	
Potassium iodide	hy		20	0	P	P	P	0	1	1	0	3	0			0	3	0	0	3	
KJ	hy		bp	0	3	P	P	0	1	1	0	3	0			0	3	0	0	3	
Potassium nitrate	hy	All	20		0	0	0	0	1	1	1	1					1	0		0	
KNO_3	hy	All	bp		0	0	0				1							0		1	
Potassium nitrite KNO_2		All	bp	1	0	0	0	1	0	0	0	0	1	1	1	1	1				
Potassium permanganate	hy	10	20	0	0	0	0				0	1	0				0	0	0	0	3
$KMnO_4$	hy	All	bp	3	1	1	1	0	1	1	1	1	0			0	0	0	0	0	
Potassium persulphate $K_2S_2O_8$	hy	10	50	3	3	0	0		0		0	3		3	3	3	3	0		3	3
Potassium silicate K_2SiO_3			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Potassium sulphate	hy	10	25	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	
K_2SO_4	hy	All	bp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Propionic acid s. Acetic acid																					
Protein solutions			20	1	0	0	0	0	0	0	0	0	0					0	0	0	
Prussiate of potash s. Potassium ferricyanide																					
Prussic acid s. Hydrogen cyanide																					
Pyridine	dr		20		0	0	0											0		0	
C_5H_5N		All	bp		0	0	0		0	0	0	0					0	0		0	
Pyrogallol		All	20	3	0	0	0				0				0			0		0	
$C_6H_3(OH)_3$		All	bp	3	0	0	0				1				0			0		0	
		100	20	0	P	P	P		0	0	0	3	3	3	3	3	0	0		1	3
Quinine bisulphate	dr		20	3	3	3	0	0		0	0	1	0			0		0	0		
Quinine sulphate	dr		20	3	0	0	0	0		0	0	1	0		0	0		0	0		
Salicylic acid	dr	100	20	1	0	0	0	0	1	0	0	1	0			0	1	0	0	0	
HOC_6H_4COOH	mo	100	20	3		0	0				1	0						0			
	hy	cs		3		0	0	0	1	0	0	0	0				0	0		1	
Saltpetre s. Potassium nitrate																					
Seawater at flow rate (v):																					
v<1.5m/s			20	1	P	P	P	0	P	0	0	P	1			1	P				
1.5<v<4.5m/s			20	1	0	0	0	0	0	0	0	0	0	0		3	1				
Silver nitrate	hy	10	20	3	0	0	0	0	1	1	1	3	3	3	3	3	3	0	0	3	
$AgNO_3$	hy	10	bp	3	0	0	0										3	0			
	hy	20	60	3	0	0	0											0			
	hy	40	20	3	0	0	0				1							0			
	me	100	250	3	3	0	0														
Soap	hy	1	20	0	0	0	0		0	0		0	0	1	0	0	0	0		0	
	hy	1	75	0	0	0	0					0	0	1	0	0	0			0	
	hy	10	20	0	0	0	0										0	0		0	
Sodium			200	0	0	0	0											0		1	
Na	me		600	3	1	0	0											0			

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low-alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Sodium acetate	hy	10	25	0	0	0	0		0	0	0	0				0	0	0	0	0	0
CH_3-COONa	hy	sa		3	0	0	0				0							0	0		
Sodium aluminate		100	20	0	0	0	0											0			
Na_3AlO_3	hy	10	25	0	0	0	0				1							0		3	
Sodium arsenate	hy	cs		0	0	0	0											0		0	
Na_2HAsO_4																					
Sodium bicarbonate		100	20		0	0	0											0		0	
$NaHCO_3$	hy	10	20	0	0	0	0	0	1	1	1	1	0	3	1	1	1	0		0	
	hy	cs			0	0	0	0	1	0	0	1	0			0	1	0	0	1	
	hy	sa			0	0	0				1							0			
Sodium bisulphate	hy	All	20	3	3	3	0	0	1	1	1	1	3	3	1	1	1	0	0	0	
$NaHSO_4$	hy	All	bp	3	3	3	1	0	1	1	1	1	3	3	1	3	1	0	0	1	
Sodium bisulphite	hy	10	20	3	3	0	0				1			1	0	3	0	0		0	
$NaHSO_3$	hy	50	20	3	0	0	0				1	0		1	0	3	0	0			
	hy	50	bp	3	3	3	0					0						0			
Sodium borate	hy	cs			0	0	0	0		0	0	1	0			0		0	0	1	
$Na_2B_4O_7$ 10 H_2O (Borax)	me			3	3	3	3				3										
Sodium bromide	hy	All	20	3	3	3	P				1							0		3	
NaBr	hy	All	bp	3	3	3	P				1							0		3	
Sodium carbonate	hy	1	20	3	0	0	0	0	1	0	0	0	0			0	0	0	0	2	
Na_2CO_3	hy	All	bp		0	0	0	0	0	0	0						0	0	0	3	
	hy		400	3	3	3	3														
	me		900	3	3	3	3					0					0				
Sodium chloride	hy	0.5	20		P	P	P	0	1	0	0	0	0				1	0	0		
NaCl	hy	2	20		P	P	P	0	1	0	0	0	0				1	0	0		
	hy	cs		3	P	P	P	0	1	0	0	0	0			0	1	0	0	2	0
	hy	sa		3	3	3	P	0	1	0	1	0	0			0	1	0	0	3	0
Sodium chlorite	dr	100	20	3	P	P	0		0									0			
$NaClO_2$	hy	5	20			3	P											0			
	hy	5	bp			3	3				1							0			
	hy	10	80	3		3	P		0		1							0			
Sodium chromate	hy	All	bp	0	0	0	0	0	0	0	0	0	0	0	0	0				0	
Na_2CrO_4																					

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non-/low-alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: Incoloy 825 2.4858	Nickel alloys: Inconel 600 2.4816	Nickel alloys: Inconel 625 2.4856	Nickel alloys: Hastelloy-C 2.4610 / 2.4819	Nickel alloys: Monel 2.4360	Copper alloys: Cunifer 30 2.0882	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Sodium cyanide	me		600	1								3	3	3	3	3				3	3
NaCN	hy	cs		1	0	0	0					3	1	3	3	3	0	0		3	3
Sodium fluoride	hy	10	20	0		0	0								3					0	
NaF	hy	10	bp	0		0	0														
	hy	cs				S	S													0	
Sodium hydrosulphate																					
s. Sodium bisulphate																					
Sodium hydrosulphite																					
s. Sodium bisulphite																					
Sodium hydroxide	solid	100	All	0	0	0	0		0	0	0	0					0				0
NaOH	hy	<10	<60	0	0	0	0		0	0	0						0				
	hy	<10	<bp	3	3	0	0		0	0	0						0				
	hy	<20	<60	0	0	0	0		0	0	0						0				
	hy	<20	<bp	3	3	0	0		0	0	0						0				
	hy	<40	<60	0	0	0	0		0	0	0						0				
	hy	<40	<100	3	3	0	0		0	0	0						0				
	hy	<40	>100	3	3	3	3		0	0	0						0				
	hy	<50	<60	0	0	0	0		0	0	0						0				
	hy	<50	<100	3	3	0	0		0	0	0						0				
	hy	<50	>100	3	3	3	3		0	0	0						0				
	hy	<60	<90	3	3	0	0		0	0	0						0				
	hy	<60	<140	3	3	3	3		0	0	0						0				
	hy	<60	>140	3	3	3	3		3	0	3						0				
Sodium hypochlorite	hy	5	20	3	3	3	P	0	3		0	3	3			3	3	0		3	
NaOCl	hy	10	50	3		P	P		0		1							0		3	
Sodium hyposulphite		All	20		3	0	0	0	1	1	1	1	3			3	1		0		
$Na_2S_2O_4$		All	bp		3	0	0	0	1	1	1	1	3			3	1		0		
Sodium iodide					P	P	P	0	0	0	0					0			1		
NaJ																					
Sodium nitrate	hy	5	20	3	0	0	0	0	0	0	0	1	0			0	1	0	0	0	
$NaNO_3$	hy	10	20	1	0	0	0	0	0	0	1	1	0	3	1	1	1	0	0	0	
	hy	<10	bp	3	0	0	0				0						1	0	0	3	3
	hy	30	20	1	0	0	0	0	0	1	1	1	0				1	0	0	0	
	hy	30	bp	1	0	0	0	0	0		3	1					1	0	0	0	
	me		320	3	0	0	0				0						1	0	0	0	3

Medium				Materials																			
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Sodium nitride	hy		20			0	0	1	0	0	0	0	0			1	3	0	0	1	
$NaNO_2$																					
Sodium perborate	hy	10	20	3	0	0	0				1							1			
$NaBO_2$	hy	10	bp	3	0	0	0				1							1			
Sodium perchlorate	hy	10	20	3	3	0	0	1			1							0			
$NaClO_4$	hy	10	bp	3		0	0	1			1							0			
Sodium peroxide	hy	10	20	3	1	0	0	1	1	1	1	0	3			3	0	3	3	3	3
Na_2O_2	hy	10	bp	3	3	0	0	1	1	1	1	0	3			3	1	3	3	3	3
	me		460					3	1		3	3					0				
Sodium phosphate	hy	10	20		0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	
Na_2HPO_4	hy	10	bp		0	0	0	0	0	0	0	0				3		0	0	1	
	hy	cs			0	0	0	0	0	0	0	0					0	0	0	0	
Sodium silicate	hy	All	20		0	0	0	0			0					0	0	0		0	
$C_6H_4(OH)COONa$																					
Sodium silicofluoride	hy	cs		3	3	3	3	0	0	1	1	0				0				1	
$Na_2(SiF_6)$																					
Sodium sulphate	hy	10	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Na_2SO_4	hy	cs		3	1	0	0	0	1	0	0	1	0			0	1	0	0	0	
	hy	sa		3	3	0	0	0	0	0	0	0						0	0	1	
Sodium sulphide	hy	1	20	3	0	0	0	0	0			1					1	0			
Na_2S	hy	cs	20	3	3	3	0	0	1	0	0		3			3	1	0	0	1	
	hy	sa		3	3	3	1											0		3	
Sodium sulphite	hy	10	20	3	1	0	0					0	1	3	1	1		0		0	
Na_2SO_3	hy	50	bp	3	3	0	0											0		3	
Sodium superoxide																					
s. Sodium peroxide																					
Sodium thiosulphate	hy	1	20	1	0	0	0					0					0	0		0	
$Na_2S_2O_3$	hy	10	20	3	0	0	0											0		0	
	hy	25	bp	3	P	P	P										0	0		1	
		cs		3	3	0	0		1			1	3			3	1	0	0	0	
Stearic acid		100	20	1	0	0	0		0	0	0	0	1	3	1	1	0	0		0	0
$CH_3(CH_2)_{16}COOH$		100	95	3	0	0	0	0	1		0	1	1			0	1	0	0	3	
		100	180								1							0		3	

Medium				Materials																			
Designation Chemical formula					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Succinic acid			bp	1	0	0	0	0	0	0	0	0	0	0	0						
$C_4H_6O_4$																					
Sulphur	dr	100	60	0	0	0	0				0						0				
S	me		130	1	0	0	0		0		0	3	3	3	3	3	3	0			3
	me		240	3	0	0	0				0					3		0			
	mo		20	3	2	1	0				0	3	3	3	3	3	3	0			
Sulphur dioxide	dr	100	20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SO_2	dr	100	60	3	3	1	1				0							0		0	
	dr	100	400	3	3	3	0				1			3				0		0	3
	dr	100	800	3	3	3	3				3						3	0		0	
	mo	100	20	3	3	3	0	0	0	0	0	0	3	3	1	3	0	0	0	3	
	mo	100	60	3	3	3	0				0							0		3	
	mo	100	70	3	3	3	3				0							0		3	
Sulphur trioxide	mo	100	20																	3	
SO_3	dr	100	20	0				2	3		0	3	2	0	0	0	3		3	0	
Sulphuric acid		0.05	20	3	1	0	0											0	0	1	
H_2SO_4		0.05	bp	3	1	1	0											1	0	3	
		0.1	20	3	3	0	0											0	0	1	
		0.2	bp	3	3	3	0											1	0	3	
		0.8	bp	3	3	3	3											1	0	3	
		1	20	3	3	1	0		1	0	0	1	3			1	0	0	0	1	
		3	bp	3	3	3	3				1		3					1	0	3	
		5	bp	3	3	3	3	1	3		3	1	3			3	3	3	0	3	
		7.5	20	3	3	1	0											1	0	1	
		10	bp	3	3	3	3	1	3		3	3	3			3	3	3	0	3	
		25	20	3	3	3	3				0		3					3	0	1	
		25	bp	3	3	3	3				3		3					3	0	3	
		40	20	3	3	3	3				0	1	3	3	3	3		1	0	1	
		40	bp	3	3	3	3				3		3					3	0	3	1
		50	20	3	3	3	3	1	3		0	3	3			3	3	3	0	3	
		50	bp	3	3	3	3	3	3		3	3	3			3	3	3		3	
		60	20	3	3	3	3				0	1		3	3	3	0	3	0	3	
		80	20	3	3	1	1				0	1	3	3	1	1		3	0	3	
		90	20	3	3	1	0				0							3	0	3	
		96	20	1	1	1	0				0	3	3			1	1	3	0	3	3

18

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature	Non-/low- alloy steels	Stainless steels			Nickel alloys					Copper alloys			Pure metals					
					Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
		%	°C																		
Sulphurous acid	hy	1	20	3	3	0	0		1		0	3					3		0	1	
H_2SO_3	hy	cs		3	3	0	0				0	3						1	0	3	
	hy	sa		3	3	1	0				1								0	3	
Tannic acid	hy	5	20	3	0	0	0		0			0	0	1	0	0	0	0		0	
$C_{76}H_{52}O_{46}$	hy	25	100	3	3	0	0											0			
	hy	50	bp	3	3	0	0						0					0			
Tannin s. Tannic acid																					
Tar			20	0	0	0	0						0	1	0	0		0		1	
Tartaric acid	hy	10	20	1	0	0	0	0	1	0	0	1	0	3	0		1	0	0	3	
	hy	10	bp	3	1	0	0	0	3		1	3	0	3			3	1	0	3	
	hy	25	20	3	1	0	0		0		0	0	0			0		0	0	3	
	hy	25	bp	3	3	1	0		0		1	1	0			1		1	0	3	
	hy	50	20	3	3	0	0				0		0					0	0	3	
	hy	50	bp	3	3	3	3				1		0					3	0	3	
	hy	5	20	3	P	P	P	0	1	0	0	1	3				1	0	0	3	
Tetrachloroethane s. Carbon tetrachloride																					
Tin chloride		sa		3	3	3	3														
$SnCl_2$; $SnCl_4$		All	<80	3	3	0	0		0		0										
Toluene		100	20	0	0	0	0					0	0	0	0	0		0		0	
C_6H_5-CH_3		100	bp	0	0	0	0					0	0	0	0	0		0		0	
Trichloroacetaldehyde s. Chloral																					
Trichloroacetic acid s. Chloroacetic acid																					
Trichloroethylene	pure	100	20	0	0	0	0				0		0	0	0	0	0	0		0	
$CHCl=CCl_2$	pure	100	bp			0	0				0		0	0	0	0	0	0		0	
	mo		20	3	3	P	P				0		1	3	1	1	0	0		3	
	mo		bp	3	3	P	P				0		1	3	1	1	0	0		3	
Trichloromethane s. Chloroform																					
Tricresyl phosphate				0	0	0	0	0	0	0	0					0					0

18

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature	Non-/low- alloy steels	Stainless steels			Nickel alloys					Copper alloys			Pure metals					
					Ferritic steels	Austenitic steels	Austenitic + Mo	Incoloy 825 2.4858	Inconel 600 2.4816	Inconel 625 2.4856	Hastelloy-C 2.4610 / 2.4819	Monel 2.4360	Cunifer 30 2.0882	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
		%	°C																		
Trinitrophenol s. Picric acid																					
Urea		100	20	0	0	0	0				0	0					0	0	0	0	
$CO(NH_2)_2$		100	150	3		1	0		3		1	1					1	0	0	3	1
Uric acid	hy		20	3	0	0	0	0	1	0	0	0	0			1		0		3	
$C_5H_4O_4N_3$	hy		100	3	0	0	0	0	1	0	0	0	0			1		0		3	
Varnish			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Water vapour																					
O_2<1ppm;Cl<10ppm			<560	1	1	1	0				0							0			
O_2>1ppm;Cl<10ppm			<315	S	S	S	S				0						0	0			
O_2>15ppm;Cl<3ppm			>450	S	S	S	S				0							0			
Wine			20	3	0	0	0		0					3	3		3		0	3	
			bp	3	0	0	0		0					3	3		3		0	3	
Yeast			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc chloride	hy	5	bp	3	3	3	3	0	3		1	3	3				1	0	0	3	
$ZnCl_2$	hy	10	20	3	P	P	P					3					0	0	0	0	
	hy	20	20	3	P	P	P						3	3	3			0	0		
	hy	75	20	3	3	P	P											0	0		
	hy	2	20	3	0	0	0				0		0					0	0	0	
Zinc sulphate	hy	20	bp	3	0	0	0				1							0	0	3	
$ZnSO_4$	hy	30	bp	3	3	0	0				1							0	0	3	
	hy	cs		3	0	0	0	0	1	0	1	1	0				1	0	0	1	
	hy	sa		3	3	0	0				1							0	0	3	
	hy	5	20	3	3	3	3	3	3		0	1	3				1	0	0	3	

18

PIPES. FLANGES. PIPE BENDS

19

In chapter 19 you can find the dimensions of flanges and pipe bends as well as seamless and welded steel pipes.

19

SEAMLESS AND WELDED STEEL PIPES

DIN EN 10220. edition 03.2003 (extract). weights and measures

Nominal diam-eter	Outside diam-eter	masses (weights) in relation to length in kg/m wall thickness in mm											
DN	mm	1.6	1.8	2	2.3	2.6	2.9	3.2	3.6	4	4.5	5	5.6
6	10.2	0.339	0.373	0.404	0.448	0.487							
8	13.5	0.470	0.519	0.567	0.635	0.699	0.758	0.813					
10	17.2	0.616	0.684	0.750	0.845	0.936	1.02	1.10	0.879	1.30	1.41		
15	21.3	0.777	0.866	0.952	1.08	1.20	1.32	1.43	1.21	1.71	1.86	2.01	
20	26.9	0.998	1.11	1.23	1.40	1.56	1.72	1.87	1.57	2.26	2.49	2.70	2.94
25	33.7	1.270	1.42	1.56	1.78	1.99	2.20	2.41	2.07	2.93	3.24	3.54	3.88
32	42.4	1.610	1.80	1.99	2.27	2.55	2.82	3.09	2.67	3.79	4.21	4.61	5.08
40	48.3	1.840	2.06	2.28	2.61	2.93	3.25	3.56	3.44	4.37	4.86	5.34	5.90
50	60.3	2.320	2.60	2.88	3.29	3.70	4.11	4.51	3.97	5.55	6.19	6.82	7.55
65	76.1	2.940	3.30	3.65	4.19	4.71	5.24	5.75	5.03	7.11	7.95	8.77	9.74
80	88.9	3.440	3.87	4.29	4.91	5.53	6.15	6.76	6.44	8.38	9.37	10.3	11.5
100	114.3	4.450	4.99	5.54	6.35	7.16	7.97	8.77	7.57	10.9	12.2	13.5	15.0
125	139.7	5.450	6.12	6.79	7.79	8.79	9.78	10.8	9.83	13.4	15.0	16.6	18.5
150	168.3	6.580	7.39	8.20	9.42	10.6	11.8	13.0	12.1	16.2	18.2	20.1	22.5
200	219.1		9.65	10.7	12.3	13.9	15.5	17.0	14.6	21.2	23.8	26.4	29.5
250	273.0			13.4	15.4	17.3	19.3	21.3	19.1	26.5	29.8	33.0	36.9
300	323.9					20.6	23.0	25.3	23.9	31.6	35.4	39.3	44.0
350	355.6					22.6	25.2	27.8	28.4	34.7	39.0	43.2	48.3
400	406.4					25.9	28.9	31.8	31.3	39.7	44.6	49.5	55.4
450	457							35.8	35.8	44.7	50.2	55.7	62.3
500	508							39.8	40.3	49.5	55.9	62.0	69.4
600	610							47.9	44.8	59.8	67.2	74.6	83.5
700	711								53.8	69.7	78.4	87.1	97.4
800	813									79.8	89.7	99.6	112
900	914									89.8	101	112	125
1000	1016									99.8	112	125	140

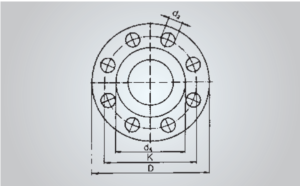
Nominal diam-eter	Outside diam-eter	masses (weights) in relation to length in kg/m wall thickness in mm											
DN	mm	6.3	7.1	8	8.8	10	11	12.5	14.2	16	17.5	20	22.2
6	10.2												
8	13.5												
10	17.2												
15	21.3												
20	26.9	3.20	3.47	3.73									
25	33.7	4.26	4.66	5.07	5.40								
32	42.4	5.61	6.18	6.79	7.29	7.99							
40	48.3	6.53	7.21	7.95	8.57	9.45	10.1	11.0					
50	60.3	8.39	9.32	10.3	11.2	12.4	13.4	14.7	16.1	17.5			
65	76.1	10.8	12.1	13.4	14.6	16.3	17.7	19.6	21.7	23.7	25.3	27.7	
80	88.9	12.8	14.3	16.0	17.4	19.5	21.1	23.6	26.2	28.8	30.8	34.0	36.5
100	114.3	16.8	18.8	21.0	22.9	25.7	28.0	31.4	35.1	38.8	41.8	46.5	50.4
125	139.7	20.7	23.2	26.0	28.4	32.0	34.9	39.2	43.9	48.8	52.7	59.0	64.3
150	168.3	25.2	28.2	31.6	34.6	39.0	42.7	48.0	54.0	60.1	65.1	73.1	80.0
200	219.1	33.1	37.1	41.6	45.6	51.6	56.5	63.7	71.8	80.1	87.0	98.2	108
250	273.0	41.4	46.6	52.3	57.3	64.9	71.1	80.3	90.6	101	110	125	137
300	323.9	49.3	55.5	62.3	68.4	77.4	84.9	96.0	108	121	132	150	165
350	355.6	54.3	61.0	68.6	75.3	85.2	93.5	106	120	134	146	166	183
400	406.4	62.2	69.9	78.6	86.3	97.8	107	121	137	154	168	191	210
450	457	70.0	78.8	88.6	97.3	110	121	137	155	174	190	216	238
500	508	77.9	87.7	98.6	108	123	135	153	173	194	212	241	266
600	610	93.8	106	119	130	148	162	184	209	234	256	291	322
700	711	109	123	139	152	173	190	215	244	274	299	341	377
800	813	125	141	159	175	198	218	247	280	314	343	391	433
900	914	141	159	179	196	223	245	278	315	354	387	441	488
1000	1016	157	177	199	219	248	273	309	351	395	431	491	544

19

FLANGES

PN 1 / PN 2.5 / PN 6

DIN EN 1092: Edition December 2018 (extract)



	DIN EN 1092
Outside diameter	D
Raised face diameter	d_1
Bolt circle diameter	K
Bolt hole diameter	L

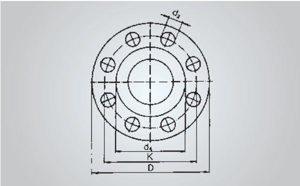
Nominal diameter	Nominal pressure 1 and 2.5						Nominal pressure 6					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10							75	35	50	4	M 10	11
15							80	40	55	4	M 10	11
20							90	50	65	4	M 10	11
25							100	60	75	4	M 10	11
32							120	70	90	4	M 12	14
40							130	80	100	4	M 12	14
50							140	90	110	4	M 12	14
65							160	110	130	4	M 12	14
80							190	128	150	4	M 16	18
100	connection dimensions see nominal pressure 6						210	148	170	4	M 16	18
125							240	178	200	8	M 16	18
150							265	202	225	8	M 16	18
200							320	258	280	8	M 16	18
250							375	312	335	12	M 16	18
300							440	365	395	12	M 20	22
350							490	415	445	12	M 20	22
400							540	465	495	16	M 20	22
450							595	520	550	16	M 20	22
500							645	570	600	20	M 20	22

Nominal diameter	Nominal pressure 1 and 2.5						Nominal pressure 6					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600							755	670	705	20	M 24	26
700							860	775	810	24	M 24	26
800	connection dimensions see nominal pressure 6						975	880	920	24	M 27	30
900							1075	980	1020	24	M 27	30
1000							1175	1080	1120	28	M 27	30
1200	1375	1280	1320	32	M 27	30	1405	1295	1340	32	M 30	33
1400	1575	1480	1520	36	M 27	30	1630	1510	1560	36	M 33	36
1600	1790	1690	1730	40	M 27	30	1830	1710	1760	40	M 33	36
1800	1990	1890	1930	44	M 27	30	2045	1920	1970	44	M 36	39
2000	2190	2090	2130	48	M 27	30	2265	2125	2180	48	M 39	42
2200	2405	2295	2340	52	M 30	33	2475	2335	2390	52	M 39	42
2400	2605	2495	2540	56	M 30	33	2685	2545	2600	56	M 39	42
2600	2805	2695	2740	60	M 30	33	2905	2750	2810	60	M 45	48
2800	3030	2910	2960	64	M 33	36	3115	2960	3020	64	M 45	48
3000	3230	3110	3160	68	M 33	36	3315	3160	3220	68	M 45	48
3200	3430	3310	3360	72	M 33	36	3525	3370	3430	72	M 45	48
3400	3630	3510	3560	76	M 33	36	3735	3580	3640	76	M 45	48
3600	3840	3770	3770	80	M 33	36	3970	3790	3860	80	M 52	56
3800	4045	3970	3970	80	M 36	39	no flanges					
4000	4245	4120	4170	84	M 36	39						

FLANGES

PN 10 / PN 16

DIN EN 1092: Edition December 2018 (extract)



	DIN EN 1092
Outside diameter	D
Raised face diameter	d_1
Bolt circle diameter	K
Bolt hole diameter	L

Nominal diameter	Nominal pressure 10						Nominal pressure 16					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6												
8												
10												
15												
20												
25	connection dimensions see nominal pressure 40						connection dimensions see nominal pressure 40					
32												
40												
50												
65												
80												
100							220	158	180	8	M 16	18
125	connection dimensions see nominal pressure 16						250	188	210	8	M 16	18
150							285	212	240	8	M 20	22
200	340	268	295	8	M 20	22	340	268	295	12	M 20	22
250	395	320	350	12	M 20	22	405	320	355	12	M 24	26
300	445	370	400	12	M 20	22	460	378	410	12	M 24	26
350	505	430	460	16	M 20	22	520	438	470	16	M 24	26
400	565	482	515	16	M 24	26	580	490	525	16	M 27	30
450	615	532	565	20	M 24	26	640	550	585	20	M 27	30
500	670	585	620	20	M 24	26	715	610	650	20	M 30	33

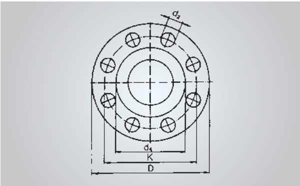
4 screws are permitted if agreed

Nominal diameter	Nominal pressure 10						Nominal pressure 16					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600	780	685	725	20	M 27	30	840	725	770	20	M 33	36
700	895	800	840	24	M 27	30	910	795	840	24	M 33	36
800	1015	905	950	24	M 30	33	1025	900	950	24	M 36	39
900	1115	1005	1050	28	M 30	33	1125	1000	1050	28	M 36	39
1000	1230	1110	1160	28	M 33	36	1255	1115	1170	28	M 39	42
1200	1455	1330	1380	32	M 36	39	1485	1330	1390	32	M 45	48
1400	1675	1535	1590	36	M 39	42	1685	1530	1590	36	M 45	48
1600	1915	1760	1820	40	M 45	48	1930	1750	1820	40	M 52	56
1800	2115	1960	2020	44	M 45	48	2130	1950	2020	44	M 52	56
2000	2325	2170	2230	48	M 45	48	2345	2150	2230	48	M 56	62
2200	2550	2370	2440	52	M 52	56						
2400	2760	2570	2650	56	M 52	56						
2600	2960	2780	2850	60	M 52	56						
2800	3180	3000	3070	64	M 52	56						
3000	3405	3210	3290	68	M 56	62						
3200							no flanges					
3400												
3600	no flanges											
3800												
4000												

FLANGES

PN 25 / PN 40

DIN EN 1092: Edition December 2018 (extract)



	DIN EN 1092
Outside diameter	D
Raised face diameter	d_1
Bolt circle diameter	K
Bolt hole diameter	L

Nominal diameter	Nominal pressure 25						Nominal pressure 40					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6							75	32	50	4	M 10	11
8							80	38	55	4	M 10	11
10							90	40	60	4	M 12	14
15							95	45	65	4	M 12	14
20							105	58	75	4	M 12	14
25							115	68	85	4	M 12	14
32	connection dimensions see nominal pressure 40						140	78	100	4	M 16	18
40							150	88	110	4	M 16	18
50							165	102	125	4	M 16	18
65							185	122	145	8	M 16	18
80							200	138	160	8	M 16	18
100							235	162	190	8	M 20	22
125							270	188	220	8	M 24	26
150							300	218	250	8	M 24	26
200	360	278	310	12	M 24	26	375	285	320	12	M 27	30
250	425	335	370	12	M 27	30	450	345	385	12	M 30	33
300	485	395	430	16	M 27	30	515	410	450	16	M 30	33
350	555	450	490	16	M 30	33	580	465	510	16	M 33	36
400	620	505	550	16	M 33	36	660	535	585	16	M 36	39
450	670	555	600	20	M 33	36	685	560	610	20	M 36	39
500	730	615	660	20	M 33	36	755	615	670	20	M 39	42

Nominal diameter	Nominal pressure 25						Nominal pressure 40					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600	845	720	770	20	M 36	39	890	735	795	20	M 45	48
700	960	820	875	24	M 39	42	995	840	900	24	M 45	48
800	1085	930	990	24	M 45	48	1140	960	1030	24	M 52	56
900	1185	1030	1090	28	M 45	48	1250	1070	1140	28	M 52	56
1000	1320	1140	1210	28	M 52	56	1360	1180	1250	28	M 52	56
1200	1530	1350	1420	32	M 52	56	1575	1380	1460	32	M 56	62
1400	1755	1560	1640	36	M 56	62	1795	1600	1680	36	M 56	62
1600	1975	1780	1860	40	M 56	62	2025	1815	1900	40	M 64	70
1800	2195	1985	2070	44	M 64	70						
2000	2425	2210	2300	48	M 64	70						
2200												
2400												
2600												
2800												
3000							no flanges					
3200	no flanges											
3400												
3600												
3800												
4000												

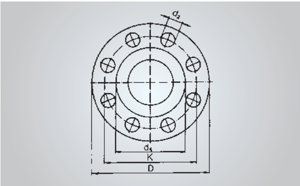
19

19

FLANGES

PN 63 / PN 100

DIN EN 1092: Edition December 2018 (extract)



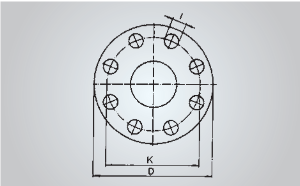
	DIN EN 1092
Outside diameter	D
Raised face diameter	d_1
Bolt circle diameter	K
Bolt hole diameter	L

Nominal diameter	Nominal pressure 63						Nominal pressure 100					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10	Connection dimensions. see nominal pressure 100						100	40	70	4	M 12	14
15							105	45	75	4	M 12	14
20							130	58	90	4	M 16	18
25							140	68	100	4	M 16	18
32							155	78	110	4	M 20	22
40							170	88	125	4	M 20	22
50	180	102	135	4	M 20	22	195	102	145	4	M 24	26
65	205	122	160	8	M 20	22	220	122	170	8	M 24	26
80	215	138	170	8	M 20	22	230	138	180	8	M 24	26
100	250	162	200	8	M 24	26	265	162	210	8	M 27	30
125	295	188	240	8	M 27	30	315	188	250	8	M 30	33
150	345	218	280	8	M 30	33	355	218	290	12	M 30	33
200	415	285	345	12	M 33	36	430	285	360	12	M 33	36
250	470	345	400	12	M 33	36	505	345	430	12	M 36	39
300	530	410	460	16	M 33	36	585	410	500	16	M 39	42
350	600	465	525	16	M 36	39	655	465	560	16	M 45	48
400	670	535	585	16	M 39	42	715	535	620	16	M 45	48
500	800	615	705	20	M 45	48	870	615	760	20	M 52	56
600	930	735	820	20	M 52	56	-	-	-	-	-	-

Nominal diameter	Nominal pressure 63						Nominal pressure 100					
DN				bolts						bolts		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
700	1045	840	935	24	M 52	56	no flanges					
800	1165	960	1050	24	M 56	62						
900	1285	1070	1170	28	M 56	62						
1000	1415	1180	1290	28	M 64	70						
1200	1665	1380	1530	32	M 72	78						

FLANGES AS PER US STANDARDS

ASME B B16.5-2020 / B16.47-2020 (series A)
Class 150

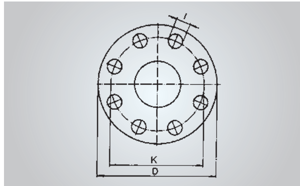


D Outside diameter
K Bolt circle diameter
I Bolt hole diameter

Nominal diameter		Flange				Bolts				
		outside diameter		bolt circle diameter		number	hole diameter		thread	
DN		D		K		–	L		–	
–	Inch	mm	Inch	mm	Inch	–	mm	Inch	mm	Inch
15	1/2	89	3.50	60.5	2.38	4	15.9	5/8	12.7	1/2
20	3/4	99	3.88	69.8	2.75	4	15.9	5/8	12.7	1/2
25	1	108	4.25	79.2	3.12	4	15.9	5/8	12.7	1/2
32	1 1/4	117	4.62	88.9	3.50	4	15.9	5/8	12.7	1/2
40	1 1/2	127	5.00	98.6	3.88	4	15.9	5/8	12.7	1/2
50	2	152	6.00	120.6	4.75	4	19.0	3/4	15.9	5/8
65	2 1/2	178	7.00	139.7	5.50	4	19.0	3/4	15.9	5/8
80	3	190	7.50	152.4	6.00	4	19.0	3/4	15.9	5/8
100	4	229	9.00	190.5	7.50	8	19.0	3/4	15.9	5/8
125	5	254	10.00	215.9	8.50	8	22.2	7/8	19.0	3/4
150	6	279	11.00	241.3	9.50	8	22.2	7/8	19.0	3/4
200	8	343	13.50	298.4	11.75	8	22.2	7/8	19.0	3/4
250	10	406	16.00	362.0	14.25	12	25.4	1	22.2	7/8
300	12	483	19.00	431.8	17.00	12	25.4	1	22.2	7/8
350	14	533	21.00	476.2	18.75	12	28.6	1 1/8	22.2	1
400	16	597	23.50	539.8	21.25	16	28.6	1 1/8	25.4	1
450	18	635	25.00	577.8	22.75	16	31.7	1 1/4	28.6	1 1/8
500	20	693	27.50	635.0	25.00	20	31.7	1 1/4	28.6	1 1/8
600	24	813	32.00	749.3	29.50	20	34.9	1 3/8	31.7	1 1/4
700	28	927	36.50	863.6	34.00	28	34.9	1 3/8	31.7	1 1/4
800	32	1060	41.75	977.9	38.50	28	34.9	1 3/8	31.7	1 1/4
900	36	1168	46.00	1085.8	42.75	32	41.3	1 5/8	38.1	1 1/2
1000	40	1289	50.75	1200.2	47.25	36	41.3	1 5/8	38.1	1 1/2

FLANGES AS PER US STANDARDS

ASME B16.5-2020 / B16.47-2020 (Serie A)
Class 300

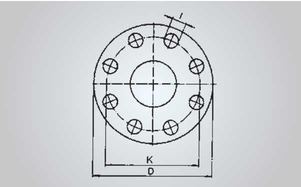


D Outside diameter
K Bolt circle diameter
I Bolt hole diameter

Nominal diameter		Flange				Bolts				
		outside diameter		bolt circle diameter		number	hole diameter		thread	
DN		D		K		–	L		–	
–	Inch	mm	Inch	mm	Inch	–	mm	Inch	mm	Inch
15	1/2	95	3.75	66.7	2.62	4	15.9	5/8	12.7	1/2
20	3/4	115	4.62	82.6	3.25	4	19.0	3/4	15.9	5/8
25	1	125	4.88	88.9	3.50	4	19.0	3/4	15.9	5/8
32	1 1/4	135	5.25	98.4	3.88	4	19.0	3/4	15.9	5/8
40	1 1/2	155	6.12	114.3	4.50	4	22.2	7/8	19.0	3/4
50	2	165	6.50	127.0	5.00	8	19.0	3/4	15.9	5/8
65	2 1/2	190	7.50	149.2	5.88	8	22.2	7/8	19.0	3/4
80	3	210	8.25	168.3	6.62	8	22.2	7/8	19.0	3/4
100	4	255	10.00	200.0	7.88	8	22.2	7/8	19.0	3/4
125	5	280	11.00	235.0	9.25	8	22.2	7/8	19.0	3/4
150	6	320	12.50	269.9	10.62	12	22.2	7/8	19.0	3/4
200	8	380	15.00	330.2	13.00	12	25.4	1	22.2	7/8
250	10	445	17.50	387.3	15.25	16	28.6	1 1/8	25.4	1
300	12	520	20.50	450.8	17.75	16	31.7	1 1/4	28.6	1 1/8
350	14	585	23.00	514.4	20.25	20	31.7	1 1/4	28.6	1 1/8
400	16	650	25.50	571.5	22.50	20	34.9	1 3/8	31.7	1 1/4
450	18	710	28.00	628.6	24.75	24	34.9	1 3/8	31.7	1 1/4
500	20	775	30.50	685.8	27.00	24	34.9	1 3/8	31.7	1 1/4
600	24	915	36.00	812.8	32.00	24	41.3	1 5/8	38.1	1 1/2
700	28	1035	40.75	939.8	37.00	28	44.4	1 3/4	41.3	1 5/8
800	32	1150	45.25	1054.1	41.50	28	47.6	1 7/8	44.4	1 3/4
900	36	1270	50.00	1168.4	46.00	32	54.0	2 1/8	50.8	2
1000	40	1240	48.75	1155.7	45.50	36	54.0	2 1/8	50.8	2

FLANGES AS PER US STANDARDS

ASME B B16.5-2020 / B16.47-2020 (series A
Class 400

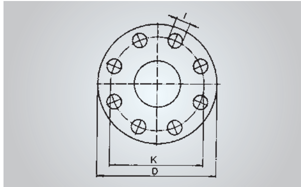


D Outside diameter
K Bolt circle diameter
I Bolt hole diameter

Nominal diameter		Flange				Bolts				
		outside diameter		bolt circle diameter		number	hole diameter		thread	
DN		D		K		–	L		–	
–	Inch	mm	Inch	mm	Inch	–	mm	Inch	mm	Inch
15	1/2	Connection dimensions. see Class 600								
20	3/4									
25	1									
32	1 1/4									
40	1 1/2									
50	2									
65	2 1/2									
80	3									
100	4	254	10.00	200.2	7.88	8	25.4	1	22.2	7/8
125	5	279	11.00	235.0	9.25	8	25.4	1	22.2	7/8
150	6	318	12.50	269.7	10.62	12	25.4	1	22.2	7/8
200	8	381	15.00	330.2	13.00	12	28.6	1 1/8	25.4	1
250	10	444	17.50	387.4	15.25	16	31.7	1 1/4	28.6	1 1/8
300	12	521	20.50	450.8	17.75	16	34.9	1 3/8	31.7	1 1/4
350	14	584	23.00	514.4	20.25	20	34.9	1 3/8	31.7	1 1/4
400	16	648	25.50	571.5	22.50	20	38.1	1 1/2	34.9	1 3/8
450	18	711	28.00	628.6	24.75	24	38.1	1 1/2	34.9	1 3/8
500	20	775	30.50	685.8	27.00	24	41.3	1 5/8	38.1	1 1/2
600	24	914	36.00	812.8	32.00	24	47.6	1 7/8	44.4	1 3/4
700	28	1035	40.75	939.8	37.00	28	47.6	1 7/8	44.4	1 3/4
800	32	1149	45.25	1054.1	43.50	28	54.0	2 1/8	50.8	2
900	36	1270	50.00	1168.4	46.00	32	54.0	2 1/8	50.8	2
1000	40	1270	50.00	1174.8	46.25	36	66.7	2 5/8	63.5	2 1/2

FLANGES AS PER US STANDARDS

ASME B16.5-2020 / B16.47-2020 (Serie A)
Class 600

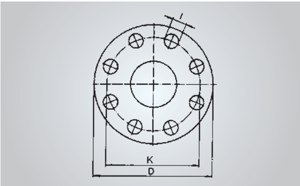


D Outside diameter
K Bolt circle diameter
I Bolt hole diameter

Nominal diameter		Flange				Bolts				
		outside diameter		bolt circle diameter		number	hole diameter		thread	
DN		D		K		–	L		–	
–	Inch	mm	Inch	mm	Inch	–	mm	Inch	mm	Inch
15	1/2	95	3.75	66.5	2.62	4	15.9	5/8	12.7	1/2
20	3/4	117	4.62	82.6	3.25	4	19.0	3/4	15.9	5/8
25	1	124	4.88	88.9	3.50	4	19.0	3/4	15.9	5/8
32	1 1/4	133	5.25	98.6	3.88	4	19.0	3/4	15.9	5/8
40	1 1/2	155	6.12	114.3	4.50	4	22.2	7/8	19.0	3/4
50	2	165	6.50	127.0	5.00	8	19.0	3/4	15.9	5/8
65	2 1/2	190	7.50	149.4	5.88	8	22.2	7/8	19.0	3/4
80	3	210	8.25	168.1	6.62	8	22.2	7/8	19.0	3/4
100	4	273	10.75	215.9	8.50	8	25.4	1	22.2	7/8
125	5	330	13.00	266.7	10.50	8	28.6	1 1/8	25.4	1
150	6	356	14.00	292.1	11.50	12	28.6	1 1/8	25.4	1
200	8	419	16.50	349.2	13.75	12	31.7	1 1/4	28.6	1 1/8
250	10	508	20.00	431.8	17.00	16	34.9	1 3/8	31.7	1 1/4
300	12	559	22.00	489.0	19.25	20	34.9	1 3/8	31.7	1 1/4
350	14	603	23.75	527.0	20.75	20	38.1	1 1/2	34.9	1 3/8
400	16	686	27.00	603.2	23.75	20	41.3	1 5/8	38.1	1 1/2
450	18	743	29.25	654.0	25.75	20	44.4	1 3/4	41.3	1 5/8
500	20	813	32.00	723.9	28.50	24	44.4	1 3/4	41.3	1 5/8
600	24	940	37.00	838.2	33.00	24	50.8	2	47.6	1 7/8
700	28	1073	42.25	965.2	38.00	28	50.8	2	47.6	1 7/8
800	32	1194	47.00	1079.5	42.50	28	54.0	2 1/8	50.8	2
900	36	1314	51.75	1193.8	47.00	28	66.7	2 5/8	63.5	2 1/2
1000	40	1321	52.00	1212.8	47.75	28	73.0	2 7/8	69.8	2 3/4

FLANGES AS PER US STANDARDS

ASME B16.5-2020 / B16.47-2020 (Serie A)
Class 900

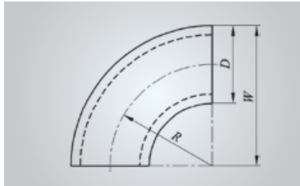


D Outside diameter
K Bolt circle diameter
I Bolt hole diameter

Nominal diameter		Flange				Bolts				
		outside diameter		bolt circle diameter		number	hole diameter		thread	
DN		D		K		–	L		–	
–	Inch	mm	Inch	mm	Inch	–	mm	Inch	mm	Inch
15	1/2	121	4.75	82.6	3.25	4	22.2	7/8	19.0	3/4
20	3/4	130	5.12	88.9	3.50	4	22.2	7/8	19.0	3/4
25	1	149	5.88	101.6	4.00	4	25.4	1	22.2	7/8
32	1 1/4	159	6.25	111.1	4.38	4	25.4	1	22.2	7/8
40	1 1/2	178	7.00	124.0	4.88	4	28.6	1 1/8	25.4	1
50	2	216	8.50	165.1	6.50	8	25.4	1	22.2	7/8
65	2 1/2	244	9.62	190.5	7.50	8	28.6	1 1/8	25.4	1
80	3	241	9.50	190.5	7.50	8	25.4	1	22.2	7/8
100	4	292	11.50	235.0	9.25	8	31.7	1 1/4	28.6	1 1/8
125	5	349	13.75	279.4	11.00	8	34.9	1 3/8	31.7	1 1/4
150	6	381	15.00	317.5	12.50	12	31.7	1 1/4	28.6	1 1/8
200	8	470	18.50	393.7	15.50	12	38.1	1 1/2	34.9	1 3/8
250	10	546	21.50	469.9	18.50	16	38.1	1 1/2	34.9	1 3/8
300	12	610	24.00	533.4	21.00	20	38.1	1 1/2	34.9	1 3/8
350	14	641	25.25	558.8	22.00	20	41.3	1 5/8	38.1	1 1/2
400	16	705	27.75	616.0	24.25	20	44.4	1 3/4	41.3	1 5/8
450	18	787	31.00	685.8	27.00	20	50.8	2	47.6	1 7/8
500	20	857	33.75	749.3	29.50	20	54.0	2 1/8	50.8	2
600	24	1041	41.00	901.7	35.50	20	66.7	2 5/8	63.5	2 1/2
700	28	1168	46.00	1022.4	40.25	28	47.6	1 7/8	44.4	1 3/4
800	32	1314	51.75	1155.7	45.50	28	54.0	2 1/8	50.8	2
900	36	1460	57.50	1289.0	50.75	32	54.0	2 1/8	50.8	2
1000	40	1511	59.50	1339.8	52.75	36	66.7	2 5/8	63.5	2 1/2

PIPE BEND. 90°

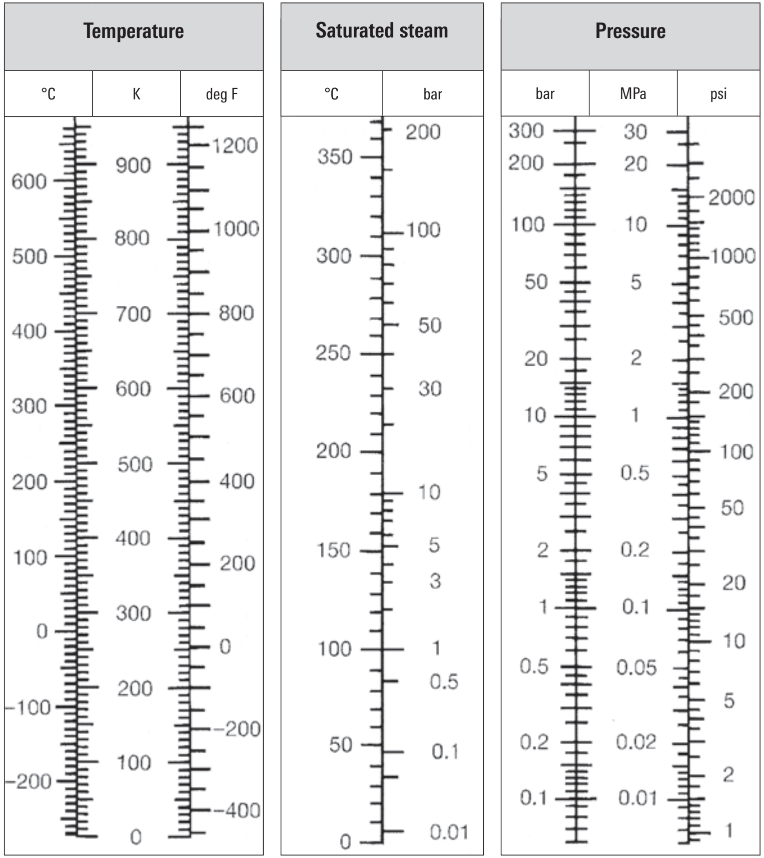
DIN EN 10253-2. edition 09.2008



Nominal diameter	Outside diameter	Type 2: R ~ 1.0 x D		Type 3: R ~ 1.5 x D	
DN	D	R 1"	O	R 1"	O
–	mm	mm	mm	mm	mm
50	60.3	51	81	76	106
65	76.1	63	102	95	133
80	88.9	76	121	114	159
100	114.3	102	159	152	210
125	139.7	127	197	190	260
150	168.3	152	237	229	313
200	219.1	203	313	305	414
250	273	254	391	381	518
300	323.9	305	467	457	619
350	355.6	356	533	533	711
400	406.4	406	610	610	813
450	457	457	686	686	914
500	508	508	762	762	1016
600	610	610	914	914	1219
700	711	711	1066	1067	1422
800	813	813	1220	1219	1626
900	914	914	1371	1372	1829
1000	1016	1016	1524	1524	2032

CONVERSION TABLES AND FORMULA SYMBOLS

TEMPERATURE, SATURATED STEAM, PRESSURE



STEAM TABLE

Pressure (absolute)	Saturation temperature	Kinematic viscosity of steam	Density of steam
bar	°C	10^{-6} m²/s	kg/m³
P	t	ν''	ρ''
0.02	17.513	650.24	0.01492
0.04	28.983	345.295	0.02873
0.06	36.183	240.676	0.04212
0.08	41.534	186.72	0.05523
0.1	45.833	153.456	0.06814
0.14	52.574	114.244	0.09351
0.2	60.086	83.612	0.1307
0.25	64.992	68.802	0.1612
0.3	69.124	58.69	0.1912
0.4	75.886	45.699	0.2504
0.45	78.743	41.262	0.2796
0.5	81.345	37.665	0.3086
0.6	85.954	32.177	0.3661
0.7	89.959	28.178	0.4229
0.8	93.512	25.126	0.4792
0.9	96.713	22.716	0.535
1	99.632	20.76	0.5904
1.5	111.37	14.683	0.8628
2	120.23	11.483	1.129
2.5	127.43	9.494	1.392
3	133.54	8.13	1.651
3.5	138.87	7.132	1.908
4	143.62	6.367	2.163
4.5	147.92	5.76	2.417

Pressure (absolute)	Saturation temperature	Kinematic viscosity of steam	Density of steam
bar	°C	10^{-6} m²/s	kg/m³
P	t	ν''	ρ''
5	151.84	5.268	2.669
6	158.84	4.511	3.17
7	164.96	3.956	3.667
8	170.41	3.531	4.162
9	175.36	3.193	4.655
10	179.88	2.918	5.147
11	184.07	2.689	5.637
12	187.96	2.496	6.127
13	191.61	2.33	6.617
14	195.04	2.187	7.106
15	198.29	2.061	7.596
20	212.37	1.609	10.03
25	223.94	1.323	12.51
30	233.84	1.126	15.01
34	240.88	1.008	17.03
38	247.31	0.913	19.07
40	250.33	0.872	20.1
45	257.41	0.784	22.68
50	263.91	0.712	25.33
55	269.93	0.652	28.03
60	275.55	0.601	30.79
65	280.82	0.558	33.62
70	285.79	0.519	36.51
75	290.5	0.486	39.48

PHYSICAL UNITS (D, GB, US)

DIN 1301-1, edition 10.2010 among others

SI-Basic Units

Size	SI-Basic Unit	
	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Current intensity	Ampere	A
Thermodynamic temperature	Kelvin	K
Quantity of material	Mol	mol
Light intensity	Candela	cd

Prefix symbols

Prefix	Prefix symbol	Multiplication factor
Piko	p	10^{-12}
Nano	n	10^{-9}
Micro	μ	10^{-6}
Milli	m	10^{-3}
Centi	c	10^{-2}
Deci	d	10^{-1}
Deca	da	10^{1}
Hecto	h	10^{2}
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}

Length - SI-Unit metre, m

Symbol	Name	in m
mm	millimetre	0.0010
km	kilometre	1000
in	Inch	0.0254
ft	foot (=12 in)	0.3048
yd	yard (=3ft / = 36 in)	0.9144

Mass – SI-Unit kilogram, kg

Symbol	Name	in kg
g	gram	0.00100
t	to	1000
oz	ounce	0.02835
lb	pound	0.45360
sh tn	short ton (US)	907.2
tn	ton (UK)	1016

Time – SI-Unit second, s

Symbol	Name	in s
min	minute	60
h	hour	3600
d	day	86400
a	year	$3.154 \cdot 10^{7}$ (≙ 8760 h)

Temperature – SI-Unit Kelvin, K

Symbol	Name	in K	in °C
°C	degree centigrade	ϑ/°C + 273.16	1
deg F	degree Fahrenheit	ϑ/deg F · 5/9 + 255.38	(ϑ/deg F - 32) · 5/9

Angle – SI-Unit Radiant, rad = m/m

Symbol	Name	in rad
	full angle	2π
gon	gon (new deg.)	$\pi/200$
°	degree (deg.)	$\pi/180$
'	minute	$\pi/1.08 \cdot 10^{-4}$
''	second	$\pi/6.48 \cdot 10^{-5}$

Pressure – SI-Unit Pascal, Pa = N/m² = kg/ms²

Symbol	Name	in Pa	in bar
Pa = N/m^2	Pascal	1	0.00001
hPa = mbar	Hectopascal = millibar	100	0.001
kPA	Kilopascal	1000	0.01
bar	Bar	100000	1
MPa = N/mm^2	Megapascal	1000000	10
mm WS	millimetre water column	9.807	0.0001
lbf/in^2 = psi	pound-force per square inch	6895	0.0689
lbf/ft^2	pound-force per square foot	47.88	0.00048

Energy (also called Work, Quantity of Heat) SI-Unit Joule, J = Nm = Ws

Symbol	Name	in J
kWs	kilowatt second	1000
kWh	kilowatt hours	$3.6 \cdot 10^6$
kcal	kilocalorie	4186
lbf x ft	pound-force foot	1.356
Btu	British thermal unit	1055

Capacity – SI-Unit Watt, W = m² kg/s³ = J/s

Symbol	Name	in W
kW	kilowatt	1000
PS	horsepower	735.5
hp	horsepower	745.7

Volume – SI-Unit, m³

Symbol	Name	in m^3
l	litre	0.001
in^3	cubic inch	$1.6387 \cdot 10^{-5}$
ft^3	cubic foot	0.02832
gal	gallon (UK)	0.004546
gal	gallon (US)	0.003785

GREEK ALPHABET

α	Alpha	Α	Alpha
β	Beta	Β	Beta
γ	Gamma	Γ	Gamma
δ	Delta	Δ	Delta
ε	Epsilon	Ε	Epsilon
ζ	Zeta	Ζ	Zeta
η	Eta	Η	Eta
ϑ θ	Theta	Θ	Theta
ι	Jota	Ι	Jota
κ	Kappa	Κ	Kappa
λ	Lambda	Λ	Lambda
μ	My	Μ	My
ν	Ny	Ν	Ny
ξ	Xi	Ξ	Xi
ο	Omikron	Ο	Omikron
π	Pi	Π	Pi
ρ	Rho	Ρ	Rho
σ ς	Sigma	Σ	Sigma
τ	Tau	Τ	Tau
υ	Ypsilon	Υ	Ypsilon
ϕ	Phi	Φ	Phi
χ	Chi	Χ	Chi
ψ	Psi	Ψ	Psi
ω	Omega	Ω	Omega