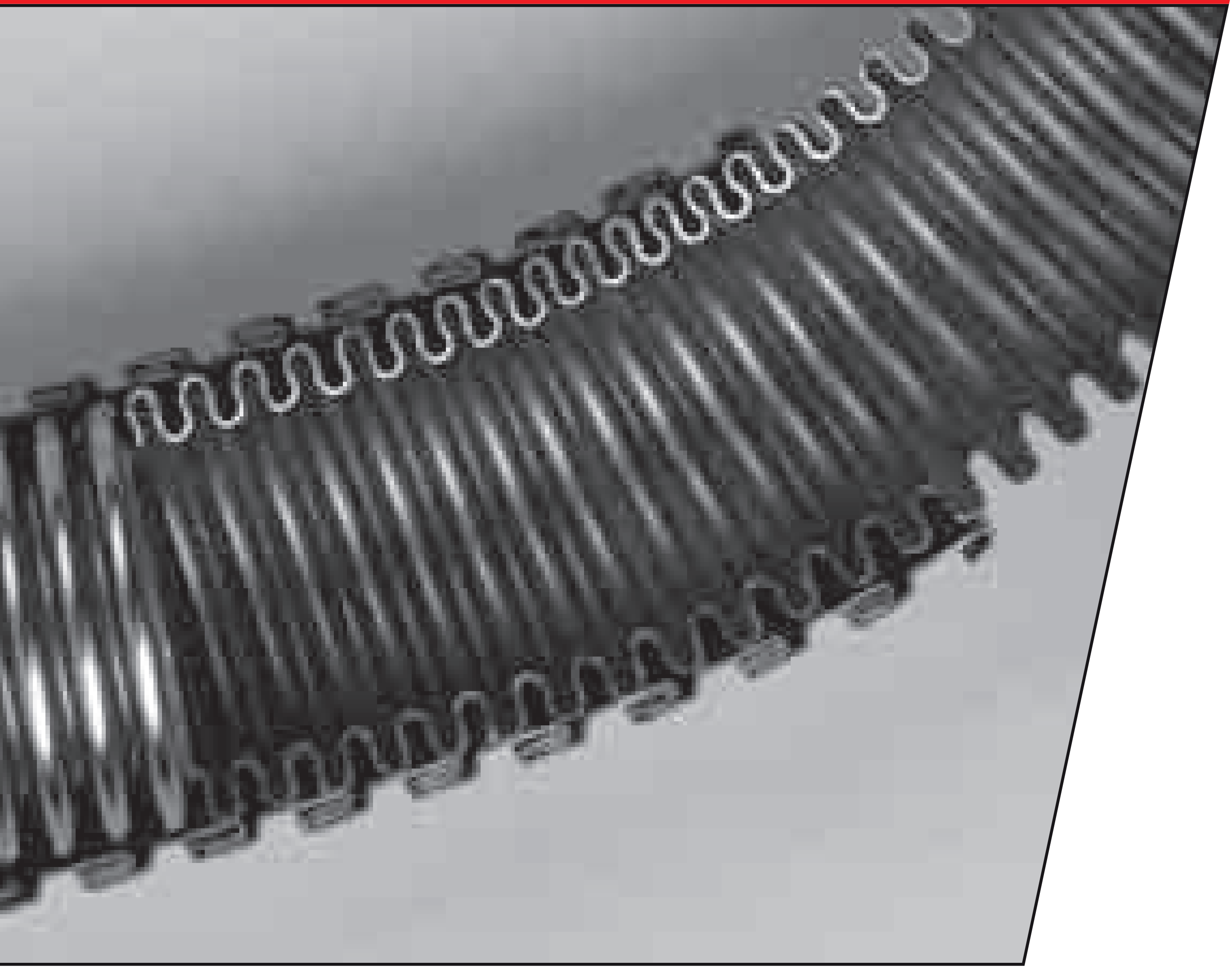
WITZENMANN

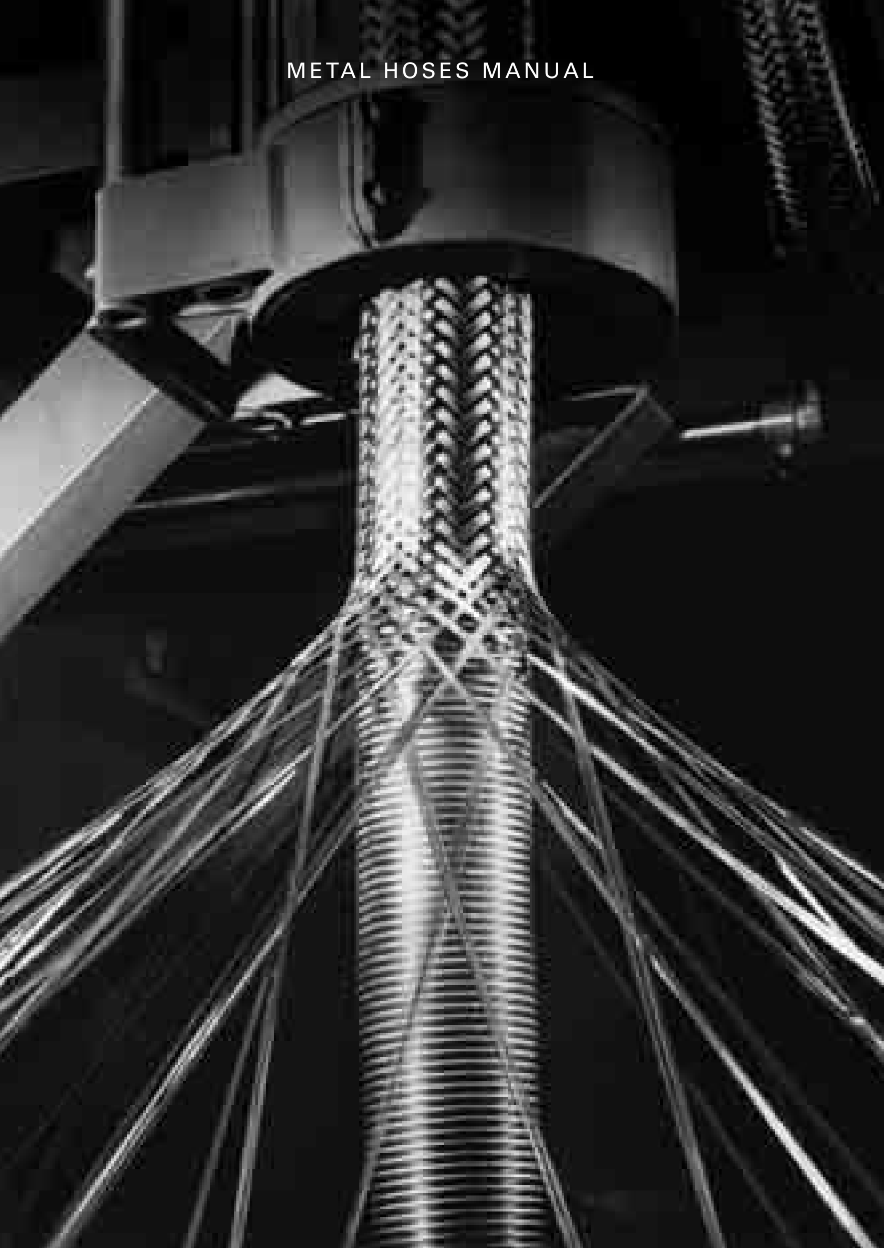
Metal Hoses Manual



ФИНТЕКС ТРЕЙД ЕООД
бул. Димитър Попов № 28,
2050 Ихтиман
Тел.: 02 489 4941
Факс: 0724 82204
E-mail: sales@fintex-trade.com
Web: www.fintex-trade.com

HYDRA
Quality by Witzenmann

METAL HOSES MANUAL



METAL HOSES MANUAL

Contents

Contents

Skilled solutions
Wherever pipes expand due to frequent changes of temperature or pressure, wherever vibrations occur in pipework, wherever heavy loads have to be carried, wherever pressure-tight transport of media is essential, wherever a high vacuum must be maintained – flexible metal elements are required.

Elements like metal hoses, expansion joints, metal bellows and automotive components as well as hangers and pipe supports.

The history of Witzenmann, the inventor of the metal hose and the founder of the metal hoses and expansion joints industry goes back to the year 1885 and the first patented metal hose. The patent for the metal expansion joint followed in 1920.

Worldwide presence
Today the Witzenmann company stands for innovation and high quality as an international group of companies with a total of 2,500 employees in more than 20 subsidiaries.

Witzenmann provides the world's widest range of flexible metal elements. Our know-how in engineering and production is the base for optimal solutions, whenever there is a need for the isolation of vibrations and accommodation of movements in pipes whether in industrial applications, the

HVAC sector, the automotive industry and numerous other markets. With in-house machine design, toolmaking and prototyping plus comprehensive testing and inspection facilities Witzenmann is the ideal partner for customized product development.

Important for the cooperation with customers are the consultancy services provided by the competence centre at Witzenmann's headquarters in Pforzheim in southern Germany. Teams of highly qualified engineers working side by side with the customer on product developments and new applications. Specialists complementing the customer's skills. From the preliminary drawings to series production.

Proficient products
This concentration of knowledge and 150 years of experience become synergies evidenced by our product solutions for a virtually unlimited diversity of applications. But all have one thing in common: maximum safety. Even in the sometimes extreme conditions.

That is why Witzenmann is the technology leader and pioneer in this branch of industry.

2 | QUALITY AND EXPERTISE

Company-
wide quality
assurance

Quality management
Quality is taking on an ever more significant role in the customer–supplier relationship. And quality assurance goes well beyond the traditional meaning of the term.

Nowadays, quality stands for quality of the company, quality of the service and quality of the relationship.

Quality management works from the top down throughout the entire corporate apparatus. Senior management regards it as its task to make quality assurance an intrinsic element of corporate strategy and an obligation for every member of staff.

In order that all members of staff are in a position to do justice to their responsibility for the quality of the company as a whole, Witzenmann GmbH has set up a comprehensive internal training programme – because only a constant upgrading of qualifications can create the foundation for an unceasing improvement in quality.

Our customers are the sole yardstick by which we measure our progress. Their requirements are our motivation, their satisfaction is our future. Senior management has made it its duty to promote an awareness of responsibility and quality throughout the workforce.

This strategy guarantees compliance with the quality demands of the customers and also with the high standards of quality the company has set itself. Such an approach makes a major contribution to consolidating and expanding Witzenmann's leading position in this branch of industry.

The Witzenmann GmbH quality management system is founded on the process-based approach of TS 16949.

Supplier management

We regard suppliers as partners who help us achieve our goals. Their reliability and their competence have a decisive influence on all our business connections. The efficient cooperation with our suppliers enables us to offer our customers – now and in the future – the product quality and delivery reliability they have come to expect from us. And to offer ongoing improvements in both areas.

The foundations for this have already been laid. Our strategic supplier management has been further upgraded since 2004, also with respect to the expanding international operations of the Witzenmann Group. We place our suppliers in one of three categories:

- Those suppliers who satisfy our minimum requirements sign a short-term framework agreement for series suppliers. Such contracts usually last for one year, after which the business relationship is re-assessed.

- Suppliers who have proved reliable as series suppliers and who have contributed suggestions to enhance the business relationship are then invited to sign a **preferred supplier** framework contract, which can last for several years.

Supplier management

- Optimum support in the achievement of our current and future goals is provided by **strategic partners** who introduce their own technological skills into the business relationship. Such suppliers participate in development projects and sign lifetime supply contracts for products developed jointly.

We want to offer our customers optimum services at optimum conditions – in the future, too. And we expect no less from our suppliers. Upholding the quality objectives at favourable prices, maximum delivery reliability and adherence to deadlines, continuous improvements to the costs structure, an eagerness to cooperate and to provide the necessary services. Only together with its partners can the Witzenmann Group achieve its goals and continue to grow.

From inquiry to installation

Product and process development
The Witzenmann Group is today acknowledged as the technology leader in many fields. Forward-looking developments today guarantee our position in the markets of tomorrow – and hence also the futures of our employees, customers and suppliers. In order to defend and expand our leading position in the market, our products and production methods are subject to an ongoing development programme.

We use our trial setups to analyse new, complex processes and technologies with the aim of being able to incorporate these into series production at a later date. But we analyse not only our manufacturing processes; the products themselves are constantly undergoing redevelopment. With the help of preliminary and feasibility studies we assess new products and in doing so find out which of these can be included in our range. Our primary guiding principles in this work are technical feasibility and the future demands of our target markets. Yet another task is the relentless further development of the existing product range in order to improve product quality and product functionality. In this way we ensure that we can continue to offer optimum solutions to meet our customers' future needs as well.

Product tests and calculations

Product tests and calculations
Our skills in devising solutions in the field of flexible metal elements are based to a great extent on synergies drawn from the networking of knowledge resources throughout the group. The different lines of business of the Witzenmann Group encourage a close-knit transfer of experience and knowledge, and take advantage of the extraordinary engineering potential that deals intensively with troubleshooting, product development and quality assurance for our customers. The objective is an optimum product solution for the particular application every time.

Every year, Witzenmann invests faithfully in its own developments. Highly qualified employees are directly involved in product development and product tests. A central pool designs the products of the future to match the given specification. The resulting prototypes – likewise further developments originating directly from the various specialist departments – are thoroughly tested by experts in our central testing laboratory.

Loading simulations calculate whether the subsequent prototypes can meet the demands placed on them. Realistic test runs reveal any potential weak spots in tests under operating conditions. All the specified and necessary product properties such as flexibility, acoustic behaviour or durability are checked systematically.

The high demands in terms of testing equipment and competence in the inspection of flexible metal elements is guaranteed through regular investment in the very latest diagnostic systems. The four- and six-axis test rigs, ultrasound and X-ray systems and thermal test apparatus have recently been joined by a fast pulsating pressure facility with an environmental test chamber for temperatures up to 180°C. The new facility can create pulsating pressures of up to 250 bar in order to simulate, for example, realistic conditions for vehicle components – an aspect crucial to safety.

Jointing methods
Witzenmann products are deployed worldwide in many industries and in the very toughest conditions. During their lives, our components often have to withstand extreme loads with maximum reliability. In order to remain fit for such conditions, the processes we use at Witzenmann undergo continuous development, and we place high demands on the processed semi-finished goods.

Welding
The most important and most frequently used welding methods are covered by tests to DIN EN 288 parts 1-3 (EN ISO 15607).

The constant updating of the testing methods is the responsibility of welding supervisors. Welding work is regulated by written instructions. The skills of our welders are guaranteed through repeat examinations to DIN EN 287-1 (EN ISO 9606-1) and EN ISO 9606-4 for fusion welding, or to DIN EN 1418 (EN ISO 14732) for the welding personnel. The supervision of welding works complies with the requirements of AD 2000 Leaflet HP3.

Soldering
The soldering methods used comply with the requirements of AD 2000 Leaflet HP0, section 3.4, DIN EN 13134 and VDTÜV Leaflet 1160 (welding). Personnel producing soldered joints are tested according to DIN EN 13133.

Materials laboratory and damage analysis

Materials laboratory

Economic production is only possible with an expedient choice of materials based on the relevant properties of those materials.
To do this, those properties must be known accurately.
The right choice of material is another factor helping to ensure optimum product quality and optimum product safety. The majority of the semi-finished goods for our products are high-quality thin metal strips, wires and sheets, also thin-wall tubes. The high standard of quality that we demand of our semi-finished goods is stated in our ordering and acceptance documents which form the basis of our procurement policy. The quality requirements incorporate both national and international standards and specifications, but also internal production and documentation requirements. Tests carried out on deliveries of materials guarantee that the dimensional, mechanical–technological and chemical properties stated in our ordering documents are upheld. Our materials laboratory is acknowledged by the relevant inspection and classification bodies as a supervisory unit for destructive and non-destructive materials tests independent from the production. Our facilities are authorised to issue inspection certificates. X-ray and ultrasound equipment is used for the non-destructive testing of components and welded seams.

Damage analysis

Another aspect of materials testing is the analysis of damage. If products fail during tests or during later use, metallographic and scanning electron microscope investigations are carried out and the pattern of damage documented with photographs.

2.3 | PRODUCT APPROVALS

Internationally approved

Before a newly developed flexible element is released for series production, it is subjected to a tough testing regime in our highly advanced development centre: electrodynamic vibration test rigs, hot-gas and long-term durability test appliances, corrosion testing systems, mobile testing units.

Witzenmann applies these tests to ensure that the metal hoses we supply can withstand everything required of them over a long time. And we proceed with the same care in series production as well.

In close cooperation with our production department, our in-house mechanical engineering and toolmaking departments guarantee stable production processes and maximum product quality. The DIN ISO 9001 certification is proof that Witzenmann has been applying these standards for a long time. Witzenmann was the first company in this branch of industry to obtain such certification. And now Witzenmann is working to the even stricter ISOTS 16949 standard. Such certification forms the basis for our leading position in the market. The following approvals are witness to our leadership when it comes to quality.

General approvals

Quality management system to DIN ISO 9001/EN 29001

Technischer Überwachungs-Verein Südwest e.V., testing and confirmation as a manufacturer to AD Leaflet HP0, W0 and to TRD 100

Specific approvals (selection)

Gas/water

DVGW Deutscher Verein des Gas- und Wasserfaches e.V.	Germany
ÖVGW Österreichische Vereinigung für das Gas- u. Wasserfach	Austria
SVGW Schweizerischer Verein des Gas- und Wasserfaches	Switzerland
AFNOR Gas Association Française de Normalisation	France
IMQ Insieme per la Qualitá e la Sucurezza, Milano	Italy
DG Danmarks Gasmateriel Prøvning	Denmark
IGNG Instytut Górnictwa Naftowego i Gazownictwa	Poland
GOST-R Gosudarstwennyj obschtschesojusnyj standart	Russia

Fire protection

VdS Verband der Sachversicherer e.V.	Germany

	Fire protection	
	FM Factory Mutual Research	USA
	UL Underwriter Laboratories Inc.	USA & Canada
Shipping		
	GL Germanischer Lloyd	Germany
	ABS American Bureau of Shipping	USA
	BV Bureau Veritas	France
	DNV DET NORSKE VERITAS	Norway
	LRS Lloyd's Register of Shipping	UK
	RINA Registro Italiano Navale	Italy
Others		
	BAM Bundesanstalt für Materialforschung und -prüfung	Germany
	VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.	Germany
	Framatome ANP GmbH für den Zusammenschluss der Kernkraftwerkbetreiber	Germany

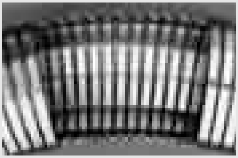
3 | BASIC FACTS ABOUT METAL HOSES

HYDRA metal hoses are supplied by the company that was the first in the world to manufacture such products. Together with his French partner Eugène Levavasseur, our company founder Heinrich Witzenmann invented and produced the first metal hose in 1885. Metal hoses have been manufactured in this factory ever since. Almost all of the metal hose products commonly in use around the world today are based upon this invention and their development has been decisively influenced by our activities.

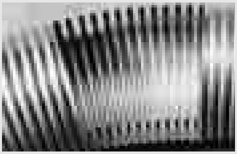
Modern technology with its high demands on pipe systems for carrying hot and cold fluids would not have reached its present standard without the metal hose as a flexible metal conduit. Its most important applications are in car production, heating, ventilation and air conditioning equipment, the chemical and petrochemical industries, the steel industry, mechanical and industrial engineering as well as in fibre optics and measurement and control systems.

There are two principal types of metal hoses whose distinguishing features – apart from a few overlaps – are seen in their design and application: stripwound hoses and corrugated hoses.

Cross-section of a stripwound hose in the plane of flexure



Cross-section of a corrugated hose in the plane of flexure



Corrugated hoses – design and function
The starting materials for corrugated hoses are either seamless or longitudinally welded, thin-walled tubes that are corrugated by special mechanical or hydraulic tools.

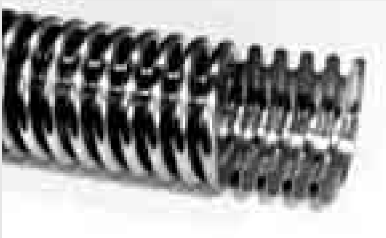
This means that corrugated hoses are absolutely leakproof, making them suitable for carrying liquids and gases under pressure or for use in vacuum systems. This is why they are also described as pressure hoses.

Corrugated hoses are used as low-cost, flexible connecting elements for absorption of movement, thermal expansion, vibration or as filling hoses. A selection from the wide range of applications is presented in Section 6.

Both their flexibility and strength under pressure are attributable to the design principle of a succession of springy corrugations shaped rather like a lyre.

Corrugated hoses are produced in two basic versions whose distinguishing feature is the form of corrugation: annular and helical.

Annularly corrugated hose



Helically corrugated hose

Corrugated hoses

The annular corrugation consists of a multitude of evenly spaced parallel corrugations whose principal plane is perpendicular to the axis of the hose. In contrast, the helical corrugation consists of a typically right-handed spiral of unvarying pitch that continues for the whole length of the hose.

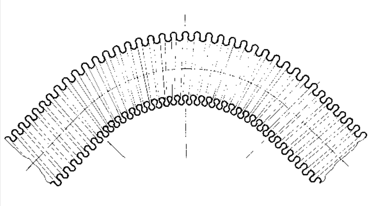
In comparison with helically corrugated hoses, hoses with annular corrugations have a number of advantages, the most important of which are:

- Assuming correct installation, they are not subjected to harmful torsion stresses when sudden increases in pressure occur (pressure pulses).

- The shape of the profile ensures that the hose end has an even geometry where the connection is. This improves the reliability of the fabrication and operation of the hose.

As a result, helically corrugated hoses are now only used in exceptional cases.

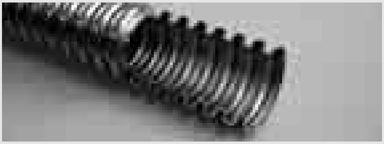
The flexibility of corrugated metal hoses mainly arises from the nature of the corrugation. When flexed, the corrugations are extended on the outside of the bend and compressed on the inside.



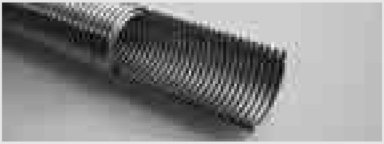
The manufacturer can individually define the flexibility, bending behaviour and pressure resistance of corrugated hoses by an appropriate choice of profile shape. The taller the profile and the smaller the distance between corrugations, the higher the flexibility, but, however, the lower is the pressure resistance of the hose.

A semi-flexible bending behaviour is desirable in many cases. A flat profile achieves this, while offering economic advantages through reduced use of materials. These differing requirements are the reason why, in addition to the standard profiles, the company has for many years offered a multitude of customized profile shapes.

Semi-flexible profile with low profile height



Heavy pattern with tall profile



Hose with compressed corrugations

Pressure resistance and flexibility can also be altered by varying the wall thickness. A reduction in wall thickness increases flexibility, but reduces pressure resistance.

In contrast to metal bellows, metal hoses are mostly single-walled. To increase the pressure resistance, they are manufactured with single or double braiding.

The hose braiding is joined tightly to the hose fittings at both ends to ensure the hose copes with the longitudinal force caused by the internal pressure. The flexibility of the braiding is also well able to adapt to the movements of the hose itself. Braidings consist of right-handed and left-handed wire coils that cross alternately over and under each other. Braiding not only prevents expansion of the hose through the internal pressure, it also absorbs external tensile forces and generally serves to protect the exterior of the hose.

Corrugated hoses

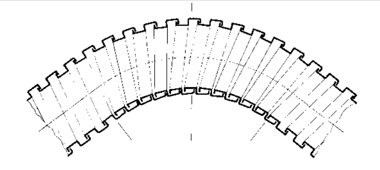
The wire braiding and corrugated hose generally consist of the same basic material. However, differing materials are sometimes chosen to provide corrosion protection or for economic reasons.

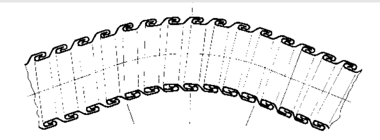
The standard range of HYDRA corrugated hoses is produced in sizes between 4 mm and 300 mm nominal internal diameter. Smaller and larger diameters are available on request. However, corrugated hoses are leakproof under both positive and negative pressure. The maximum operating pressure for small diameters extends to 380 bar (with a 3-to-1 bursting pressure safety factor). For technical reasons, large diameter hoses have a lower pressure resistance. Stainless steel types are heat-proof up to approx 600ºC. and special materials can provide even higher performance. For low-temperature applications, stainless steel hoses can be used down to -270ºC!

Pressure-proof corrugated hoses have a wide range of applications.

Stripwound hoses – design and function
HYDRA stripwound hoses are produced by helical coiling of a cold-rolled shaped metal strip onto a spindle. Due to the shape of the profile, one helical coil interlocks with the next but is also moveable. The moveable joins between the profiled coils is what makes the metal stripwound hose flexible. The starting material for such hoses is typically strip of galvanized steel, stainless steel or brass but we also offer stripwound hoses of brass with a chrome or nickel-plated finish. The main applications in the automotive industry require stripwound hoses with a metallic seal. Enhanced sealing can be achieved by introducing a thread into a specially profiled groove during the winding process. This packing thread is typically cotton, rubber or ceramic. To improve sealing against water spray, for example, stripwound hoses are also available with a PVC or silicone sheathings.

Stripwound hoses are manufactured with round and polygonal cross-sections; the coil shape extends from the simple hooked profile (top picture) to the high-strength Agraff profile (bottom picture). Apart from these, a whole range of special profiles are available for exhaust systems (see section 6).





The characteristics of wound metal hoses depend on the respective profile, the strip dimensions, the material and, where used, the type of seal.

Stripwound hoses

The most important of these are flexibility, tensile strength, sealing effectiveness, torsional resistance, internal pressure resistance, shear force resistance, resistance to chemical and thermal influences.

Witzenmann now has a wide range of stripwound hose types to cover a diversity of applications. Recently introduced are miniature protective hoses with internal diameters of up to 1 mm! The standard range includes stripwound hoses with a diameter of DN 500. The maximum production lengths depend on design and diameter, but can be 100 m and greater.

Stripwound hoses are frequently used as elements of exhaust systems, especially in trucks and special-purposes vehicles such as tractors, where their flexibility, heat resistance and non-ageing property are advantageous. A further important application is their use as exterior protection for optical fibres and electrical cables in fibre optics or measurement and control systems. In addition, they are used as hoses for extraction and delivery of smoke, machining chips, granules, etc. However, stripwound hoses are also used to protect corrugated hoses against excessive bending or as a liner to optimize flow characteristics.

The range of wound metal hoses also includes flexible arms – also referred to as goose-necks – which are produced by winding round-wire coils one over the other with triangular section wire wound on top. They can be bent in any direction and remain in any position. Applications are flexible holders for lamps, magnifiers, microphones, etc. With an inner plastic hose, this design also serves as coolant delivery piping for machine tools, enabling the fluid to be controlled very precisely.

As a market and technology leader, Witzenmann is represented in the most important national and international standardization committees and industrial associations. Not least for the sake of users, we work to raise and harmonize the quality standards for metal hoses.

The past ten years, in particular, have seen an abundance of standardization activities that have lead to the publication of new or revised standards, although further important standards are being presently revised or prepared. These include DIN 2827 “Hoses of stainless steel for chemical substances”.

The “Overview of standards” table on page 31 summarises the most important standards for metal hoses.

The two most important bodies of regulation include **European Directive 97/23/EC (Pressure Equipment Directive – PED)** with the associated product standard **EN 14585-1 “Corrugated metal hose assemblies for pressure applications”** as well as **DIN EN ISO 10380 “Corrugated metal hoses and hose assemblies”**. A few explanations on this are given below.

Pressure equipment directive EN 14585
After a five-year transitional period, EC directive 97/23/EC was introduced with binding effect on 29 May 2002. The so-called Pressure Equipment Directive (PED) is important for both users and manufacturers alike. It has legal status and in crucial cases must therefore be observed.

This directive regulates the manufacture and putting onto the market of pressure vessels with a maximum permissible operating pressure of PS > 0.5 bar. According to the terminology of the directive, metal hoses belong to the pressure equipment category of "Pipework".

The directive essentially only applies to deliveries within or into the European Union.

The directive cites a whole range of exceptions, some of which fall under the scope of other guidelines. Among others, these include applications in the aerospace industry, nuclear engineering, automotive engineering and the medical industry.

The essential element of the PED is that pressure vessels are classified into different categories according to the hazard potential they present. The hazard potential of metal hoses depends on the nominal diameter, the maximum permissible operating or design pressure PS, the dangerousness of the medium, the state of aggregation (liquid/gaseous) and the vapour pressure of the medium.

In addition to the segment for which sound engineering practice (SEP) applies, categories I to III were defined for metal hoses. Hose assemblies of categories I–III are stamped with the CE mark.

The hose manufacturer must carry out a conformity assessment relating to the relevant category. There are 9 different procedures with 11 modules available for this. The modules describe procedures which the manufacturer must use to establish and declare that the respective product conforms to the requirements of the directive.

However, the directive only describes the fundamental requirements on pressure vessels. More detailed stipulations for specific components are stated in the respective engineering or product standards.

The product standard EN 14585 that is decisive for metal hoses was published at the beginning of 2006.

EN 14585 refers to DIN EN ISO 10380 in respect of type examinations, among other things.

It goes without saying that our corrugated hoses conform to the PED in respect of design, material specification, method of manufacture, etc. The stainless steel corrugated hoses conform to EN 14585 and DIN EN ISO 10380.

With their quality systems, welding approvals and supplier selection procedures, the companies of the Witzenmann Group also satisfy the requirements for the supply of hose assemblies conforming to the PED.

Since metal hose specifications are generally customized to suit their intended use, they can only be categorized and assessed for conformity on the basis of the respective operating parameters.

For this, please use the inquiry specification on page 47 or our design program Flexperte, which is available on CD ROM or for download on the Internet at **www.flexperte.com**. The program also determines the relevant category from the PED.

If the customer gives no details on the medium and operating conditions, we assume that the hose assembly falls within the bounds of sound engineering practice as defined by the PED.

DIN EN ISO 10380
The general and currently most important standard for corrugated metal hoses is DIN EN ISO 10380 “Corrugated metal hoses and hose assemblies” of October 2003. ISO 10380 is the first to establish important standards worldwide, especially in respect of the design, manufacture and testing of metal hoses.

As meant by the PED, this has the nature of a supporting standard.

Essential new definitions are a **4-to-1 bursting pressure safety factor** and the introduction of **nominal pressure levels**. A 3-to-1 bursting pressure safety factor was previously widespread in Europe.

The majority of our annularly corrugated hose products have been tested in accordance with this standard and the technical data modified accordingly.

The raised bursting pressure safety factor and the introduction of pressure levels mean that, on a purely calculated basis, the stated nominal/operating pressures are significantly lower than in the past.

Our product range therefore offers you maximum safety for your application corresponding to the latest state of technical development.

If you intend to compare our data with those of other manufacturers, please make sure their products also offer a 4-to-1 bursting pressure safety factor.

Summary of standards

1. General standards			
Standard	Title	Date of issue	Remarks
DIN EN ISO 10380	Pipework – corrugated metal hoses and metal hose assemblies	2003-10	"Supporting standard, but not harmonized"
DIN EN ISO 10806	Pipework – fittings for corrugated metal hoses	2004-03	
DIN EN ISO 7369	Pipework – metal hoses and hose assemblies – vocabulary	2005-03	
DIN EN ISO 6708	Pipework components – definition and selection of DN (nominal size)	1995-09	
EN 14585	Corrugated metallic hose assemblies for pressure applications	2006-04	Product standard to the PED
DIN EN 13480-1	Metallic industrial piping; general information (amendment 1)	2005-12	harmonized standard
DIN EN 13480-3	Metallic industrial piping; design and calculation (amendment 1)	2005-12	harmonized standard
DIN EN 13480-5	Metallic industrial pipes; inspection and testing	2002-08	harmonized standard
DIN EN 1092-1	Flanges and their joints – circular flanges for pipes, fittings, valves, and accessories – part 1: steel flanges, PN destignated	2005-06	"harmonized, currently being revised"
2. Standards for industrial applications			
DIN EN ISO 10807	Pipework – corrugated flexible metallic hose assemblies for protection of electrical cables in explosive atmospheres	1997-01	
DIN EN 13221	High-pressure flexible connections for use with medical gases	2000-04	
DIN EN 12434	Cryogenic vessels – cryogenic flexible hoses	2000-11	
DIN EN 1736	Refrigerating systems and heat pumps – flexible pipe elements, vibration isolators and expansion joints – requirements, design and installation	2000-04	Vibration compensators Type VX
DIN 2827	Hose assemblies of stainless steel for chemical products	1994-02	"new, harmonized draft 2005-08"
3. Standards for heating, ventilation and air conditioning			
DIN 3384	Stainless steel flexible hose assemblies for gas applications – safety requirements, testing, marking	1998-05	Not within the scope of the PED
DIN 3383-1	Hose assemblies and connection valves for gas; safety hose assemblies; safety valves with quick connection device	1990-06	"Gas hose assemblies Type GA; not within the scope of the PED"
3. Standards for stripwound hoses			
DIN EN ISO 15465	Pipework – stripwound metal hoses and hose assemblies	2004-07	"For stripwound hose types SG, SA"
DIN EN 50086-2-4	Conduit systems for cable management – Parts 2–4; particular requirements for conduit systems buried underground	2001-12	"VDE approval for type SG-E-O and SG-S-P"

Opening remark

The two fundamental static design criteria for metal hoses described in DIN EN ISO 10380 are the bursting pressure and the permanent elongation under pressure (where PT = 1.5 x PS). These criteria define the strength of metal hose, braiding, fitting and jointing method.

The standard specifies that the service life be tested on the basis of load cycles for a few important installation types by way of example. For hose assemblies of diameters up to DN 100, an average life of 10,000 load cycles applies to installation in a vertical U-bend, with a minimum service life of 8,000 load cycles (with unlubricated braiding).

The principal factors affecting service life are:

- Operating pressure
- Operating temperature
- Installation situation (shape and radius, among other things)
- Correct storage, handling and assembly
- Corrosion resistance to the piped medium and external influences such as sea water
- Dynamic stresses caused by movement, vibration or pressure pulses, among other things
- Flow conditions (depending on the properties and flow rate of the medium).

Service life issues usually relate to braided hose assemblies. A variety of failure mechanisms are associated with these. The system for connecting the metal hose to the fitting and friction effects between hose and braiding also play a significant role in this. However, it is still only possible to estimate these effects very approximately using calculation methods.

Wherever there is a risk of injury to persons or excessive damage to equipment or other property through failure of a hose, the manufacturer must be informed before the order is placed.

In these cases, it is necessary to verify the service life through empirical methods or a combination of empirical and calculation methods. We have the necessary facilities and methods to do this. Please contact us if this is the case.

Metal hoses for use in vehicles are as a matter of principle subject to particular quality standards and must be separately specified in consultation with us.

Dynamic reduction factors
Historically, we have taken account of the effects of dynamic stresses by applying reduction factors to the pressure dimensioning.

The change of test conditions stipulated by DIN EN ISO 10380 (load cycle tests at the rated pressure) can mean that a reduction is necessary as a result of the movements covered by the tests.

The rated pressures given in the tables that are defined in DIN EN ISO 10380 also apply to applications for the absorption of movement, heat expansion and vibration provided the design guidelines stated in Section 7 – Design/Calculation/Installation are observed for the respective application.

Where unusual mechanical stresses such as pressure pulses, jerky movements or heavy vibration / resonant vibration are expected in operation, assemblies must be individually designed in consultation with us.

Pressure reduction factors in the event of increased operating temperature

Pressure reduction factors in the event of increased operating temperature
As already mentioned, the pressure data given in this manual are nominal pressures that, as described in the definition, relate to a temperature of 20°C.

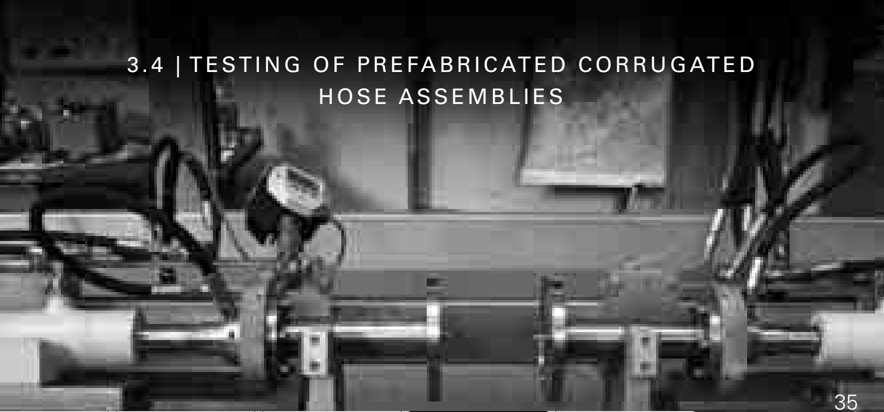
The effect of operating temperature is a decisive factor for the design pressure of the assembly.

The fall in pressure resistance of the used materials must be taken into account in the design. Reduction factors for the most important materials are given in the table on page 251.

Further material characteristics can be found in Appendix A.

For the design of assemblies, you should always take the lowest value for the material of the hose and braiding for your calculation.

This notwithstanding, the maximum permissible operating temperature specified for soldered joints (300°C) or any sealing materials used must not be exceeded.



Pressure-proof, absolutely leakproof

Before shipment

As a matter of principle, all corrugated hose assemblies are subjected to a pressure and leak test before they are sent out.

The respective cold pressure at 20°C is calculated on the basis of the operating pressure PS, operating temperature TS and the ruling temperature reduction factors.

Hose assemblies not falling within the scope of the Pressure Equipment Directive are then tested at a test pressure of PT = 1.3 x cold pressure. Where the PED applies, the test pressure is defined in accordance with its rules.

Depending on the level of the test pressure and the nominal diameter, a combined pressure/leak test using nitrogen under water or a two-stage test – hydraulic pressure test with water followed by a leak test at reduced test pressure (N2 under water) is carried out.

If the customer does not give any data regarding medium and operating conditions, hose assemblies without braiding are subjected to a leak test with PT = 0.5 bar N2/air, braided hose assemblies to a pressure/leak test with PT = 10 bar nitrogen under water.

Further tests such as the helium leak test can be agreed in individual cases.

After shipment
HYDRA metal hose assemblies require no maintenance. However, the user should perform regular visual checks at intervals appropriate for the operating conditions. In particular, hoses should be examined for defects such as kinks, corrosion and braiding damage.

Metal hose assemblies with visible defects should be immediately taken out of service!

In many areas, hose assemblies fall under the Industrial Health and Safety Regulations or other regulations. Please abide by the rules that apply to your area. More detailed information on this issue can be found in code of practice T 002 6/2004 of BG Chemie, in whose creation we played an active part.

If you or a third party carries out pressure tests, the maximum permissible test pressure for the metal hose assembly must not be exceeded. The test pressure is 1.5 times the operating pressure at 20°C or rated pressure PN stated in the technical table of hose types.

The scope of testing and documentation for our metal hoses can be agreed individually with the customer.

Where agreed, test certificates to DIN EN 10204:2005-01 can be issued, for example.

Ordered products that fall under Pressure Equipment Directive 97/23/EC are at least issued with a Declaration of Conformity as per Appendix VII. For such products, the issue of test certificates is not an absolute requirement. Our quality management system guarantees traceability. In addition, general operating and assembly instructions are supplied with the product.

Please note that in all other cases the issue of a test certificate after shipment is associated with extra work/cost or may not be possible (Approval Certificates 3.1/3.2).

Extract from DIN EN 10204 "Metallic products – types of test certificate":

Applications
This document contains definitions of the various types of test certificate that can be issued for the customer.

Extract from DIN EN 10204, concepts

Non-specific testing
Tests carried out by the manufacturer to establish that the requirements stipulated in the order have been fulfilled. The tested products do not necessarily have to come from the consignment itself.

Specific testing
Tests carried out before shipment to ascertain whether the products fulfil the requirements stipulated in the order.

Test certificates based on non-specific testing

Certificate of conformity "2.1"
Certificate in which the manufacturer confirms that the supplied products conform with the requirements of the order, without stating the test results.

Works test certificate "2.2"
Certificate in which the manufacturer confirms that the supplied products conform with the requirements of the order, stating the results of non-specific tests.

Test certificates based on specific testing

Approval certificate "3.1"
Certificate in which the manufacturer confirms that the supplied products conform with the requirements of the order, stating the test results.

The test unit and the execution of the test are stipulated in the product specification, the official rules and technical regulations and/or the customer order. The certificate is issued by an appointed inspector of the manufacturer who is independent of the production department.

A manufacturer may include in approval certificate 3.1 the test results he has determined through specific testing of the raw materials or products used by him, on the proviso that he uses methods to guarantee traceability and can present the corresponding test certificate.

Approval certificate "3.2"
Certificate in which both an appointed inspector of the manufacturer independent of the production department and the inspector of the customer or the inspector named in the official rules confirm that the supplied products conform with the requirements of the order, stating the test results.

Summary of test certificates
(extract from EN 10204 – Appendix A, Table A.1)

Type	Name of test certificates to EN 10204	Content of the certificate	Confirmation of certification by
2.1	Declaration of compliance with the order	Confirmation of agreement with the order	the manufacturer
2.2	Test report	Confirmation of agreement with the order stating results of non-specific testing	the manufacturer
3.1	Inspection certificate 3.1	Confirmation of agreement with the order stating results of specific testing	the appointed inspector of the manufacturer independent of the production department
3.2	Inspection certificate 3.2	Confirmation of agreement with the order stating results of specific testing	the appointed inspector of the manufacturer independent of the production department and the inspector of the customer or the inspector named in the official rules

Safety advice

HYDRA metal hoses are quality products. They are reliable and have a long service life. However, it is essential to choose the correct hose design and that the hose is properly and perfectly installed. If you have any doubts, please contact us for advice. The most important safety advice is given below. The safety advice and installation instructions are available in the form of a leaflet.

Please also refer to application-related information from page 250 in Section 7.

Design and service life

Hose assemblies may only be used for the operating and installation conditions named in the order and certified by the manufacturer. There is a whole series of factors that have a major affect on service life. Please refer to the explanations on pages 303-307 on this.

Correct choice of hose assembly length

Connections must have no movement or bending stresses acting directly on them. This so-called “neutral” component at the ends of hoses must be adequately dimensioned. Where necessary, this is taken into account in the dimensioning formulae in Section 7. A kink protection device can be fitted at the ends if required. To determine the correct hose length, calculation formulae are available for a variety of installation shapes (see Section 7 or www.flexperte.de).

Effect of temperature

The rated pressure / operating pressure given in each case for our hoses relates to ambient temperature (20°C). At higher temperatures, the maximum operating pressure and service life are reduced. Temperature reduction factors must be taken into account when calculating the maximum operating pressure (see page 251).

Materials/corrosion

The suitability and choice of materials of all the components of a hose assembly must be checked with the help of the resistance tables in industry literature or the HYDRA manual.
Also to be taken into account are the resistance of the hose to the carried medium in all operating conditions and also to external influences such as seawater (sea atmosphere). In addition, no insulating materials that could trigger corrosion may be affixed. Etching and passivating, especially of braided hose assemblies, is not permitted since the construction of the hose makes it difficult to remove all etching and passivating residues afterwards and can therefore cause corrosion.

Tests

As a matter of principle, all corrugated hose assemblies are subjected to a pressure and leak test before shipment. HYDRA metal hose assemblies require no maintenance. However, the user should perform regular visual checks at intervals appropriate for the operating conditions. In particular, hoses should be examined for defects such as kinks, corrosion and braiding damage.

Metal hose assemblies with visible defects should be immediately taken out of service!

In many areas, hose assemblies fall under the Industrial Health and Safety Regulations or other regulations. Please abide by the rules that apply to your area.
If you or a third party carries out pressure tests, the maximum permissible test pressure for the metal hose assembly must not be exceeded. The test pressure is 1.5 times the operating pressure at 20°C or rated pressure PN stated in the technical table of hose types.
(Further information is available on pages 35-36, Section 3 – Tests).

Handling and assembly
Hose assemblies must be protected from external mechanical damage. They should therefore not be dragged along the ground or over sharp edges. Physical contact with other hoses or surrounding objects must be avoided during operation.

The hose assembly must be checked for damage before installation!

The hose should not be bent tighter than the minimum **bending radius**. The values can be found in the tables for the selected hose type.

Torsion must be avoided since this can result in premature failure. Therefore make sure you adhere to the following assembly sequence:

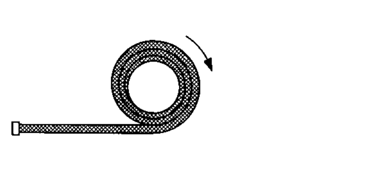
First, fully tighten the connection fitting of the hose assembly at one end. Where the hose assembly has one fixed fitting and one swivel fitting, start with the fixed fitting. In the case of hose assemblies that are intended to absorb movements, first connect the other end loosely. Then perform the expected movement of the hose 2 to 3 times in the relevant direction in order to align it without torsion. You can now tighten this end too.

In the case of screwed joints, it is essential to use a second spanner to brace the hose against twisting. When selecting the connection fittings, make sure at least one end of the hose assembly is connected by means of a swivel joint.

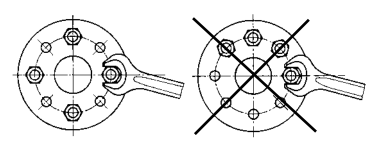
Where there will be movements in operation, fit the hose so that hose axis and direction of movement are in one plane so that no torsion can arise.

During welding or soldering, the hose assemblies must be protected from welding or soldering flux spatter. Carefully remove any flux residue. Appropriate measures must be taken to protect soldered joints of the fittings from overheating / unsoldering. Be sure to prevent short-circuits through welding electrodes or earthing cables, since this can destroy the hose.

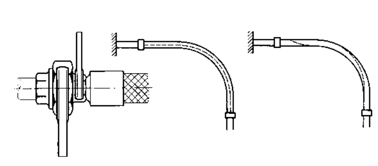
Example 1
Lay hose assembly out straight by unrolling the hose coil. Avoid pulling on one end of the hose coil, as this will bend the hose tighter than the minimum permissible radius while subjecting the hose to too much torsional stress.



Example 2
Tighten mating flanges evenly (crosswise). The bolt holes of the two flanges must be precisely aligned. Use a loose flange on one side.

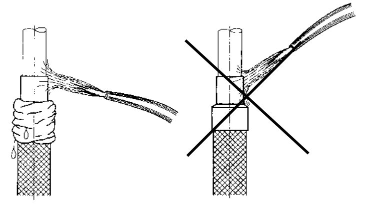


Examples 3
Make sure hose assembly is not twisted when connecting. If using swivel hose connections, use a second spanner to brace the hose end.
If the hose serves to absorb **expansion or vibration**, a reliable anchor must be fixed to the pipe section directly after the hose.

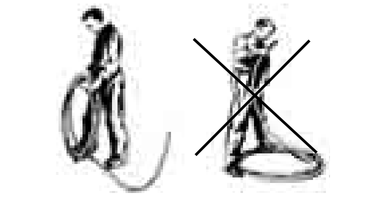


Handling and assembly

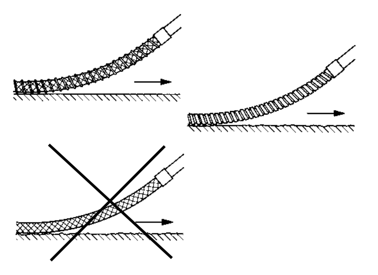
Example 4
When making soldered joints, use a wet tape or heat insulating paste to protect the end of the hose as sembly to be soldered from overheating and unsoldering. Keep the gas torch away from the hose assembly. Carefully remove any flux residue.



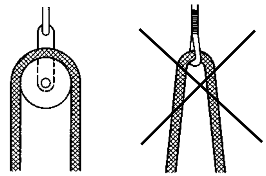
Example 5
Make sure you handle metal hoses correctly, any damage to the hose can cause leaks. Avoid pulling on a rolled-up hose to straighten it out, uncoil it instead.



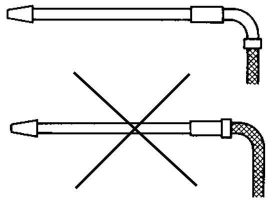
Example 6
If it is impossible to avoid mechanical stresses (for example, through frequent dragging along the ground), it may be necessary to protect the hose assembly from damage by using either an external round wire spiral or a protective hose.



Example 7
Avoid excessive bending stress on the hose by using a roller with a diameter at least as large as the minimum bending radius of the hose.



Example 8
Even when using the hose manually, the hose end should be protected from excessive bending stress by the use of a rigid elbow.



Designing made simple
Our inquiry specification guides you through the specification process by asking you for all relevant design data in a logical sequence. It is aimed at producing designs for complicated situations and applications while observing the PED.

To make completion of the **inquiry specification** as effective as possible for you, the adjacent form is also available on the Internet at **www.witzenmann.de/Formulare**.

Simply complete the form and fax it to the responsible contact in the Witzenmann Group.

You can, of course, prepare your own specification if you wish. There's a quick and easy way.

Go to www.flexperte.de for the necessary program. The menu guidance system makes it uncomplicated, enabling you to design your hose assembly simply and securely.

Not only that, processing your requirements takes even less time.

INQUIRY SPECIFICATION FOR HYDRA METAL HOSE ASSEMBLIES

Company:

Date:

Inquiry no./project:

Contact:

Quotation deadline:

Phone/fax:

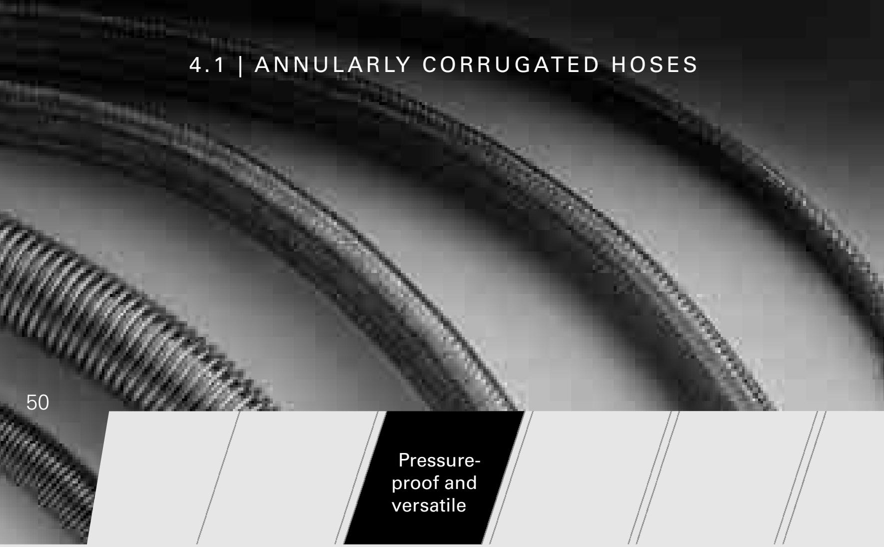
E-mail:

Receiver inquiry-specific WI Group:

Item		**1**	**2**	**3**
Quantity				
Type designation				
Nominal Diameter (DN)				
Nominal Length [mm]				
Material	Hose			
	Braiding			
Type designation	one end of			
fitting	other end			
Medium				
Group as per PED: 1 – hazardous **or** 2 – other				
Gaseous/liquid, where pD > 0.5 bar **or** liquid				
Category as defined in the PED				
Operating/design data				
Max. pressure PS [bar above atmospheric]				
Min./max. temperature TS [°C]				
Installation shape*	Straight/90°/180° bend			
Movement*	Type and magnitude			
	Load cycles per unit time			
Vibration*	Ampl. [mm]/frequency [Hz]			
	Direction			
External influences	e.g. mechanical/chem. effects			
Approval requirements / certificate				
Hose/braiding/connection fitting/pressure test				

Additional information

*provide sketch, if possible



Pressure-proof and versatile

The following section contains descriptions of the most common types of hose. The two features that characterise the hoses are the version and the corrugation:

	Geometric dimension	Designation
Version:	Wall thickness	medium / heavy
Corrugation:	Length of corrugation	narrow / medium / wide

Note that pressure resistance increases both with wall thickness and corrugation length. Flexibility, on the other hand, falls with both increasing corrugation length and wall thickness.

The technical detail tables are preceded by a description of the hose type. If you cannot find “your” hose, please contact us. Witzenmann produces a multitude of hose types. The hose for your application will certainly be among them.

Operating pressure

The operating pressures in the following tables that are applicable to stainless steel contain two pressure values:

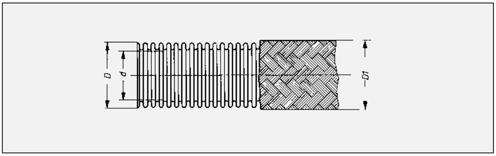
1) Permissible operating pressure Pzul at 20°C for static loading without movement with 3-to-1 safety factor against bursting.

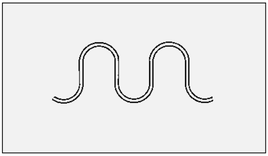
2) Nominal pressure level as defined in DIN EN ISO 10380: maximum permissible pressure as defined in DIN EN ISO 10380 rounded to the associated pressure level. The maximum permissible pressure includes a safety factor of 4 against bursting and an average flexibility of 10,000 load cycles in the U-bend (see Section 3).

At higher operating temperatures, the reduction factor given on page 251 applies to the two pressure values.

Annularly corrugated hoses, stainless steel Type RS 331 (up to DN 100)

medium version, normal corrugation **Type RS 330 (from DN 125)**





Construction:
Annularly corrugated all-metal hose made of butt-welded tube with or without braiding.

Versions:
- RS ...**S00** without braiding
- RS ...**S12** with single stainless steel wire braiding

Type tests:
The hose type is tested in accordance with DIN EN ISO 10380.

Material of hose:
stainless austenitic steel to DIN EN ISO 10088-2, bright
- Standard: material no. 1.4404 comparable with AISI 316 L
- Standard: material no. 1.4541 comparable with AISI 321
- Other materials:
  e.g. material no. 1.4571
  comparable with AISI 316Ti on request

Material of braiding:
stainless austenitic steel
- Material no. 1.4301 comparable with AISI 304
- Material no. 1.4571 comparable with AISI 316Ti on request

Temperature range:
-270°C up to max. 600°C
(only for the hose)

Operating pressure:
The following tables with technical data of metal hoses contain two pressure values. Please refer to the general information on page 50.

Connection fittings:
- Flanges
- Threaded connections
- Welding ends
- Customized connections on request

Approvals:
see page 16-17

Production lengths:
- DN 4 5-30 m
- DN 6-50 10-100 m
- DN 65-100 20 m
- DN 125-150 10 m

Annularly corrugated hoses, stainless steel

medium version, normal corrugation

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
4	RS331S00	4.2	7.1	±0.1	15	80	40	40	0.06
	RS331S12		8.2		25		135	100	0.11
6	RS331S00	6.2	9.7	±0.2	15	80	25	25	0.08
	RS331S12		10.8		25		200	150	0.14
8	RS331S00	8.3	12.3		16	120	20	20	0.10
	RS331S12		13.7		32		180	100	0.21
10	RS331S00	10.2	14.3		18	130	16	16	0.11
	RS331S12		15.7		38		140	100	0.23
12	RS331S00	12.2	16.8		20	140	12	10	0.12
	RS331S12		18.2		45		85	65	0.25
16	RS331S00	16.2	21.7		28	160	8	6	0.19
	RS331S12		23.3		58		90	65	0.40
20	RS331S00	20.2	26.7	±0.3	32	170	5	4	0.27
	RS331S12		28.3		70		55	40	0.49
25	RS331S00	25.5	32.2		40	190	4	4	0.38
	RS331S12		34.2		85		55	50	0.79
32	RS331S00	34.2	41.0		50	260	3	2.5	0.49
	RS331S12		43.0		105		35	25	0.96
40	RS331S00	40.1	49.7		60	300	2.5	2.5	0.77
	RS331S12		52.0		130		50	40	1.46
50	RS331S00	50.4	60.3	±0.4	70	320	1.5	0.5	0.91
	RS331S12		62.6		160		40	25	1.67
65	RS331S00	65.3	78.0		115	460	1	0.5	1.51
	RS331S12		81.2		200		32	25	2.88

** Minimum bending radius ≤ DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius ≤ DIN EN ISO 10380 Type 1*

Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
80	RS331S00	80.2	94.8	±0.5	130	660	2	0.5	2.28
	RS331S12		98.0		240		30	16	4.08
100	RS331S00	100.0	116.2		160	750	1.5	0.5	2.53
	RS331S12		119.4		290		25	10	4.54
125	RS330S00	126.2	145.0	± 0.6	350	1000	0.8	0.5	2.68
	RS330S12		148.2				20	6	5.25
150	RS330S00	151.6	171.0	± 1.4	400	1250	0.5	0.5	3.41
	RS330S12		174.2				16	6	6.48

** Minimum bending radius ≤ DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius DIN EN ISO 10380 Type 1*

Please quote when ordering:

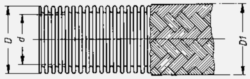
1. Type of hose, material, nominal diameter (DN), nominal length (NL)

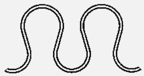
2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Annularly corrugated hoses, stainless steel — Type RS 321

medium version, narrow corrugation / highly flexible





Construction:
Annularly corrugated all-metal hose made of butt-welded tube with or without braiding.

Versions:
- RS …**S00** without braiding
- RS …**S12** with single stainless steel wire braiding

Type tests:
The hose type is tested in accordance with DIN EN ISO 10380.

Material of hose:
stainless austenitic steel to DIN EN ISO 10088-2, bright
- Standard: material no. 1.4404 comparable with AISI 316 L
- Standard: material no. 1.4541 comparable with AISI 321
- Other materials: e.g. material no. 1.4571 comparable with AISI 316Ti on request

Material of braiding:
- Material no. 1.4301 comparable with AISI 304
- Material no. 1.4571 comparable with AISI 316Ti on request

Temperature range:
-270°C up to max. 600°C
(only for the hose)

Operating pressure:
The following tables with technical data of metal hoses contain two pressure values. Please refer to the general information on page 50.

Connection fittings:
- Flanges
- Threaded connections
- Welding ends
- Customized connections on request

Production lengths:
- DN 6-12 10-70 m
- DN 40-50 20 m
- DN 65-100 7,5 m

Annularly corrugated hoses, stainless steel — Type RS 321

medium version, narrow corrugation / highly flexible

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
6	RS321S00 RS321S12	6.1	9.9 11.0	±0.2	20 25	70	20 140	20 100	0.10 0.17
8	RS321S00 RS321S12	8.2	12.5 13.9	±0.2	25 30	80	16 140	16 65	0.14 0.25
10	RS321S00 RS321S12	10.1	14.4 15.8	±0.2	30 35	90	10 120	10 65	0.14 0.26
12	RS321S00 RS321S12	12.4	17.1 18.5	±0.2	35 40	100	8 90	6 50	0.17 0.30
16	RS321S00 RS321S12	16.2	22.0 23.6	±0.2	40 50	110	6 65	6 50	0.26 0.46
20	RS321S00 RS321S12	20.2	26.8 28.4	±0.3	50 55	130	4 40	4 40	0.31 0.53
25	RS321S00 RS321S12	25.1	32.2 34.2	±0.3	60 65	150	5 55	4 40	0.49 0.90
32	RS321S00 RS321S12	34.2	41.0 43.0	±0.3	70 75	200	2.5 55	2.5 20	0.50 0.97
40	RS321S00 RS321S12	40.0	49.8 52.1	±0.4	80 90	210	2 40	0.5 20	1.13 1.81
50	RS321S00 RS321S12	50.1	60.5 62.8	±0.5	100 110	240	1 30	0.5 16	1.34 2.10
65	RS321S00 RS321S12	65.0	78.2 81.4	±0.5	145 200	280	1 25	0.5 16	1.96 3.33
80	RS321S00 RS321S12	80.0	95.0 98.2	±0.5	200 240	400	1.5 25	0.5 10	3.12 4.92
100	RS321S00 RS321S12	99.4	116.8 120.0	± 0.6	240 290	500	1 20	0.5 6	3.70 5.71

** Minimum bending radius ≤ DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius < DIN EN ISO 10380 Type 1*

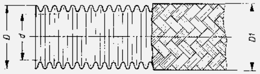
Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

Annularly corrugated hoses, stainless steel   Type RS 341

medium version, wide corrugation



Construction:
Annularly corrugated all-metal hose made of butt-welded tube with or without braiding.

Versions:
- RS 341**S00** without braiding
- RS 341**S12** with single stainless steel wire braiding

Type tests:
The hose type is tested in accordance with DIN EN ISO 10380.

Material of hose:
stainless austenitic steel to DIN EN ISO 10088-2, bright
- Standard: material no. 1.4404 comparable with AISI 316 L
- Standard: material no. 1.4541 comparable with AISI 321
- Other materials: e.g. material no. 1.4571 comparable with AISI 316Ti on request

Material of braiding:
- Material no. 1.4301 comparable with AISI 304

Temperature range:
-270°C up to max. 600° C
(only for the hose)

Operating temperature:
At higher operating temperatures, different reduction factors apply depending on the material –> see page 251.

Operating pressure:
The following tables with technical data of metal hoses contain two pressure values. Please refer to the general information on page 50.

Connection fittings:
In addition to the common types and versions, there are special connections, e.g. for building service equipment.

Production lengths:
- DN 6-8 10 m
- DN 10-50 10-100 m
- DN 65-100 6,5 m

Annularly corrugated hoses, stainless steel

Type RS 341

medium version, wide corrugation

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
6	RS341S00	6.3	9.5		11	110	65	65	0.05
	RS341S12		10.6		25		175	100	0.12
8	RS341S00	8.5	12.0	± 0.3	15	130	35	25	0.07
	RS341S12		13.4		32		150	65	0.18
10	RS341S00	10.3	14.1		18	150	16	16	0.09
	RS341S12		15.5		38		120	65	0.20
12	RS341S00	12.5	16.5	±0.2	20	165	18	16	0.10
	RS341S12		18.0		45		80	65	0.23
16	RS341S00	16.3	21.4	±0.3	25	195	13	10	0.15
	RS341S12		23.0		58		80	65	0.36
20	RS341S00	20.7	26.5		30	225	20	20	0.31
	RS341S12		28.1		70		55	40	0.54
25	RS341S00	25.8	31.7	±0.4	35	260	14	16	0.39
	RS341S12		33.7		85		60	50	0.80
32	RS341S00	34.6	41.0		40	300	2.5	2.5	0.36
	RS341S12		43.0		105		35	25	0.82
40	RS341S00	40.5	49.5	±0.5	50	340	3	2.5	0.57
	RS341S12		51.5		130		50	40	1.26
50	RS341S00	50.8	60.2		60	390	2.5	2.5	0.71
	RS341S12		62.5		160		35	25	1.47
65	RS341S00	65.7	77.7	± 0.4	75	460	4	4	1.07
	RS341S12		80.9		200		35	25	2.44
80	RS341S00	80.6	94.2	± 0.5	90	660	4	4	1.72
	RS341S12		97.4		240		40	20	3.52
100	RS341S00	100.4	115.0	± 0.6	110	750	3	2.5	1.95
	RS341S12		118.2		290		20	16	3.94

** Minimum bending radius ≤ DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius DIN EN ISO 10380 Type 1*

Please quote when ordering:

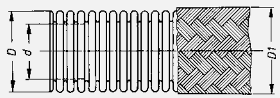
1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Annularly corrugated hoses, stainless steel — Type RS 531 (DN 5 -16)

heavy version, normal corrugation — **Type RS 430 (from DN 20 - 300)**



Construction:
Annularly corrugated all-metal hose made of butt-welded tube with or without braiding.

Versions:
- RS …**S00** without braiding
- RS …**S12** with single stainless steel wire braiding
- RS …**S22** with double stainless steel braiding
- RS …**S42** with single stainless steel braided braid
- RS …**S52** with double stainless steel braided braid
- RS …**S92** with double stainless steel braiding of special design

Type tests:
The hose type is tested in accordance with DIN EN ISO 10380.

Material of hose:
stainless austenitic steel to DIN EN ISO 10088-2, bright
- Standard: material no. 1.4404 comparable with AISI 316 L (< DN 150)
- Standard: material no. 1.4541 comparable with AISI 321
- Other materials: e.g. material no. 1.4571 comparable with AISI 316Ti on request

Material of braiding:
- Material no. 1.4301 comparable with AISI 304
- Material no. 1.4306 comparable with AISI 304 L (knurled braiding DN 150–300)
- Material no. 1.4571 comparable with AISI 316Ti on request

Temperature range:
-270°C up to max. 600°C
(only for the hose)

Operating pressure:
The following tables with technical data of metal hoses contain two pressure values. Please refer to the general information on page 50.

Connection fittings:
- Flanges
- Threaded connections
- Welding ends
- High-pressure type connection fittings
- Customized connections on request

Production lengths:
- DN 5-16 10-100 m
- DN 20-125 10 m
- DN 150-300 3 m

Annularly corrugated hoses, stainless steel — Typ RS 531

heavy version, normal corrugation

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
5	RS531S00	5.3	9.1	±0.2	15	100	32	25	0.10
	RS531S12		10.2		25		230	150	0.16
	RS531S22		11.3		35		380	200	0.22
6	RS531S00	6.2	10.2		15	110	50	50	0.12
	RS531S12		11.6		25		315	200	0.23
	RS531S22		13.0		40		380	250	0.33
8	RS531S00	8.0	12.9		20	130	50	50	0.20
	RS531S12		14.5		32		250	200	0.35
	RS531S22		16.1		50		380	250	0.49
10	RS531S00	10.0	15.9	±0.3	25	150	35	25	0.29
	RS531S12		17.5		38		200	150	0.48
	RS531S22		19.1		60		300	200	0.66
12	RS531S00	12.1	18.7		30	165	32	25	0.41
	RS531S12		20.3		45		185	100	0.62
	RS531S22		21.9		70		315	200	0.82
16	RS531S00	16.1	23.8		40	195	20	20	0.55
	RS531S12		25.8		58		190	150	0.92
	RS531S22		27.8		90		280	200	1.29

** Minimum bending radius RS 531S00/S12 ≤ DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius DIN EN ISO 10380 Type 1*

Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Annularly corrugated hoses, stainless steel — Type RS 430

heavy version, normal corrugation

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
20	RS 430S00	20.2	29.2	±0.3	45	285	8	6	0.54
	RS 430S12		31.2		70		125	65	0.93
	RS 430S22		33.2		70		165	100	1.32
25	RS 430S00	25.2	34.2		50	325	6	6	0.65
	RS 430S12		36.2		85		80	50	1.07
	RS 430S22		38.2		85		135	100	1.49
32	RS 430S00	33.7	42.7		60	380	4	4	0.77
	RS 430S12		45.0		105		85	65	1.41
	RS 430S22		47.2		105		100	65	2.05
40	RS 430S00	40.0	55.0	±0.4	75	430	2.5	2.5	1.37
	RS 430S12		57.3		130		50	40	2.09
	RS 430S22		59.5		130		75	65	2.82
50	RS 430S00	50.0	65.0		90	490	3	2.5	1.61
	RS 430S12		68.2		160		65	50	2.91
	RS 430S22		71.3		160		65	65	4.21
65	RS 430S00	65.0	81.0		110	580	2	0.5	2.06
	RS 430S12		84.2		200		40	25	3.46
	RS 430S22		87.3		200		60	50	4.86
80	RS 430S00	79.8	98.3	±0.5	135	800	1.5	0.5	2.82
	RS 430S12		101.5		240		40	16	4.65
	RS 430S22		104.6		240		60	25	6.48
100	RS 430S00	99.8	117.8		160	1000	1.5	0.5	3.59
	RS 430S12		121.0		290		35	10	5.97
	RS 430S22		124.1		290		60	16	8.35

** Minimum bending radius < DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius DIN EN ISO 10380 Type 2*

Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Annularly corrugated hoses, stainless steel — Type RS 430

heavy version, normal corrugation

DN	Type	Inside diameter	Outside diameter	Permissible deviation	Minimum bending radius* one bending process	Nominal bending radius** frequent bending	Permissible operating pressure at 20°C SF 3	Nominal pressure DIN EN ISO 10380 SF 4	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–	–
–	–	mm	mm	mm	mm	mm	bar	PN	kg/m
125	RS 430S00	125.6	146.0	± 0.6	350	1250	1	0,5	5.23
	RS 430S12		149.2				25	10	7.80
	RS 430S22		152.4				45	16	10.4
150	RS 430S00	151.9	177.4	± 1.4	400	800	0.2	-	4.97
	RS 430S42		181.4				15	10	8.37
	RS 430S92		185.4				19	20	11.9
200	RS 430S00	202.2	231.4	±1.6	520	1100	0.2	-	7.92
	RS 430S42		236.9				13	10	12.5
	RS 430S52		242.4				16	16	17.3
250	RS 430S00	248.4	284.2		620	1350	0.2	-	13.0
	RS 430S42		289.7				8	6	18.1
	RS 430S52		295.2				15	10	23.4
300	RS 430S00	298.6	335.8		720	1600	0.1	-	17.2
	RS 430S42		341.3				5	4	23.1
	RS 430S52		346.8				9	6	29.1

** Minimum bending radius DIN EN ISO 10380 Type 1/2*

*** Nominal bending radius ≤ DIN EN ISO 10380 Type 2*

Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

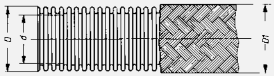
2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Annularly corrugated hoses of bronze

Type RZ 331

medium version, normal corrugation



Construction:
Annularly corrugated all-metal hose made of butt-welded tube with or without braiding.

Versions:
- RZ 331**S00** without braiding
- RZ 331**S13** with single bronze wire braiding

Material of hose:
- Bronze to DIN 1791
- Material no. 2.1010 (CuSn 2)

Material of braiding:
- Bronze wire, bright, material no. 2.1016 (CuSn 4) or CW450K, DIN EN 1652

Temperature range:
-196°C up to max. 250°C
(only for the hose)

Operating pressure:
The permissible operating pressure stated in the table applies to static pressure and movement loading at +20°C. For reduction factors for higher operating temperature
–> see page 251.
Exposure to dynamic stresses caused by movement or pressure necessitates a special design. Please contact us if this applies to you.

Connection fittings:
to customer specification

Annularly corrugated hoses of bronze

Type RZ 331

medium version, normal corrugation

DN	Type	Inside diameter	Outside diameter	Maximum deviation	Minimum bending radius one bending process	Nominal bending radius frequent bending	Permissible operating pressure at 20°C SF 3	Weight. approx.
–	–	d	D, D1	d, D, D1	r_{min}	r_n	P_{zul}	–
–	–	mm	mm	mm	mm	mm	bar	kg/m
8	RZ331S00 RZ331S13	8.6	12.6 14.0	±0.2	16 32	90	6 75	0.11 0.23
10	RZ331S00 RZ331S13	10.7	15.1 16.5		18 38	130	6 50	0.13 0.27
12	RZ331S00 RZ331S13	12.7	17.7 19.1		20 45	150	4 40	0.14 0.31
16	RZ331S00 RZ331S13	16.7	22.2 23.6		28 58	170	4 40	0.24 0.47
20	RZ331S00 RZ331S13	20.6	27.1 28.5		32 70	200	4 35	0.44 0.71
25	RZ331S00 RZ331S13	25.6	33.2 35.5	±0.3	40 85	230	2.5 35	0.46 0.97
32	RZ331S00 RZ331S13	32.6	42.0 44.3		50 105	260	2.5 35	0.72 1.43
40	RZ331S00 RZ331S13	40.5	51.5 53.8		60 130	310	1.6 28	0.95 1.83
50	RZ331S00 RZ331S13	50.5	63.0 66.2	±0.4	70 160	360	1.6 30	1.35 2.77

Please quote when ordering:

1. Type of hose, material, nominal diameter (DN), nominal length (NL)

2. Type of connection fitting, material

3. Operating conditions, refer to Inquiry Specification, page 47

Ordering example for hose assembly

Hose with fittings

Most of the fittings described on the following pages are available from stock or can be obtained at short notice. It goes without saying that others and special connection fittings can be supplied, e.g. NPT thread, ANSI flange, tongue and groove type, etc.

Below is an example of a detailed ordering:

for hot water, 12 bar, 180°C
properties of medium as defined in PED:
Group 1 non-hazardous liquid,
pD > 0.5 bar, PED Section 3 Para. (3),
Sound Engineering Practice
quantity 10, DN 50,
nominal length 2000 mm

HYDRA annularly corrugated hose, medium version, normal corrugation, of stainless steel 1.4404 with single braiding of stainless steel 1.4301.

Connection fittings, WIG-welded:
1.4301 stainless steel end sleeves
at both ends
at one end: welding collar of stainless steel 1.4571 and loose flange PN 16 of steel, flange dimensions to DIN 2501
at other end: welding end 60.3 x 2.9 x 70 of 1.4571 stainless steel:

The short form sufficient for us:

for hot water 12 bar, 180°C
RS 331L12 (1.4404), GIP
DN 50 NL 2000
one end: AB82E (1.4571)
other end: UA22S (1.4571)
welded
quantity 10

Metal hoses with different connections for different applications

Versatile and perfectly fitting

A multitude of different connections ensures that our metal hoses have a broad range of applications. Depending on the operating conditions and materials used, the connections are either welded or brazed to the hose. Below is a selection of common connection types. The first letter of the type designation indicates the respective connection type.

Flange connection

A Loose flange with welding collar
Swivel flange

B Loose flange with collar connection piece
Swivel flange

C Loose flange with welding rim
Swivel flange

G Welding neck flange
Fixed flange

Threaded connection

L Fixed, internal thread

M Fixed, external thread

N Swivel, internal thread

Threaded fitting

Q Internal thread

R External thread

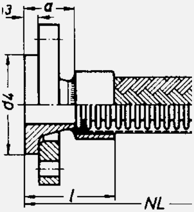
S Pipe end

Pipe fitting

U Pipe fittings of all kinds

Other

W Couplings



Flange connection, swivelling
Welding collar of steel or stainless steel 1.4541 or 1.4571
loose flange of steel or stainless steel 1.4541 or 1.4571
welded or brazed

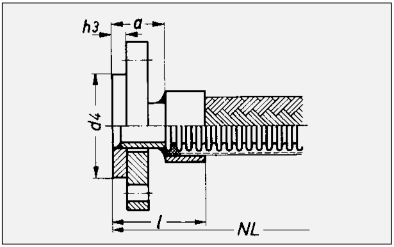
Fitting type				Material		Maximum operating temperature
PN 10	PN 16	PN 25	PN 40	Welding collar	Flange	
AB12D	**AB12E**	**AB12F**	**AB12G**	Steel	Steel	480 °C*
AB82D	**AB82E**	**AB82F**	**AB82G**	Stainless steel	Steel	480 °C*
AB22D	**AB22E**	**AB22F**	**AB22G**	Stainless steel	Stainless steel	550 °C

Connection dimensions PN 10 and PN 16/25/40 up to DN 65 to DIN 2501 / DIN EN 1092
Dimensions in mm, weight G in kg

DN	10	16	20	25	32	40	50	65	80	100	125	150	200	250	300
d4 / d1	40	45	58	68	78	88	102	122	138	158	188	212	268	320	370
h3 (DIN 2673)	10	10	12	12	12	12	14	14	16	16	18	18	20	22	22
F (DIN EN 1092)	12	12	14	14	14	14	16	16	16	18	18	20	20	22	22
a (DIN 2673)	35	35	40	40	40	40	45	45	50	50	50	50	55	60	60
a (DIN EN 1092)	35	38	40	40	42	45	45	45	50	52	55	55	62	68	68
l (DIN 2673)	45	49	56	58	60	62	70	73	80	82	86	90	100	110	115
l (DIN EN 1092)	45	52	56	58	62	67	70	73	80	84	91	95	107	118	123
G approx.	0.70	0.80	1.06	1.43	2.05	2.40	3.02	3.77	4.84	5.60	7.35	8.90	12.9	17.7	23.3

** For choice of steel materials: see "Appendix A – Materials"*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Flange connection, swivelling
Collar pipe of steel or stainless steel 1.4541 or 1.4571
loose flange of steel or stainless steel 1.4541 or 1.4571
welded or brazed

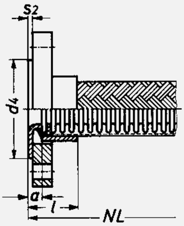
Fitting type				Material		Maximum operating temperature
PN 10	PN 16	PN 25	PN 40	Collar pipe	Flange	
BB12D	**BB12E**	**BB12F**	**BB12G**	Steel	Steel	480 °C*
BB82D	**BB82E**	**BB82F**	**BB82G**	Stainless steel	Steel	480 °C*
BB22D	**BB22E**	**BB22F**	**BB22G**	Stainless steel	Stainless steel	550 °C

Connection dimensions PN 10 and PN 16/25/40 up to DN 65 to DIN 2501 / DIN EN 1092
Dimensions in mm, weight G in kg

DN	10	16	20	25	32	40	50	65	80	100	125	150	200	250	300
d4 / d1	40	45	58	68	78	88	102	122	138	158	188	212	268	320	370
h3 (DIN 2642)	10	10	12	12	12	12	14	14	16	16	18	18	20	22	22
F (DIN EN 1092)	12	12	14	14	14	14	16	16	16	18	18	20	20	22	22
a (DIN 2642)	45	45	46	51	51	51	57	57	63	68	79	79	85	85	90
a (DIN EN 1092)	46	46	47	52	52	52	58	58	63	69	79	80	85	85	90
l (DIN 2642)	55	59	62	69	71	73	82	85	93	100	115	119	130	135	145
l (DIN EN 1092)	56	60	63	70	72	74	83	86	93	101	115	120	130	135	145
G approx.	0.72	0.84	1.08	1.48	2.13	2.46	3.08	3.90	5.00	5.75	8.00	9.80	13.5	18.4	24.3

** For choice of steel materials: see "Appendix A – Materials"*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Flange connection, swivelling

Welding rim of stainless steel 1.4541 or 1.4571
loose flange of steel or stainless steel 1.4541 or 1.4571
welded or brazed

Fitting type PN 10	PN 16 (bis DN 150)	Material Welding rim	Flange	Maximum operating temperature
CA82D	**CA82E**	Stainless steel	Steel	480 °C*
CA22D	**CA22E**	Stainless steel	Stainless steel	550 °C

Connection dimensions PN 10 and PN 16 up to DN 250 to DIN 2501 / DIN EN 1092

Dimensions in mm, weight G in kg

DN	10	16	20	25	32	40	50	65	80	100	125	150	200	250	300
d4 / d1	40	45	58	68	78	88	102	122	138	158	188	212	268	320	370
s2 (DIN 2642)	3	3	3	3	3.5	3.5	3.5	3.5	4	4	4	4	4	5	5
s2(DIN EN 1092)**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
a (DIN 2642)	9	9	12	15	15	17	23	23	23	28	30	30	35	30	35
a (DIN EN 1092)**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
l (DIN 2642)	19	23	28	33	35	39	48	51	53	60	66	70	75	80	90
l (DIN EN 1092)**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G approx.	0.63	0.71	0.84	1.15	1.68	1.90	2.21	2.88	3.55	3.86	4.95	6.00	8.2	11.0	13.7

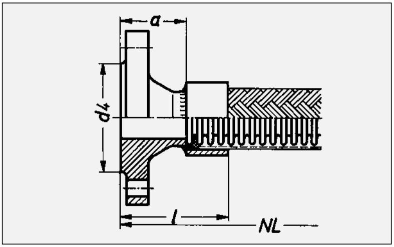
** For choice of steel materials: see "Appendix A – Materials"*

*** Dimension not standardized in DIN EN 1092*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type GB12
GB22



Flange connection, fixed

Welding neck flange of steel or stainless steel 1.4541 or 1.4571
welded or brazed

Fitting type				Material	Maximum operating
PN 10	PN 16	PN 25	PN 40	Flange	temperature
GB12D	**GB12E**	**GB12F**	**GB12G**	Steel	480 °C*
GB22D	**GB22E**	**GB22F**	**GB22G**	Stainless steel	550 °C

Connection dimensions PN 10 and PN 16/25/40 up to DN 80 to DIN 2501 / DIN EN 1092
Dimensions in mm, weight G in kg

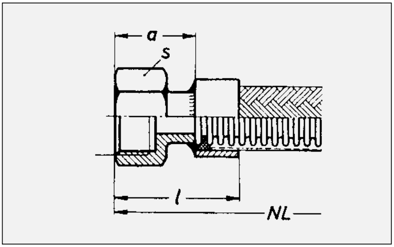
DN	10	16	20	25	32	40	50	65	80	100	125	150	200	250	300
d4 / d1	40	45	58	68	78	88	102	122	138	158	188	212	268	320	370
a (DIN 2642)	35	35	38	38	40	42	45	45	50	52	55	55	62	68	68
a (DIN EN 1092)	35	38	40	40	42	45	45	45	50	52	55	55	62	68	68
l (DIN 2642)	45	49	54	56	60	64	70	73	80	84	91	95	107	118	123
l (DIN EN 1092)	45	52	56	58	62	67	70	73	80	84	91	95	107	118	123
G approx.	0.60	0.67	1.00	1.20	1.76	2.00	2.66	3.30	3.95	4.95	6.75	8.35	12.4	16.1	20.0

** For choice of steel materials: see "Appendix A – Materials"*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type LA12S LA22S LA52S



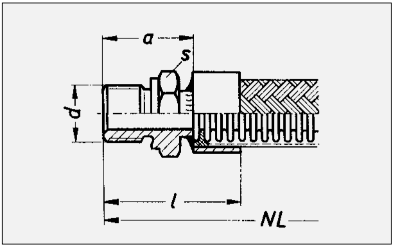
Threaded connection, fixed
Hexagon socket with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
LA12S	Steel	300° C
LA22S	Stainless steel	550 °C
LA52S	Brass	250 °C

Dimensions in mm, weight G in kg

PN	100							63			40	
DN	6	8	10	12	16	20	25	32	40	50	65	80
d	Rp$^1/_4$	Rp$^1/_4$	Rp$^3/_8$	Rp$^1/_2$	Rp$^1/_2$	Rp$^3/_4$	Rp1	Rp1$^1/_4$	Rp1$^1/_2$	Rp2	Rp2$^1/_2$	Rp3
a	19	19	21	24	24	27	31	34	36	42	49	54
l	27	29	31	36	38	43	49	54	58	67	77	84
s	17	17	22	24	24	32	41	46	55	65	85	100
G approx.	0.02	0.03	0.04	0.06	0.07	0.10	0.19	0.22	0.31	0.41	0.86	1.22

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Threaded connection, fixed

Hexagon nipple with Whitworth pipe thread ISO 228/1
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

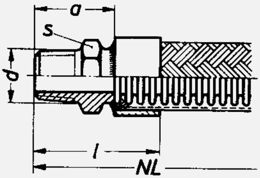
Fitting type	Material	Maximum operating temperature
MA12S	Steel	300° C
MA22S	Stainless Steel	550 °C
MA52S	Brass	250 °C

Dimensions in mm, weight G in kg

PN	250				160		100			63	40		
DN	6	8	10	12	16	20	25	32	40	50	65	80	100
d	G1/4A	G1/4A	G3/8A	G1/2A	G1/2A	G3/4A	G1A	G1 1/4A	G1 1/2A	G2A	G2 1/2A	G3A	G4A
a	24	25	25	29	29	32	38	40	43	45	52	54	64
l	32	35	35	41	43	48	56	60	65	70	78	84	96
s	19	19	22	27	27	32	41	50	55	70	85	100	120
G approx.	0.04	0.04	0.06	0.08	0.08	0.12	0.2	0.29	0.32	0.47	0.75	0.85	1.35

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

On request, also available with metric fine-pitch thread

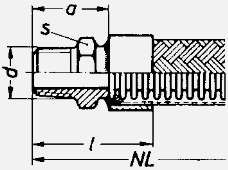


Threaded connection, fixed
Hexagon nipple with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of malleable cast iron
brazed

Fitting type	Maximum operating temperature	Max. operating pressure
MH02S	see page 336	see page 336

Dimensions in mm, weight G in kg

DN	10	12	16	20	25	32	40	50	65	80
d	R3/8	R1/2	R1/2	R3/4	R1	R1 1/4	R1 1/2	R2	R2 1/2	R3
a	32	35	35	39	42	45	48	52	55	60
l	42	47	49	55	60	65	70	77	83	90
s	22	28	28	32	42	50	55	70	85	100
G approx.	0.06	0.08	0.08	0.12	0.18	0.26	0.29	0.49	0.85	1.26



Threaded connection, fixed

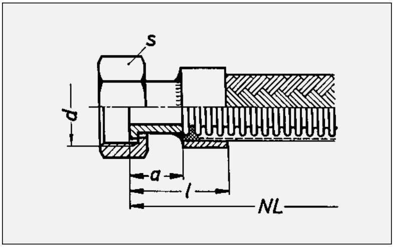
Hexagon nipple with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
MH12S	Steel	300 °C
MH22S	Stainless steel	550 °C
MH52S	Brass	250 °C

Dimensions in mm, weight G in kg

PN	100							63			40	
DN	6	8	10	12	16	20	25	32	40	50	65	80
d	R1/4	R1/4	R3/8	R1/2	R1/2	R3/4	R1	R1 1/4	R1 1/2	R2	R2 1/2	R3
a	24	24	25	29	29	32	38	40	40	47	52	56
l	32	34	35	41	43	48	56	60	62	72	80	86
s	14	14	17	22	22	27	36	46	50	60	80	90
G approx.	0.02	0.03	0.04	0.05	0.06	0.09	0.14	0.23	0.25	0.43	0.65	0.75

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



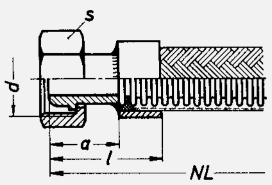
Threaded connection, swivelling
Collar pipe, flat sealing
union nut with Whitworth pipe thread ISO 228/1
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
NA12S	Steel	300 °C
NA22S	Stainless steel	550 °C
NA52S	Brass	250 °C

Dimensions in mm, weight G in kg

PN	25									
DN	6	8	10	12	16	20	25	32	40	50
d	G1/4	G3/8	G1/2	G5/8	G3/4	G1	G1 1/4	G1 1/2	G1 3/4	G2 1/4
a	20	21	21	24	24	24	26	26	29	29
l	28	31	31	36	38	40	44	46	51	54
s	17	22	27	27	32	41	50	55	65	75
G approx.	0.03	0.04	0.07	0.08	0.10	0.15	0.25	0.28	0.49	0.54

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Threaded connection, swivelling
Ball-type bushing to DIN 3863
union nut with Whitworth pipe thread ISO 228/1
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
NF12S	Steel	300 °C
NF22S	Stainless steel	550 °C
NF52S	Brass	250 °C

Dimensions in mm, weight G in kg

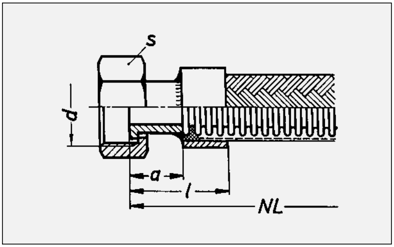
PN	25									
DN	6	8	10	12	16	20	25	32	40	50*
d	G1/4	G3/8	G1/2	G5/8	G3/4	G1	G1 1/4	G1 1/2	G1 3/4	G2 1/4
a	24	24	24	29	29	29	31	31	31	34
l	32	34	34	41	43	45	49	51	53	59
s	17	22	27	27	32	41	50	55	65	75
G approx.	0.03	0.04	0.07	0.08	0.10	0.15	0.28	0.29	0.47	0.58

***DN 50 is not standardized!*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type NI12S
NI22S
NI52S



Threaded connection, swivelling
Collar pipe, flat sealing
union nut with metric thread DIN 3870, series LL
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
NI12S	Steel	300 °C
NI22S	Stainless steel	550 °C
NI52S	Brass	250 °C

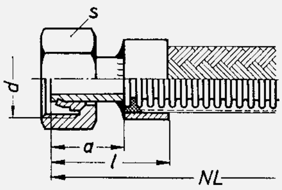
Dimensions in mm, weight G in kg

PN	25									
DN	6	8	10	12	16	20	25	32	40	50
d	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M26x1.5	M30x1.5	M38x1.5	M45x1.5	M52x1.5	M65x2
a	20	21	21	24	24	24	26	26	29	29
l	28	31	31	36	38	40	44	46	51	54
s	17	19	22	27	32	36	46	50	60	75
G approx.	0.03	0.04	0.05	0.07	0.10	0.12	0.19	0.28	0.34	0.45

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type NL12Q NL22Q



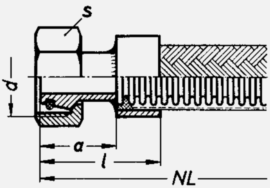
Threaded connection, swivelling
Precision pipe connection with tapping ring DIN 3861, DIN EN ISO 8434-1
union nut with metric thread to DIN EN ISO 8434-1, series L
of steel or stainless steel 1.4541 or 1.4571 (union nut 1.4571),
welded or brazed

Fitting type	Material	Maximum operating temperature
NL12Q	Steel	300 °C
NL22Q	Stainless steel	550 °C

Dimensions in mm, weight G in kg

PN	250				160		100		
DN	6	8	10	12	16	20	25	32	40
Pipe dimensions	8x1	10x1.5	12x1.5	15x2	18x1.5	22x2	28x2	35x2	42x3
d	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M26x1.5	M30x2	M36x2	M45x2	M52x2
a	28	30	30	32	32	36	40	45	45
l	36	40	40	44	46	52	58	65	67
s	17	19	22	27	32	36	41	50	60
G approx.	0.04	0.04	0.06	0.09	0.11	0.16	0.21	0.31	0.44

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Threaded connection, swivelling

24° sealing cone with O-ring, union nut DIN ISO 12151-2, series L of steel or stainless steel 1.4541 or 1.4571 (union nut 1.4571), welded or brazed

Fitting type	Material Threaded connection	O-ring	Maximum operating temperature
NN12Q	Steel	NBR (Perbunan) or FPM (Viton)	-20 to + 90 °C
NN22Q	Stainless steel		-20 to + 200 °C

Dimensions in mm, weight G in kg

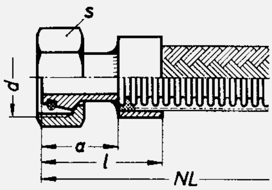
PN	250				160		100		
DN	6	8	10	12	16	20	25	32	40
d	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M26x1.5	M30x2	M36x2	M45x2	M52x2
a	32	35	35	35	38	40	44	46	50
l	40	45	45	47	52	56	62	66	72
s	17	19	22	27	32	36	41	55	60
G approx.	0.03	0.04	0.05	0.07	0.11	0.15	0.21	0.31	0.48

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material for O-ring, material no. if stainless steel

Note

This threaded connection is suitable for the tapping ring connection to DIN EN ISO 8434-1, series L or for connection to threaded pins with bore shape W (24°), series L to DIN 3861.

Associated pipe outside diameter	8	10	12	15	18	22	28	35	42



Threaded connection, swivelling

24° sealing cone with O-ring, union nut DIN ISO 12151-2, series S of steel or stainless steel 1.4541 or 1.4571 (union nut 1.4571), welded or brazed

Fitting type	Material Threaded connection	 O-ring	Maximum operating temperature
NN12R	Steel	NBR (Perbunan)	-20 to + 90 °C
NN22R	Stainless steel	or FPM (Viton)	-20 to + 200 °C

Dimensions in mm, weight G in kg

PN	630			400			250	
DN	6	8	10	12	16	20	25	32
d	M18x1.5	M20x1.5	M22x1.5	M24x1.5	M30x2	M36x2	M42x2	M52x2
a	35	35	35	35	40	44	48	50
l	43	45	45	47	54	60	66	70
s	22	24	27	30	36	46	50	60
G approx.	0.05	0.06	0.08	0.1	0.16	0.30	0.37	0.58

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material for O-ring, material no. if stainless steel

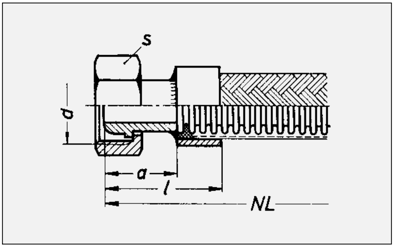
Note

This threaded connection is suitable for the tapping ring connection to DIN EN ISO 8434-1, series S or for connection to threaded pins with bore shape W (24°), series S to DIN 3861.

Associated pipe outside diameter	10	12	14	16	20	25	30	38

Connection fittings for corrugated hoses

Type NO12S
NO22S
NO52S



Threaded connection, swivelling
Ball-type bushing to DIN 3863
union nut with metric thread DIN 3870, series LL
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
NO12S	Steel	300° C
NO22S	Stainless steel	550 °C
NO52S	Brass	250 °C

Dimensions in mm, weight G in kg

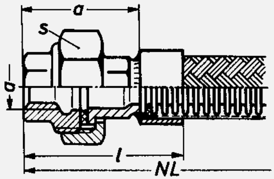
PN	25										
DN	6	8	10	12	16	20	25	32	40	*50	*65
d	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M26x1.5	M30x1.5	M38x1.5	M45x1.5	M52x1.5	M65x2	M78x2
a	24	24	24	29	29	29	31	31	31	34	40
l	32	34	34	41	43	45	49	51	53	59	68
s	17	19	22	27	32	36	46	50	60	75	90
G approx.	0.03	0.04	0.05	0.08	0.10	0.12	0.22	0.30	0.31	0.48	0.72

**DN 50 + 65 are not standardized!*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Note

This threaded connection is suitable for the connection to bore shapes U and Y (60°) to DIN 3863.



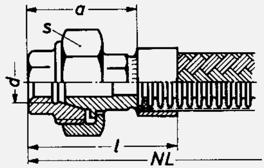
Threaded fitting, internal thread
flat sealing,
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of malleable cast iron, brazed

Fitting type	Maximum operating temperature	Max. operating pressure
QA02S	see page 336	see page 336

Dimensions in mm, weight G in kg

DN	6	8	10	12	16	20	25	32	40	50
d	Rp1/4	Rp1/4	Rp3/8	Rp1/2	Rp1/2	Rp3/4	Rp1	Rp1 1/4	Rp1 1/2	Rp2
a	52	52	54	59	59	65	70	78	85	94
l	60	62	64	71	73	81	88	98	107	119
s	28	28	32	39	39	48	55	67	74	90
G approx.	0.11	0.12	0.14	0.18	0.19	0.31	0.42	0.68	0.87	1.31

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature



Threaded fitting, internal thread
conically sealing,
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of malleable cast iron, brazed

Fitting type	Maximum operating temperature	Max. operating pressure
QB02S	see page 336	see page 336

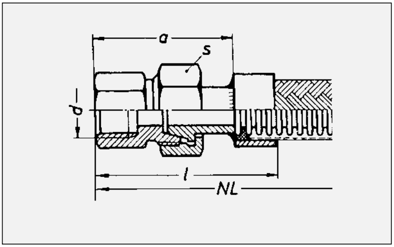
Dimensions in mm, weight G in kg

DN	6	8	10	12	16	20	25	32	40	50
d	Rp1/4	Rp1/4	Rp3/8	Rp1/2	Rp1/2	Rp3/4	Rp1	Rp1 1/4	Rp1 1/2	Rp2
a	52	52	54	59	59	65	70	78	85	94
l	60	62	64	71	73	81	88	98	107	119
s	28	28	32	39	39	48	55	67	74	90
G approx.	0.11	0.12	0.14	0.19	0.20	0.33	0.44	0.72	0.88	1.37

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature

Connection fittings for corrugated hoses

Type QB12W
Type QB22W
Type QB52W



Threaded fitting, internal thread
conically sealing with 24° cone angle
suitable for bore shape W DIN 3861 L, DIN EN ISO 8434-1
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of steel, stainless steel 1.4541 or 1.4571 (union nut 1.4301 in each case) or brass,
welded or brazed

Fitting type	Material	Maximum operating temperature
QB12W	Steel	300° C
QB22W	Stainlss steel	550 °C
QB52W	Brass	250 °C

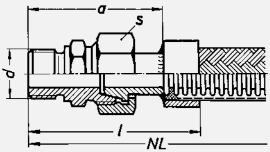
Dimensions in mm, weight G in kg

PN	100							63		
DN	6	8	10	12	16	20	25	32	40	50
d	Rp1/4	Rp1/4	Rp3/8	Rp1/2	Rp1/2	Rp3/4	Rp1	Rp1 1/4	Rp1 1/2	Rp2
a	43	44	47	52	53	60	66	71	75	83
l	51	54	57	64	67	76	84	91	97	108
s	17	19	22	27	32	36	41	50	60	70
G approx.	0.05	0.06	0.08	0.13	0.16	0.21	0.31	0.48	0.61	0.81

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type RB12W
Type RB22W
Type RB52W



Threaded fitting, external thread
conically sealing with 24° cone angle
suitable for bore shape W to DIN 3861 L, DIN EN ISO 8434-1 L
with Whitworth pipe thread ISO 228/1
of steel, stainless steel 1.4541 or 1.4571 (union nut 1.4301) or brass,
welded or brazed

Fitting type	Material	Maximum operating temperature
RB12W	Steel	300° C
RB22W	Stainless steel	550 °C
RB52W	Brass	250 °C

Dimensions in mm, weight G in kg

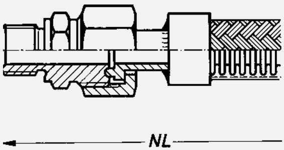
PN	100							63		
DN	6	8	10	12	16	20	25	32	40	50
d	G1/4A	G1/4A	G3/8A	G1/2A	G1/2A	G3/4A	G1A	G1 1/4A	G1 1/2A	G2A
a	49	51	54	59	60	68	74	79	83	92
l	57	61	64	71	74	84	92	99	105	117
s	17	19	22	27	32	36	41	50	60	70
G approx.	0.05	0.06	0.08	0.13	0.16	0.21	0.32	0.5	0.68	0.93

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

special applications

Type RD16
Type RD26



High-pressure threaded fitting, external thread
without intermediate seal, metallically sealing
with Whitworth pipe thread ISO 228/1
of steel C22 or stainless steel,
welded

Fitting type PN 100	PN 200	Material	Maximum operating temperature
RD16S	**RD16W**	Steel	350 °C
RD26S	**RD26W**	Stainless steel	400 °C

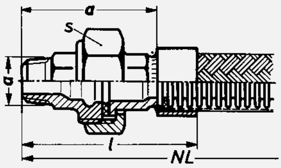
Application:
- High pressure
  (also for pulsations, vibrations)
- Vacuum
- Critical media
  (e.g. superheated steam, thermal oil)
- High temperatures

Nominal diameter:
DN 6 to DN 50

Operating pressure:
as per table
Higher pressure levels on request

Operating temperature:
as per table
Higher operating temperatures on request

Please quote when ordering:
- Fitting type
- Nominal diameter (DN)
- Operating temperature



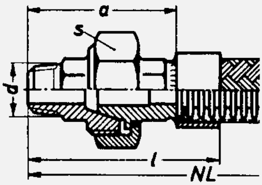
Threaded fitting, external thread
flat sealing
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of malleable cast iron
brazed

Fitting type	Maximum operating temperature	Max. operating pressure
RE02S	see page 336	see page 336

Dimensions in mm, weight G in kg

DN	12	16	20	25	32	40	50
d	R1/2	R1/2	R3/4	R1	R1 1/4	R1 1/2	R2
a	77	77	86	93	103	111	123
l	89	91	102	111	123	133	148
s	39	39	48	55	67	74	90
G approx.	0.21	0.22	0.33	0.48	0.74	0.91	1.43

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature



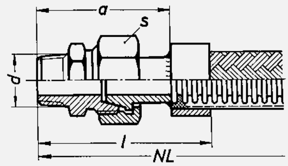
Threaded fitting, external thread
conically sealing
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of malleable cast iron
brazed

Fitting type	Maximum operating temperature	Max. operating pressure
RF02S	see page 336	see page 336

Dimensions in mm, weight G in kg

DN	6	8	10	12	16	20	25	32	40	50
d	R1/4	R1/4	R3/8	R1/2	R1/2	R3/4	R1	R1 1/4	R1 1/2	R2
a	66	66	69	77	77	86	93	103	111	123
l	74	76	79	89	91	102	111	123	133	148
s	28	28	32	39	39	50	55	67	74	90
G approx.	0.11	0.11	0.15	0.22	0.23	0.35	0.51	0.78	0.99	1.50

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature



Threaded fitting, external thread
conically sealing with 24° cone angle
suitable for bore shape W DIN 3861L, DIN EN ISO 8434-1
with Whitworth pipe thread DIN EN 10226 (ISO 7/1)
of steel, stainless steel 1.4541 or 1.4571 or brass
welded or brazed

Fitting type	Material	Maximum operating temperature
RF12W	Steel	300° C
RF22W	Stainless steel	550 °C
RF52W	Brass	250 °C

Dimensions in mm, weight G in kg

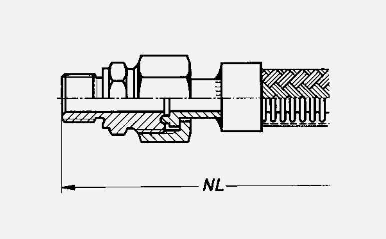
PN	100							63		
DN	6	8	10	12	16	20	25	32	40	50
d	R1/4	R1/4	R3/8	R1/2	R1/2	R3/4	R1	R1 1/4	R1 1/2	R2
a	47	49	52	59	60	67	74	80	82	93
l	55	59	62	71	74	83	92	100	104	118
s	17	19	22	27	32	36	41	50	60	70
G approx.	0.05	0.06	0.08	0.13	0.16	0.21	0.32	0.5	0.68	0.93

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

special applications

Type RM16
Type RM26



High-pressure threaded fitting, external thread
without intermediate seal, metallically sealing
with metric ISO thread to DIN 13
of steel C22 or stainless steel,
welded

Fitting type PN 100	Fitting type PN 200	Material	Maximum operating temperature
RM16S	**RM16W**	Steel	350 °C
RM26S	**RM26W**	Stainless steel	400 °C

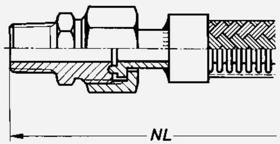
Application:
- High pressure
  (also for pulsations, vibrations)
- Vacuum
- Critical media
  (e.g. superheated steam, thermal oil)
- High temperatures

Nominal diameter:
DN 6 to DN 50

Operating pressure:
as per table
Higher pressure levels on request

Operating temperature:
as per table
Higher operating temperatures on request

Please quote when ordering:
- Fitting type
- Nominal diameter (DN)
- Operating temperature



High-pressure threaded fitting, external thread
without intermediate seal, metallically sealing
with conical NPT thread ANSI B1.20.1
of steel C22 or stainless steel,
welded

Fitting type PN 100	Fitting type PN 200	Material	Maximum operating temperature
RN16S	**RN16W**	Steel	350 °C
RN26S	**RN26W**	Stainless steel	400 °C

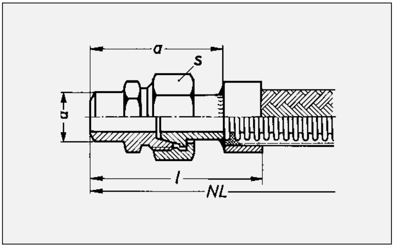
Application:
- High pressure (also for pulsations, vibrations)
- Vacuum
- High temperatures

Nominal diameter:
DN 6 to DN 50

Operating pressure:
as per table
Higher pressure levels on request

Operating temperature:
as per table
Higher operating temperatures on request

Please quote when ordering:
- Fitting type
- Nominal diameter (DN)
- Operating temperature



Threaded fitting, welding end
conically sealing with 24° cone angle
suitable for bore shape W DIN 3861 L, DIN EN ISO 8434-1L
with welding end, pipe dimensions ISO
of steel, stainless steel 1.4541 or 1.4571
welded or brazed

Fitting type	Material	Maximum operating temperature
SS12W	Steel	300 °C
SS22W	Stainess steel	550 °C

Dimensions in mm, weight G in kg

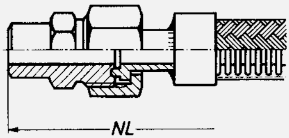
PN	100							63		
DN	6	8	10	12	16	20	25	32	40	50
d	10.2	13.5	17.2	21.3	21.3	26.9	33.7	42.4	48.3	60.3
a	45	47	49	52	53	61	65	70	74	83
l	53	57	59	64	67	77	83	90	96	108
s	17	19	22	27	32	36	41	50	60	70
G approx.	0.04	0.05	0.07	0.11	0.13	0.23	0.29	0.44	0.64	1.01

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

special applications

Type ST16
Type ST26



High-pressure threaded fitting, welding end
without intermediate seal, metallically sealing
of steel C22 or stainless steel,
welded

Fitting type PN 100	Fitting type PN 200	Material	Maximum operating temperature
ST16S	**ST16W**	Steel	350 °C
ST26S	**ST26W**	Stainless steel	400 °C

Application:
- High pressure (also for pulsations, vibrations)
- Vacuum
- Critical media (e.g. superheated steam, thermal oil)
- High temperatures

Nominal diameter:
DN 6 to DN 50

Operating pressure:
as per table
Higher pressure levels on request

Operating temperature:
as per table
Higher operating temperatures on request

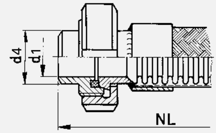
Please quote when ordering:
- Fitting type
- Nominal diameter (DN)
- Operating temperature

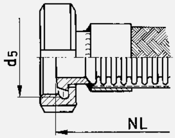
Connection fittings for corrugated hoses

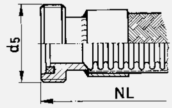
special applications

Type SY22S
Type SY22U
Type SY22V

Threaded fitting, DIN 11851 for liquid foodstuffs
of stainless steel 1.4301, welded without burr and gap sterilizable







Type SY22S
Ball-type socket with grooved union nut with round thread DIN 405. Threaded pipe socket with welding end.

Type SY22U
Ball-type socket with grooved union nut with round thread DIN 405.

Type SY22V
Threaded pipe socket with sealing ring.

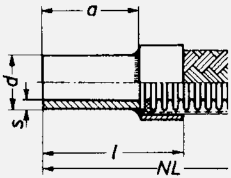
Fitting type	Material		Maximum operating temperature
	Threaded fitting	Sealing ring	
SY22S **SY22U** **SY22V**	Stainless steel 1.4301 Other material no. on request	NBR (Perbunan) FPM (Viton) MVQ (Silicone) or PTFE (Teflon)	-20 to +230 °C depending on seal material and flow medium

Dimensions in mm

PN	40							25		
DN	10	16	20	25	32	40	50	65	80	100
d4*	13	19	23	29	35	41	53	70	85	104
d1*	10	16	20	26	32	38	50	66	81	100
d5	Rd28x$^1/_8$	Rd34x$^1/_8$	Rd44x$^1/_6$	Rd52x$^1/_6$	Rd58x$^1/_6$	Rd65x$^1/_6$	Rd78x$^1/_6$	Rd95x$^1/_6$	Rd110x$^1/_4$	Rd130x$^1/_4$

**If required, also with ISO pipe dimensions, see page 95*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, sealing ring material or medium and pressure.



Pipe fitting
Welding end with
ISO pipe dimensions
of steel or stainless steel 1.4541 or 1.4571
welded or brazed

Fitting type	Material	Maximum operating temperature
UA12S	Steel	480 °C
UA22S	Stainless steel	550 °C

Dimensions in mm, weight G in kg

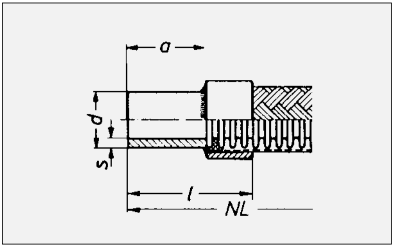
PN	160				100		40									16	
DN	8	10	12	16	20	25	32	40	50	65	80	100	125	150	200	250	300
d	10.0[2)]	13.5	17.2	21.3	26.9	33.7	42.4	48.3	60.3	76.1	88.9	114.3	139.7	168.3	219.1	273	323.9
a	1.5[2)]	1.8[1)]	1.8[1)]	2	2.3	2.6	2.6	2.6	2.9	2.9	3.2	3.6	4	4.5	6.3	6.3	7.1
l	50	55	55	60	60	65	65	70	70	75	80	85	85	90	100	100	120
s	60	65	67	74	76	83	85	92	95	103	110	117	121	130	145	150	175
G approx.	0.04	0.05	0.06	0.08	0.13	0.18	0.26	0.30	0.41	0.55	0.74	1.10	1.54	2.14	3.83	5.13	7.95

**1) if stainless steel: s = 1.6*

2) if steel: 10.2 x 1.6

For choice of steel materials: see “Appendix A – Materials”

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel



Pipe fitting
Precision pipe socket for
tapping ring fitting DIN 3861 (series L), DIN EN ISO 8434-1
of steel or stainless steel 1.4541 or 1.4571,
welded or brazed

Fitting type	Material	Maximum operating temperature
UD12Q	Steel	300 °C
UD22Q	Stainless steel	550 °C

Dimensions in mm, weight G in kg

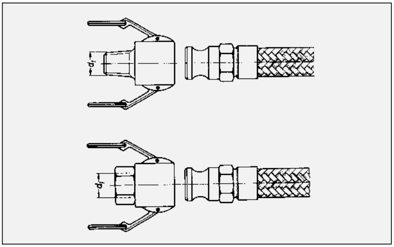
PN	250				160		100		
DN	6*	8*	10*	12*	16*	20*	25	32	40
d	8	10	12	15	18	22	28	35	42
a	1	1.5	1.5	2	1.5	2	2	2	3
l	28	30	30	32	32	36	40	45	45
s	36	40	40	44	46	52	58	65	67
G approx.	0.02	0.02	0.03	0.04	0.04	0.06	0.10	0.14	0.18

** also suitable for Swagelok® threaded fittings for metric pipe dimensions*

Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, material no. if stainless steel

Connection fittings for corrugated hoses

Type WA22S WA32S



Quick-release coupling
Lever arm coupling DIN 2828 with internal Whitworth pipe thread ISO 228/1 or external Whitworth thread DIN 2999 (ISO 7/1) of brass or stainless steel
welded or brazed

This quick-release coupling is characterised by simple handling, quick installation, robust construction and long service life. Offering safe and pressure-proof coupling, the connection is made by plugging the two halves of the coupling together then locking them by flipping the two cam levers. Because the inserted sealing ring is compressed and not subjected to rotational movement during the coupling action, the connection is made with no damaging twisting of the hose.

Applications
Lever arm couplings to DIN 2828 are designed for joining hoses with connection fittings that are intended to carry liquids, solids and gases, except liquid gas and steam. Use for substances falling under the Hazardous Substances Regulations (GefStoffV) must be specifically checked. The couplings can be used in the pressure range -800 mbar to 10 bar at 65°C.
NOTE: If separating lever arm couplings where the hose assembly is under pressure, there is no preliminary pressure relief before the coupling is unlocked.

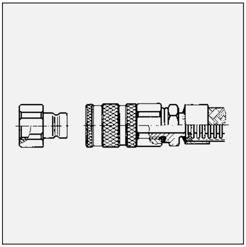
Please state when ordering: fitting type, nominal diameter (DN), operating temperature, internal and external thread, seal material or medium and pressure.
If only one half of the coupling is required (male of female part), this must be specifically stated. Other DN on request.

Fitting type	Material		Max. operating pressure	Maximum operating temperature
	Quick-release coupling	Sealing ring		
WA22S	Stainless steel	NBR (Perbunan) FPM (Viton)	10 bar	65 °C
WA32S	Brass			

DN	20	25	32	40	50	65	80	100
d1 R/G	¾	1	1 ¼	1 ½	2	2 ½	3	4

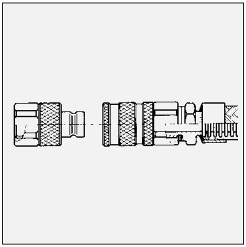
Connection fittings for corrugated hoses

Type WB12S
Type WB22S
Type WB52S



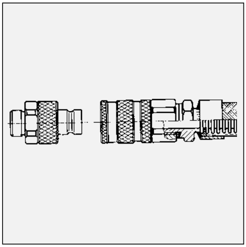
Version 1
Sealing coupling (female part) – self-sealing after uncoupling

Coupling nipple (male part) with internal thread – free inner surface



Version 2
Sealing coupling (female part) – self-sealing after uncoupling

Sealing nipple (male part) with internal thread – self-sealing after uncoupling



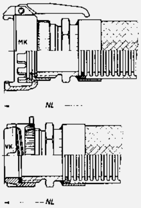
Version 3
Sealing coupling (female part) – self-sealing after uncoupling

Sealing nipple (male part) with external thread – self-sealing after uncoupling

Quick-sealing coupling
connected at hose end
with thread fitting Type MA ... (page 72)
consisting of sealing coupling (female part)
and coupling nipple (male part)
Thread: Whitworth pipe thread ISO 228/1

Fitting type P_{zul} bar and. vacuum	Material		Max. operating temperature
	Coupling	Sealing ring	
WB12S	Steel, galvanized	NBR (Perbunan)	-50 to +200 °C depending on seal material and flow medium
WB22S	Stainless steel	FPM (Viton)	
WB52S	Brass	EP (Ethylene-propylene)	

Nominal diameter: DN 6 to DIN 50, larger sizes on request
Please quote when ordering: fitting type, nominal diameter (DN), operating temperature, version for male part and/or female part, seal material or medium and pressure.
Other materials and versions on request.



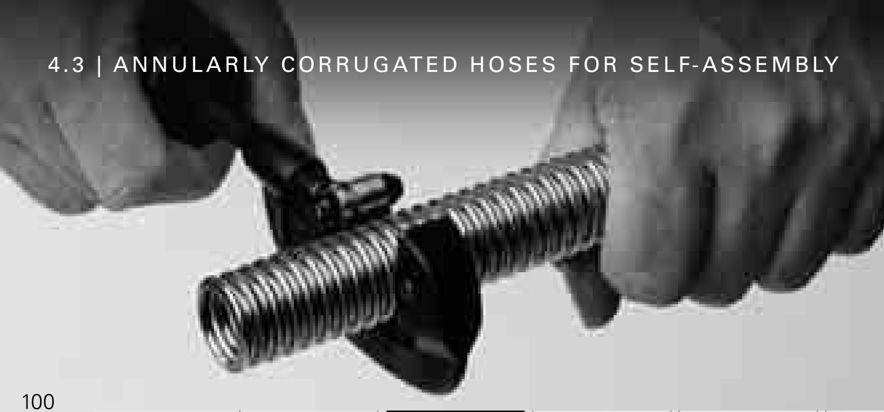
Quick-release coupling for fuel vehicles DIN 28450
connected at hose end with thread fitting Type MA ...(page 72)
consisting of swivelling female part
(MK coupling) with coupling levers or
fixed male part (VK coupling)

Both male part and female part can be fitted to the hose.
Thread: Whitworth pipe thread ISO 228/1

Fitting type PN 10	Material Coupling	Sealing ring	Max. operating temperature
WC22S	Stainless steel	AU, EU (Vulkollan) NBR (Perbunan) FPM (Viton) CSM (Hypalon) or PTFE (Teflon)	100 °C
WC52S	Brass		

DN	50	80	100
Nominal diameter designation for:			
Male part	VK50	VK80	VK100
Female part	MK50	MK80	MK100

**Please quote when ordering: fitting type, operating temperature, nominal diameter designation for male part and/or female part, seal material or medium and pressure.*
Higher temperatures on request



quick,
safe,
pressure-tight

In real life, it is sometimes impossible to determine in advance the exact length of a metal hose and the connection fittings that are needed. In these cases, it makes sense to buy the hose by the metre. This can then be cut to size at the place of use and the appropriate fittings attached. The connection components are available in various types, are easy to fit, seal reliably and can be separated again without difficulty. Annularly corrugated hoses for self-assembly are designed for various applications:

Type RS 341:
annularly corrugated hose with long corrugation for flexible connections with small radii, e.g. appliance pipework, radiator connection, etc.
Particular characteristic: they are ideal for taking up heat expansion and for preventing the transmission of vibration and noise.

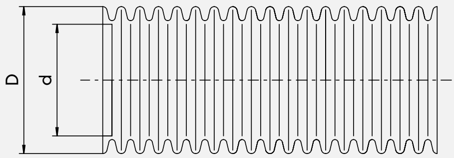
Type IX 331:
semi-flexible hose with low, flat corrugation as a substitute for curved pipes, assembly offsets, etc.
Particular characteristic: they remain reliably in the position into which they are bent.

Type RS 331S12:
braided corrugated hose with high corrugation. The braiding prevents elongation under pressure loading and also serves to protect the annularly corrugated hose.
Particular characteristic: suitable for pipework operating at pressures up to 16 bar.

Note:
Metal hoses with connection fittings for self-assembly are not suitable for dynamic loads and frequent movement.
They are also unsuitable for hazardous media (Group 1 – PED) and thermal oils.

Annularly corrugated hoses for self-assembly   Type RS 341S00

without braiding



Construction:
Annularly corrugated hose of stainless steel, medium version, long corrugation, without braiding

Connection fittings for self-assembly:
–> see page 102-104 (please choose)

Material:
Material no. 1.4404 or 1.4541

Temperature range:
-20 °C to +200 °C (for the system)
At temperatures > 20 °C, the reduction factors on page 251 must be applied.

DN	Type	Inside diameter	Outside diameter	Maximum deviation	Minimum bending radius one bending process	Permissible operating pressure at 20 °C*	Weight	Production length	Order no. 1.4404	Order no. 1.4541
–	–	d	D	d, D	r_{min}	P_{zul}	–	–	–	–
–	–	mm	mm	mm	mm	bar	kg/m	m	–	–
10	RS 341S00	10.3	14.1	± 0.3	18	20	0.086	10-100	378242	461982
12	RS 341S00	12.5	16.5	± 0.2	20	20	0.102	10-100	378243	461983
16	RS 341S00	16.3	21.4	± 0.3	25	20	0.153	10-100	378244	461984
20	RS 341S00	20.7	26.5	± 0.3	30	20	0.311	10-100	378245	461985
25	RS 341S00	25.8	31.7	± 0.4	35	20	0.388	10-100	378246	461986
32	RS 341S00	34.6	41.0	± 0.5	40	2.5	0.355	10-100	378247	461987

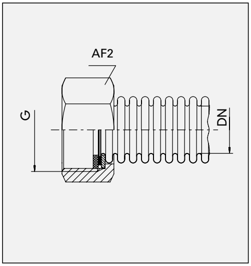
** applies to complete systems: corrugated hose with connection fitting / max. length expansion 2%*

Note:
If using Hydra Quick threaded coupling: P_{zul} = 6 bar (DN 12 - 25)

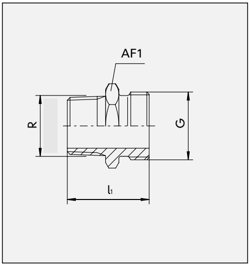
Connection fittings for self-assembly

Type NA50S

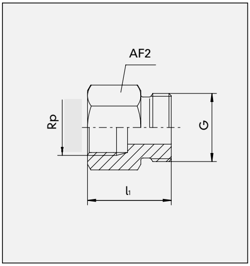
threaded fitting, separable, suitable for RS 341S00



Type NA50S – union nut



Type MA50S – male thread



Type MA50S – female thread

Set consisting of: union nut of brass, flat sealing, **clamp ring** (DBGM - German registered design) of stainless steel, **seal** (AFM 34 – metal)

DN	Type	Set threaded fitting DIN EN ISO 228-1	AF2	Weight approx.	Order no.
–	–	–	mm	kg	–
12	NA50S	G $^{1}/_{2}$	24	0.026	377093
16	NA50S	G $^{3}/_{4}$	30	0.037	377094
20	NA50S	G 1	38	0.075	377095
25	NA50S	G 1$^{1}/_{4}$	46	0.091	377096
32	NA50S	G 1$^{1}/_{2}$	55	0.146	377097

Connection fittings for self-assembly

Type MA50S

threaded fitting, separable, suitable for RS 341S00

Threaded insert of brass, **male thread** suitable for threaded fitting type NA50S

DN	Type	Threaded insert DIN EN 10226-1	Male thread DIN EN ISO 228-1	l1	AF1	Weight approx.	Order no.
–	–	–	–	mm	mm	kg/Set	–
10	MA50S	R 3/8	G 3/8	27.0	19	0.045	275486
12	MA50S	R 1/2	G 1/2	33.0	22	0.058	275487
16	MA50S	R 1/2	G 3/4	34.0	27	0.070	284264
20	MA50S	R 3/4	G 1	38.0	36	0.125	275489
25	MA50S	R 1	G 1 1/8	45.5	46	0.243	275490
25	MA50S	R 1	G 1 1/4	45.5	46	0.246	080142
32	MA50S	R 1 1/4	G 1 1/2	48.0	50	0.298	086459

Threaded insert of brass, **female thread** suitable for threaded fitting type NA50S

DN	Type	Threaded insert DIN EN 10226-1	Female thread DIN EN ISO 228-1	l1	AF2	Weight approx.	Order no.
–	–	–	–	mm	mm	kg	–
10	MA50S	Rp 3/8	G 3/8	27.0	22	0.065	275491
12	MA50S	Rp 1/2	G 1/2	29.0	27	0.070	275495
16	MA50S	Rp 1/2	G 3/4	29.0	27	0.074	275496
20	MA50S	Rp 3/4	G 1	33.0	36	0.154	275497
25	MA50S	Rp 1	G 1 1/8	37.0	41	0.308	275498
25	MA50S	Rp 1	G 1 1/4	37.0	41	0.308	328006
32	MA50S	Rp 1 1/4	G 1 1/2	42.0	50	0.311	315474

Connection fittings for self-assembly

Connector types, suitable for RS 341S00

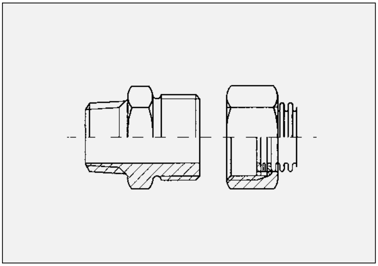


Fig. 1

Threaded coupling

Threaded insert with male thread.

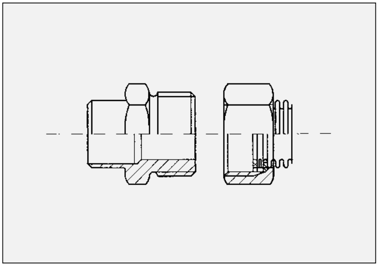


Fig. 2

Threaded coupling, threaded insert with ISO welding end or precision pipe section for tapping ring and swagelok threaded coupling.

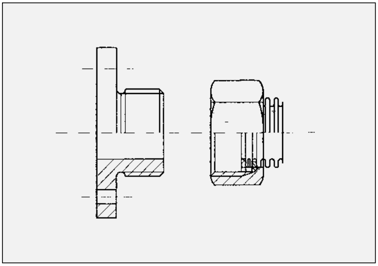


Fig. 3

Threaded coupling

Threaded insert with threaded flange PN 16–1.4541.

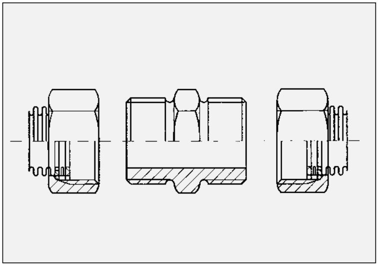


Fig. 4

Connection fitting:

- 1 double nipple

- 2 union nuts

Note:
All sets are supplied with the necessary number of clamp washers (single-piece) and seals (graphite Sigraflex for VA or AFM 34 – metal for brass).

Annularly corrugated hoses for self-assembly

Connector types, suitable for RS 341S00

Threaded coupling

DN	Threaded coupling Fig. 1 Order no.		Threaded coupling Fig. 2 Order no.		Threaded coupling Fig. 3 Order no.
–	Stainless steel 1.4301 RE20S	Brass RE50S	Welding end SS20S	Precision pipe SS20S	Stainless steel 1.4301/1.4541 KB20E
12	340 287	294 708	340 289	393 001	–
16	340 210	294 709	340 213	393 000	340 203
20	340 211	295 004	340 215	393 002	340 204
25	340 212	295 005	340 216	393 003	340 206

Connection fitting

DN	Connection fitting Fig. 4 Order no.		Reduction Order no.	
–	Stainless steel 1.4301 WN20S	Brass WN50S	DN –	Stainless steel 1.4301 WN20S
12	340 286	319 947	–	–
16	340 207	319 948	16/12	426 120
20	340 208	319 949	–	–
25	340 209	319 950	20/25	426122

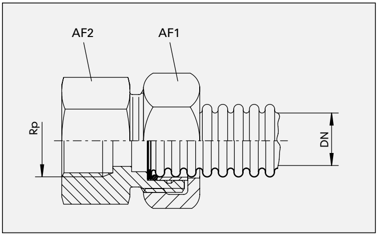
Dimensions for connection parts

DN	Union nut Thread	Union nut AF size	Threaded inserts male thread	Threaded inserts welding end	Precision pipe	AF size
–	–	AF	–	mm	mm	AF
12	G 1/2	24	R 1/2	17.2 x 1.8	12 x 1.5 x 32 15 x 2 x 32	22
16	G 3/4	30	R 1/2	21.3 x 2.0	18 x 1.5 x 32	27
20	G 1	41	R 3/4	26.9 x 2.3	22 x 2 x 36	36
25	G 1 1/4	46	R 1	33.7 x 2.6	28 x 2 x 40	46

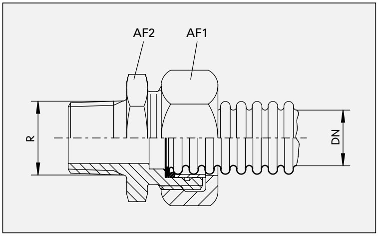
Connection fittings for self-assembly Hydra Quick

Type QD90B Type RH90B

Threaded connection, separable, metallically sealing of brass, for RS 341S00



Type QD90B – female thread



Type RH90B – male thread

Threaded connection, female thread

DN	Type	Set threaded connection DIN EN 10226-1	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	QD90B	Rp 1/2	30	27	427563
16	QD90B	Rp 1/2	34	32	425547
20	QD90B	Rp 3/4	41	36	425621
25	QD90B	Rp1	46	46	427647

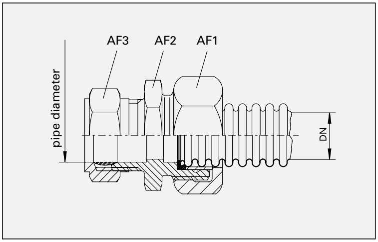
Threaded connection, male thread

DN	Type	Set threaded connection DIN EN 10226-1	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	RH90B	R 1/2	30	27	427556
16	RH90B	R 1/2	34	32	425179
20	RH90B	R 3/4	41	36	425538
25	RH90B	R 1	46	46	427644

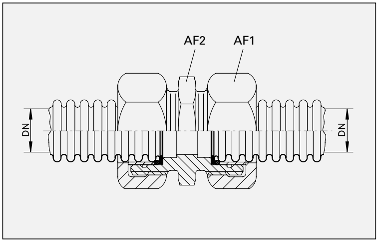
Connection fittings for self-assembly Hydra Quick

Type TT90B Type TY90B

Threaded connection, separable, metallically sealing of brass, for RS 341S00



Type TT90B – copper pipe connector



Type TY90B – hose connector

Threaded connection, copper pipe connector

DN	Type	Set copper pipe connector	AF1	AF2	AF3	Order no.
–	–	mm	mm	mm	mm	–
12	TT90B	10x1 / 12x1	30	27	22	427551
16	TT90B	15x1 / 18x1	34	32	27	424696
20	TT90B	22x1	41	36	32	424697
25	TT90B	28x1	46	46	41	427641

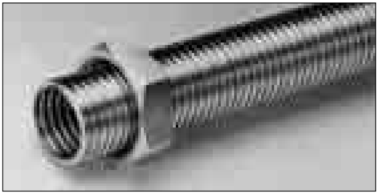
Threaded connection, hose connector

DN	Type	Set threaded connection	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	TY90B	DN12 - DN12	30	27	427571
16	TY90B	DN16 - DN16	34	32	424700
20	TY90B	DN20 - DN20	41	36	425623
25	TY90B	DN25 - DN25	46	46	427653

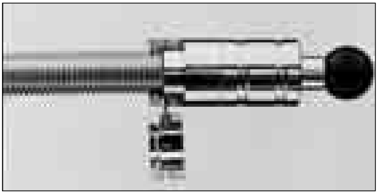
Assembly instructions RS 341S00

for Hydra Quick threaded coupling, see page 112

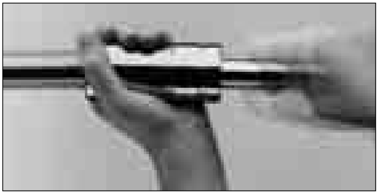
1. Cut hose to required length in the corrugation groove using a pipe cutter.



2. Slip on union nut.



3. Open clamping jaws with striking pin pulled back. Position hose so that second corrugation groove is in clamping jaw.



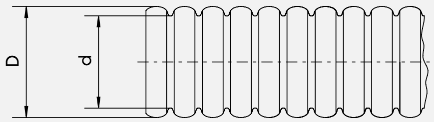
4. Close clamping jaws. Move the striking pin to compress the corrugation into a flange.

5. Use the swaging rod to push the burr inwards.

6. Insert clamp ring in the first corrugation groove and press together to form a closed ring. Insert seal, position threaded insert and use two spanners to tighten.

Annularly corrugated hoses for self-assembly Type IX 331S0

without braiding



Construction:
Corrugated tube, stainless steel, semi-flexible

Connection fittings for self-assembly:
–> see page 110-111 (please choose)

Material:
Material no. 1.4404

Temperature range:
-20 °C to max. +200 °C for the system
With temperatures >20 °C, the reduction factors on page 251 must be applied

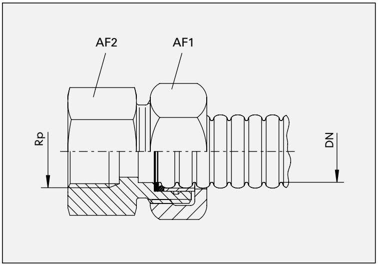
DN	Type	Inside diamete	Outside diamete	Maximum deviation	Minimum bending radius one bending process	Permissible operating pressure at 20 °C*	Weight	Production length	Order no.
–	–	d	D	d, D	r_{min}	P_{zul}	–	–	–
–	–	mm	mm	mm	mm	bar	kg/m	m	–
12	IX 331S0	12.5	15.7	± 0.2	32	6	0.10	10-100	374853
16	IX 331S0	16.5	20.4	± 0.2	40	6	0.15	10-100	394709
20	IX 331S0	20.6	24.9	± 0.3	50	6	0.17	10-100	394011
25	IX 331S0	25.6	30.5	± 0.3	60	6	0.25	10-100	374795

** applies to complete systems: corrugated hose with connection fitting*

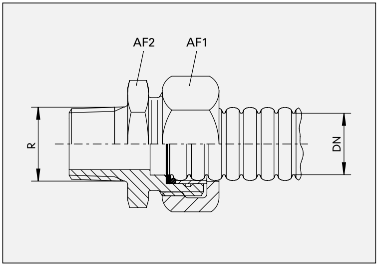
Connection fittings for self-assembly Hydra Quick

Type QD90A Type RH90A

Threaded connection, separable, metallically sealing of brass, for IX 331S0



Type QD90A – female thread



Type RH90A – male thread

Threaded connection, female thread

DN	Type	Set threaded connection DIN EN 10226-1	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	QD90A	Rp $^1/_2$	30	27	426970
16	QD90A	Rp $^1/_2$	34	32	425541
20	QD90A	Rp $^3/_4$	41	36	425562
25	QD90A	Rp 1	46	46	427624

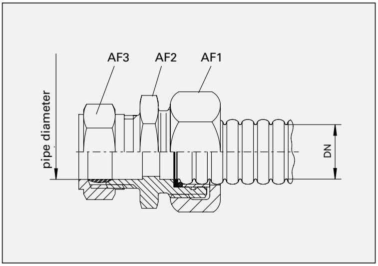
Threaded connection, male thread

DN	Type	Set threaded connection DIN EN 10226-1	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	RH90A	R $^1/_2$	30	27	426963
16	RH90A	R $^1/_2$	34	32	425175
20	RH90A	R $^3/_4$	41	36	425185
25	RH90A	R 1	46	46	427594

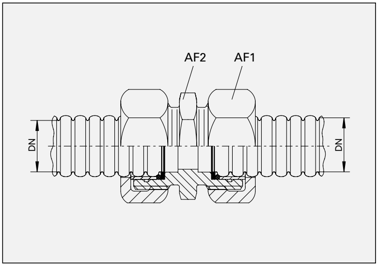
Connection fittings for self-assembly Hydra Quick

Type TT90A Type TY90A

Threaded connection, separable, metallically sealing of brass, for IX 331S0



Type TT90A – copper pipe connector



TypeTY90A – hose connector

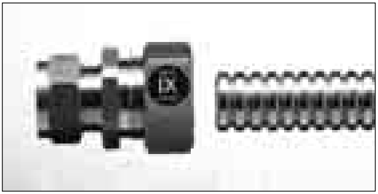
Threaded connection, copper pipe connector

DN	Type	Set copper pipe connector	AF1	AF2	AF3	Order no.
–	–	mm	mm	mm	mm	–
12	TT90A	10x1 / 12x1	30	27	22	426906
16	TT90A	15x1 / 18x1	34	32	27	424694
20	TT90A	22x1	41	36	32	424695
25	TT90A	28x1	46	46	41	427591

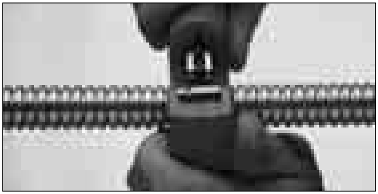
Threaded connection, hose connector

DN	Type	Set threaded connection	AF1	AF2	Order no.
–	–	–	mm	mm	–
12	TY90A	DN12 - DN12	30	27	426976
16	TY90A	DN16 - DN16	34	32	424698
20	TY90A	DN20 - DN20	41	36	424699
25	TY90A	DN25 - DN25	46	46	427625

Assembly instructions Hydra Quick



The assembly sets are marked accordingly for use with RS and IX annularly corrugated hoses: Green sticker: high profile (RS 341S00) Black sticker: flat profile (IX 331S0)

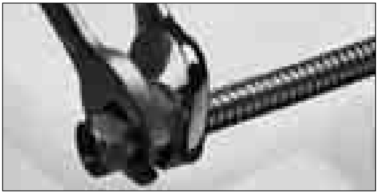


Cut through hose in the corrugation groove using a pipe cutter. The hose end has a clean cut so does not have to be deburred.

Loosen union nut (1/2 turn in anticlockwise direction). The tongue engages in the groove and the sleeve is loosely inserted under the union nut.

Insert the hose end in the fitting. The first corrugation is pushed over the retaining ring so that you feel it engage.

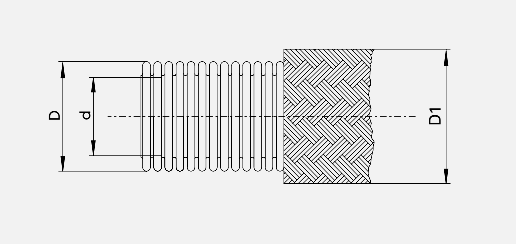
Tighten the union nut by hand. The hose is then pushed as far as the inner face and the retaining ring closed. The hose is now fixed, but can still be turned.



Tighten the union nut with open-ended spanners until you feel strong resistance. Use the guide values for max. tightening torque (90 Nm).

Annularly corrugated hoses for self-assembly   Type RS 331S12

single braiding



Construction:
Annularly corrugated hose, medium version, normal corrugation, with single stainless steel, wire braiding

Material:
Hose: material no. 1.4404 or 1.4541
Braiding: material no. 1.4301

Connection fittings for self-assembly:
–> see page 114-115 (please choose)

Temperature range:
-20 °C to max. +250 °C for the system

Note on reduced pressures:
> 120°C to 200°C = 13 bar
> 200°C to 250°C = 11 bar

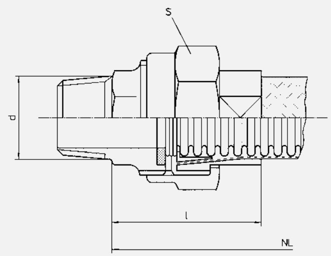
DN	Type	Inside diameter	Outside diameter	Maximum deviation	Minimum bending radius one bending process	Permissible operating pressure at 20 °C*	Weight	Production length	Order no. 1.4404	Order no. 1.4541
–		d	D	d, D, D1	r_{min}	P_{zul}	–	–	–	–
–		mm	mm	mm	mm	bar	kg/m	m	–	–
6	RS 331S12	6.2	10.8	± 0.2	25	16	0.14	10 - 100	378291	81515
8	RS 331S12	8.3	13.7	± 0.2	35	16	0.21	10 - 100	378292	81516
10	RS 331S12	10.2	15.7	± 0.2	40	16	0.23	10 - 100	378293	81517
12	RS 331S12	12.2	18.2	± 0.2	45	16	0.25	10 - 100	378294	81518
16	RS 331S12	16.2	23.3	± 0.2	60	16	0.40	10 - 100	378295	81519
20	RS 331S12	20.2	28.3	± 0.3	70	16	0.49	10 - 100	378296	72020
25	RS 331S12	25.5	34.2	± 0.3	85	16	0.79	10 - 100	378297	72021
32	RS 331S12	34.2	43.0	± 0.3	105	16	0.96	10 - 100	378298	72022
40	RS 331S12	40.1	52.0	± 0.3	130	16	1.46	10 - 100	378299	72023
50	RS 331S12	50.4	62.6	± 0.4	160	16	1.67	10 - 100	378300	72024

** applies to complete systems: corrugated hose with connection fitting*

Connection fittings for self-assembly

Type RE58W

Threaded coupling, separable, suitable for RS 331S12



Type RE58W

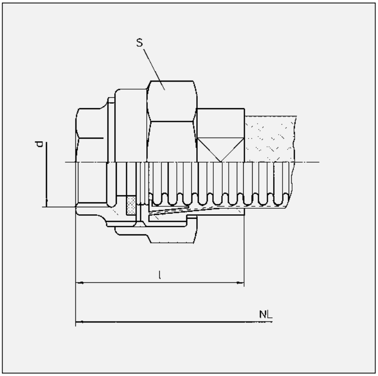
Threaded coupling, male thread, brass, flat sealing
Set consists of threaded insert, union nut, insert, clamp ring and seal (AFM 34 – metal)

DN	Type	Male thread d	Dimensions s	l	Weight approx.	Order no.
–	–	DIN EN 10226-1	mm	mm	kg/each	–
6	RE58W	R 1/4	24	41	0.09	87542
8	RE58W	R 1/4	27	43	0.10	87543
10	RE58W	R 3/8	30	47	0.11	87544
12	RE58W	R 1/2	32	55	0.15	87545
16	RE58W	R 1/2	41	59	0.25	87546
20	RE58W	R 3/4	46	62	0.37	87547
25	RE58W	R 1	55	68	0.50	87548
32	RE58W	R 1 1/4	65	71	0.76	87549

Connection fittings for self-assembly

Threaded coupling, separable, suitable for RS 331S12

Type QA58W
Type QA08W



Type QA58W

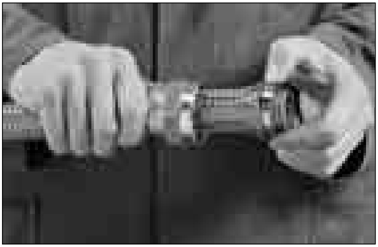
Threaded coupling, female thread, brass, flat sealing, *DN 40–50 of malleable cast iron
Set consists of threaded insert, union nut, insert, clamp ring and seal (AFM 34 – metal)

DN	Type	Female thread d	Dimensions s	l	Weight approx.	Order no.
–	–	DIN EN 10226-1	mm	mm	kg/each	–
6	QA58W	Rp 1/4	24	31	0.08	87522
8	QA58W	Rp 1/4	27	34	0.09	87523
10	QA58W	Rp 3/8	30	37	0.10	87524
12	QA58W	Rp 1/2	32	42	0.14	87525
16	QA58W	Rp 1/2	41	45	0.24	87526
20	QA58W	Rp 3/4	46	46	0.31	87527
25	QA58W	Rp 1	55	50	0.42	87528
32	QA58W	Rp 1 1/4	65	52	0.59	87529
40*	QA08W	Rp 1 1/2	75	64	0.75	87538
50*	QA08W	Rp 2	90	70	1.08	87539

Assembly instructions RS 331S12

Slip insert and union nut for both connector sides onto the braided hose. Measure off the required length of hose and cut the braiding all round at this point using a wire snip.

Push the braid back a little and saw off the corrugated hose to the required length. This should be done in the corrugation groove and at right angles to the hose axis. The best tool for this is a fine-toothed high-speed circular saw. Remove any burrs that may occur.



At the end of the hose, open up the braiding a little and insert the two halves of the hose ring between the third and fourth corrugation.

Slide the insert forwards until it sits snugly against the hose ring. At the same time, flatten down the braid so that it lies smoothly along the hose. Using a wire snip, trim the braid ends flush with the face of the hose ring.

Assembly instructions RS 331S12

Clamp the hose in the vice at the faces provided on the insert (do not clamp the hose!). With light strokes of the hammer, compress the three exposed corrugations of the hose to form a sealing ring. The best tool for this is a pin turned to match the inside diameter of the hose.

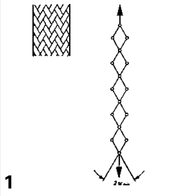
Slip the union nut over the insert and clamp in the vice. Position the threaded insert with seal fitted and tighten with a spanner, without using excessive force. The union nut can be fully tightened once assembled with the pipework. Protect the hose assembly from being damaged by twisting by bracing on the insert.

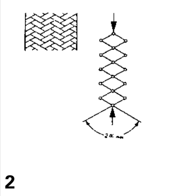
high
tensile
strength

The most important applications for our wire braids are metal hoses. On corrugated hoses, the braiding prevents expansion when pressure or tension is applied and enables many times greater resistance to internal pressure.

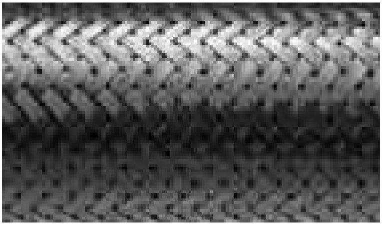
HYDRA braids are very flexible. The braid perfectly adjusts to the movement of the hose, even when a second braid is used to increase resistance to pressure. The braid is anchored to the connection fittings of the hose using the latest production techniques. The method of attachment depends on the type of connection fitting and the demands on the hose. For rough operating conditions, a round-wire spiral can additionally be wound onto the braid or a protective hose slipped over the top for protection.

The functioning of the wire braid is based on the principle of lazy tongs.

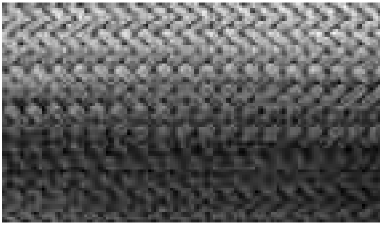




1 When axial tension is applied, the braiding reaches its limit of stretch, where the wires cross with the smallest angle and lie very close together. In this state, the wires form a braid of the smallest possible diameter and greatest possible length.
2 When pushed together in the axial direction, the braiding reaches its limit of compression, where the crossing angle and diameter reach their greatest values. The wires similarly lie close together and the shortest length is reached.



Standard braid



Braided braid

Construction:
There are two basic types of hose braiding – standard braid and braided braid.

With the standard braids, the strands of the groups of wires lie parallel to each other. These braids are used for hose diameters of DN 4–150.

Braided braids are used for hose diameters of DN 150–300. With these types, the individual wires of the groups of wires are additionally interlaced. This means the wire cross-section per group of wires can be increased and thus the load-bearing capacity.

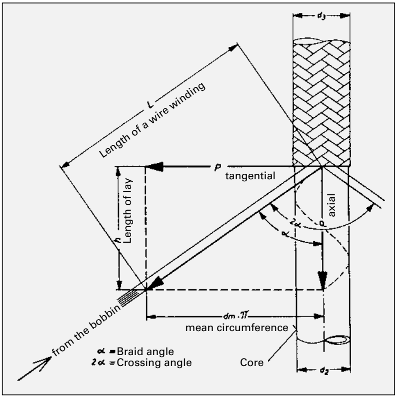
Versions:

Standard braids:
- Type RG 12
  single braid of stainless steel wire
- Type RG 22
  double braid of stainless steel wire
- Type RG 13
  single braid of bronze wire

Materials:
- stainless austenitic steel
  to EN 10088-3,
  material no. 1.4301
  (comparable to AISI 304)
- bronze wire, bright, to DIN EN 1652,
  material no. 2.1016 (CW450K)
- other materials such as 1.4571
  on request

Braided braids:
- Type RG 42
  single braided braid
  of stainless steel wire
- Type RG 52
  double braided braid
  of stainless steel wire

Materials:
- stainless austenitic steel
  to EN 10088-3,
  material no. 1.4306
  (comparable to AISI 304L)



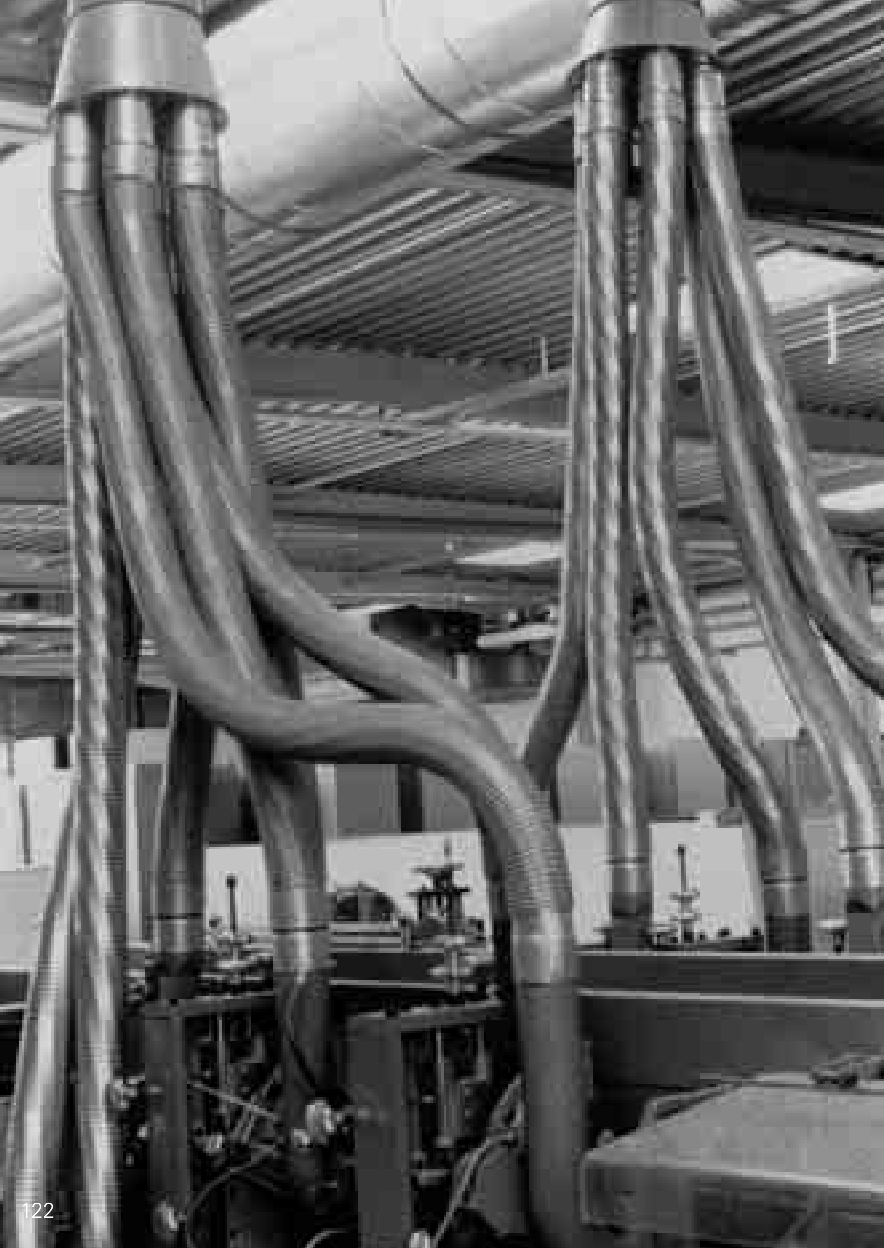
With hose braids, not only are braid diameter, length of lay and braid angle in a certain natural relationship to each other, so are also the axial and tangential forces to be taken up by the wires.

For single braids of metal corrugated hoses, the following formulae applies:

$$f_{ax} = \sigma_{zul} \cdot n_k \cdot n_d \cdot \frac{\Pi \cdot d_d^2}{4} \cdot \cos \alpha$$

f_{ax}	=	maximum permissible load-bearing capacity of a single braid	(N)
σ_{zul}	=	yield point of the wire material reduced by a safety coefficient	(N/mm^2)
n_k	=	number of wire groups	
n_d	=	number of wires of a wire group	
d_d	=	wire diameter	(mm)
α	=	braid angle	(∢°)

The braiding machine turns stainless steel wires into a braid



Structure and function

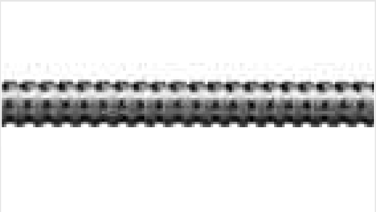
The entire metal-hose and expansion-joint industry owes its origins to the stripwound hose first created in 1885 by Heinrich Witzenmann. The company has kept alive this spirit of invention right up to the present day: well-engineered products and innovative solutions have made Witzenmann the leader in technology within the industry.

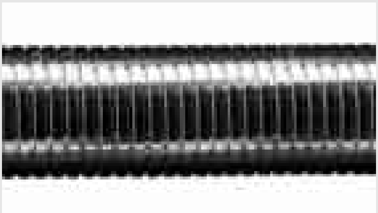
The Witzenmann Group employs more than 2300 people in over 20 subsidiaries, making it one of the world's leading providers of metal hoses and expansion joints.

Stripwound hoses are made from a profilated strip that is helically coiled in an "interhooked" manner.

Depending on the intended application, these metal hoses are made with an engaged or interlocked profile – ranging from highly flexible versions to more robust forms.

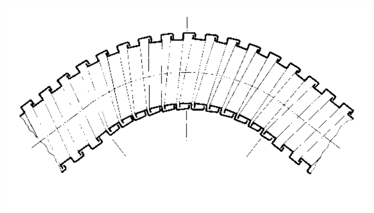
Strips of metal - different grades of stainless steel or non-ferrous metals such as brass or aluminium – are used as the basic material.

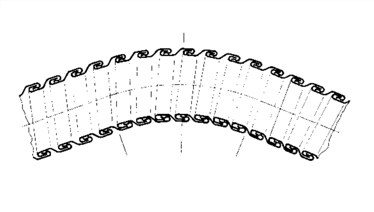




The benefits of stripwound hoses:
Extremely resistant to tensile and transversal stresses, high torsional resistance, resistant to chemical and thermal stresses available in a wide range of materials, flexible and with defined bending radii.

Stripwound hoses are used for protective purposes and also as extraction, exhaust and conveying hoses. They are employed in machine construction, measuring technology and control engineering, communications technology, fibreoptics and the medical industry. For special applications our product range includes flexible arms which, once bent, remain in any position desired.





Note these changes: old and new type designation

Protective hoses

NEW		OLD
SG-S-0	Galvanised steel	DE 330S
SG-M-0	Blank brass	DE 430S
SG-M-C	Chrome-plated brass	DE 430S
SG-M-N	Nickel-plated brass	DE 430S
SG-E-0	Stainless steel	DE 330S
SG-S-P	Galvanised steel with PVC coating	DE 331S
SG-S-U	Galvanised steel with braiding	DE 333S
SD-S-0	Galvanised steel	SI 300S
SD-S-G	Galvanised steel with rubber seal	SI 310S
SD-S-B	Galvanised steel with cotton seal	SI 320S
SD-S-K	Galvanised steel with ceramic seal	SI 360S
SD-E-K	Stainless steel with ceramic seal	SI 360S
SV-S-0	Galvanised steel	SV 300S
SV-S-G	Galvanised steel with rubber seal	SV 310S
SV-S-B	Galvanised steel with cotton seal	SV 320S
SA-S-0	Galvanised steel	SA 230S, SA 330S
SA-E-0	Stainless steel	SA 230S, SA 330S
SA-E-S	Stainless steel with silicone coating	SA 233S, SA 333S, SA 433S

Extraction, exhaust and conveying hoses

NEW		OLD
FG-S-0	Galvanised steel	DX 300S
FG-S-G	Galvanised steel with rubber seal	DX 310S
FG-S-B	Galvanised steel with cotton seal	DX 320S
FG-S-K	Galvanised steel with ceramic seal	DX 360S
FG-E-K	Stainless steel with ceramic seal	DX 360S
FS-S-G	Galvanised steel with rubber seal	DS 310S
FS-S-B	Galvanised steel with cotton seal	DS 320S
FS-S-K	Galvanised steel with ceramic seal	DS 360S
FS-E-K	Stainless steel with ceramic seal	DS 360S

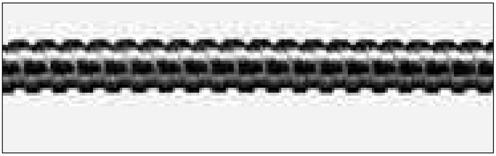
Extremely robust and versatile

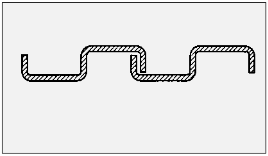
Protective hoses with an engaged or interlocked profile are mainly used to protect electrical cables and light conductors. Depending on the version and profile selected, they are very flexible, have high tensile strength and are resistant to both torsion and transverse pressure. Protective hoses come in a variety of different materials; the choice of materials for the hose and (if applicable) for the seal and coating enables a wide range of requirements to be met in terms of leak-tightness and resistance to both corrosion and heat.

Protective hoses

Type SG

to DIN EN ISO 15465 (type SOU), DIN EN 50086-2-3





Types:
SG-S-O, SG-M-O, SG-M-C, SG-M-N, SG-E-O

Application:
- Protective hose to DIN EN ISO 15465 (type SOU)
- Standard protective hose for VDE-approved electrical installations to DIN EN 50086-2-3
- Protective hose for rubber and plastic hoses

Properties:
Highly flexible, good tensile strength and high crushing strength, hoses with PVC coating are liquid-tight

Design:
- Stripwound metal hose
- Interlocked profile
- Round cross-section

Designation:
HYDRA AS < VDE > galvanised, uncoated, but PG dimensions only

Materials:
- Steel, galvanised (1.0330): up to DN 18
- Steel, hot-dip galvanised (1.0226): DN 20 and above
- Brass (2.0321)
- Stainless steel (1.4301)

Versions:
- Galvanised steel, uncoated
- Brass, blank, nickel- or chromium-plated
- Stainless steel, uncoated

Operating temperature:
- Brass: 250°C
- Galvanised steel: 400°C
- Stainless steel: 600°C
  (for VDE-approved applications: from -15°C to +60°C)

Classification:
Uncoated
01-02-03-04-05-06-07-08-09-10-11-12
--3--3---4---1---4---1--4---0---2---1---1--3
(DN 8)
--3--3---4---1---4---1--4---0---2---1---1--3
(DN 11-51)

Production lengths:
Measured in extended position
- DN 3 bis 11: 50 u. 100 m bundle
- DN 14 bis 23: 25 u. 50 m bundle
- DN 31: 25 m bundle

Supplied in the following forms:
Bundled in rings

Order specifications:
- Protective hose, galvanised steel
  Type SG-S-O
- Protective hose, brass, blank
  Type SG-M-O
- Protective hose, chromium-plated brass
  Type SG-M-C
- Protective hose, nickel-plated brass
  Type SG-M-N
- Protective hose, stainless steel
  Type SG-E-O

Protective hoses

Type SG-S-O

to DIN EN ISO 15465 (type SOU), DIN EN 50086-2-3

DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
3		3.0	4.6	± 0.2	18	0.028
4		4.0	5.8	± 0.2	19	0.035
5		5.0	6.8	± 0.2	20	0.045
6		6.0	8.0	± 0.3	21	0.050
7		7.1	9.1	± 0.3	23	0.060
8	7	8.0	10.0	± 0.3	25	0.065
9		9.0	11.0	± 0.3	30	0.075
10		10.0	13.0	± 0.3	32	0.110
11*	9	11.0	14.0	± 0.3	34	0.120
12		12.0	15.0	± 0.3	36	0.130
13		13.0	16.0	± 0.3	40	0.140
14		13.5	16.5	± 0.3	40	0.135
14*	11	14.0	17.0	± 0.3	40	0.145
15		15.0	18.0	± 0.3	45	0.155
16*	13.5	16.0	19.0	± 0.3	45	0.165
17		17.0	20.0	± 0.3	50	0.175
18*	16	18.0	21.0	± 0.3	50	0.185
20		20.0	24.0	± 0.3	60	0.280
21		21.0	25.0	± 0.3	62	0.295
22		21.8	25.8	± 0.3	65	0.305
23*	21	23.0	27.0	± 0.3	67	0.320
25		25.0	29.0	± 0.3	75	0.345
28		28.0	32.0	± 0.3	80	0.385
29		29.2	34.2	± 0.4	85	0.415
30		30.0	35.0	± 0.4	85	0.430
31*	29	31.0	36.0	± 0.4	90	0.445
32		32.0	37.0	± 0.4	90	0.455
35		35.0	40.0	± 0.4	95	0.495

Protective hoses

Type SG-S-O

to DIN EN ISO 15465 (type SOU), DIN EN 50086-2-3

DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
36		36.0	41.0	± 0.4	100	0.510
37		37.0	42.0	± 0.4	105	0.530
38		38.2	43.2	± 0.4	105	0.540
40*	36	40.0	45.0	± 0.4	110	0.560
45		45.2	50.2	± 0.4	120	0.630
47*	42	47.0	52.0	± 0.4	125	0.660
48		48.0	53.0	± 0.5	125	0.670
49		49.2	54.2	± 0.5	125	0.680
50		50.0	55.0	± 0.5	125	0.700
51*	48	51.0	56.0	± 0.5	130	0.710

**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*

Protective hoses

Type SG

Chromium- or nickel-plated brass

DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
3	2.4	3.8	±0.2	15	0.030
3	2.6	3.0	±0.2	15	0.030
3	3.0	4.5	±0.2	15	0.031
3	3.2	4.7	±0.2	15	0.032
4	3.5	5.0	±0.2	15	0.033
4	4.0	6.0	±0.2	20	0.044
5	5.0	7.0	±0.2	20	0.050
6	6.0	8.0	±0.2	20	0.056
7	7.0	9.0	±0.2	20	0.074
8	8.0	9.0	±0.2	25	0.084
9	9.0	11.0	±0.2	25	0.105
10	10.0	13.0	±0.3	25	0.104
12	11.5	14.0	±0.3	30	0.103
12	12.0	15.0	±0.3	30	0.115
13	13.0	16.0	±0.3	35	0.119
14	14.0	17.4	±0.3	35	0.148
15	15.0	18.0	±0.3	40	0.157
16	16.0	19.2	±0.3	40	0.205
17	17.0	20.0	±0.3	45	0.218
18	18.0	21.3	±0.3	45	0.238
19	19.0	22.0	±0.3	45	0.268
20	20.0	23.0	±0.3	50	0.282

**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*

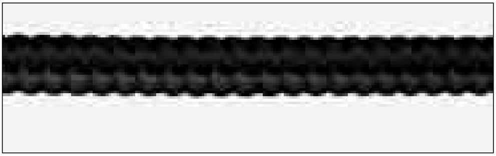
DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
2	1.4	3.0	±0.1	16	0.020
3	3.0	4.6	±0.2	18	0.030
4	4.0	5.8	±0.2	19	0.035
5	5.0	6.8	±0.2	20	0.040
6	6.0	8.0	±0.3	25	0.050
7	7.0	9.0	±0.3	27	0.060
8	8.0	10.0	±0.3	29	0.065
9	9.0	11.0	±0.3	30	0.075
10	10.0	13.0	±0.3	25	0.105
11	11.0	14.0	±0.3	30	0.115
12	12.0	15.0	±0.3	30	0.125
13	13.0	16.0	±0.3	35	0.135
14	14.0	17.4	±0.3	35	0.140
15	15.0	18.0	±0.3	40	0.160
16	16.0	19.2	±0.3	40	0.170
17	17.0	20.0	±0.3	45	0.175
18	18.0	21.3	±0.3	45	0.185
19	19.0	23.0	±0.3	45	0.235
20	20.0	24.0	±0.3	50	0.250
20	21.5	25.5	±0.3	50	0.265
22	22.0	26.0	±0.3	50	0.270
23	23.0	27.0	±0.3	55	0.285
25	24.5	28.5	±0.3	55	0.305
25	25.0	29.0	±0.3	60	0.315
26	26.0	30.0	±0.3	60	0.325
27	27.0	21.0	±0.3	60	0.335
28	28.0	32.0	±0.3	60	0.350

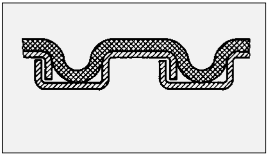
**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*

Protective hoses

Type SG

to DIN EN 50086-2-3 (VDE 0605 part 2-3),
galvanised steel with plastic coating





Types:
SG-S-P

Application:
- Standard protective hose for VDE-approved electrical installations to DIN EN 50086-2-3
- Protective hose for rubber and plastic hoses

Properties:
Highly flexible, good tensile strength and high crushing strength, hoses with PVC coating are liquid-tight

Design:
- Stripwound metal hose
- Interlocked profile
- Round cross-section

Designation:
HYDRA AS < VDE > galvanised, coated, but PG dimensions only

Materials:
- Steel, galvanised (1.0330): up to DN 18
- Steel, hot-dip galvanised (1.0226): DN 20 and above

Versions:
Galvanised steel, with black PVC coating

Operating temperature:
Galvanised steel with PVC coating:
from -20°C to +80°C
(for VDE-approved applications:
from -15°C to +60°C)

Classification:
Coated
01-02-03-04-05-06-07-08-09-10-11-12
--3--3---3---1---4---1--4---0---3---1---1--3
(DN 7)
--3--3---3---1---4---1--4---0---2---2---1--3
(DN 10-49)

Production lengths:
Measured in extended position
- DN 4 bis 11: 50 u. 100 m bundle
- DN 14 bis 23: 25 u. 50 m bundle
- DN 31: 25 m bundle

Supplied in the following forms:
Bundled in rings

Order specifications:
Protective hose, galvanised steel with black PVC coating
Type SG-S-P

Protective hoses

Type SG-S-P

to DIN EN 50086-2-3 (VDE 0605 part 2-3),
galvanised steel with plastic coating

DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
4		4.0	6.6	±0.2	23	0.050
5		5.0	7.6	±0.2	25	0.055
6		6.0	8.8	±0.3	28	0.070
7*	7	7.1	9.9	±0.3	30	0.075
8		8.0	10.8	±0.3	34	0.085
9		9.0	11.8	±0.3	38	0.095
10*	9	10.0	14.0	±0.3	42	0.140
11		11.0	15.0	±0.3	46	0.155
12		12.0	16.0	±0.3	48	0.165
13*	11	13.0	17.0	±0.3	51	0.175
14		13.5	17.5	±0.3	51	0.185
14		14.0	18.2	±0.3	53	0.195
15*	13.5	15.0	19.2	±0.3	56	0.210
16		16.0	20.2	±0.3	58	0.220
17*	16	17.0	21.2	±0.3	60	0.235
18		18.0	22.2	±0.3	64	0.245
20		20.0	25.4	±0.3	69	0.370
21		21.0	26.4	±0.3	74	0.385
22*	21	21.8	27.2	±0.3	75	0.400
23		23.0	28.4	±0.3	77	0.420
25		25.0	30.4	±0.3	82	0.450
28		28.0	33.4	±0.4	90	0.500
29*	29	29.2	35.8	±0.4	93	0.560
30		30.0	36.6	±0.4	96	0.580
31		31.0	37.6	±0.4	98	0.600
32		32.0	38.6	±0.4	101	0.615
35		35.0	41.6	±0.4	109	0.665

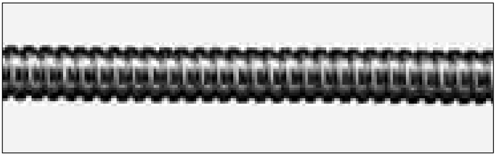
Protective hoses

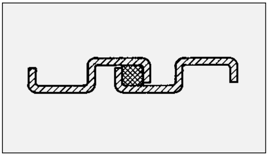
Type SG-S-P

to DIN EN 50086-2-3 (VDE 0605 part 2-3), galvanised steel with plastic coating

DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
36		36.0	42.6	± 0.4	112	0.685
38*	36*	38.2	44.8	± 0.4	117	0.730
40*		40.0	46.6	± 0.4	122	0.765
45*	42*	45.2	51.8	± 0.4	136	0.850
47		47.0	53.8	± 0.4	138	0.905
48		48.0	54.8	± 0.5	142	0.920
49*	48*	49.2	56.0	± 0.5	145	0.950
50		50.0	56.8	± 0.5	148	0.955
51		51.0	57.8	± 0.5	151	0.975

**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*





Types:
SD-S-G, SD-S-B, SD-S-K, SD-E-K

Application:
Universal protective hose with seal, can also be used as extraction or exhaust hose

Properties:
Highly flexible, good tensile strength and high crushing strength

Design:
- Stripwound metal hose
- Interlocked profile
- Round cross-section

Materials:
- Steel, galvanised (1.0330): up to DN 18
- Steel, hot-dip galvanised (1.0226): DN 20 and above
- Stainless steel (1.4301)

Versions:
- With rubber seal – G
- With cotton seal – B
- With ceramic seal - K

Operating temperature:
- Galvanised, with rubber seal: 60°C
- Galvanised, with cotton seal: 120°C
- Galvanised, with ceramic seal: 400°C
- Stainless steel with ceramic seal: 600°C

Production lengths:
Measured in extended position
- DN 8 bis 11; 50 u. 100 m bundle
- DN 14 bis 23; 25 u. 50 m bundle
- DN 31; 25 m bundle

Supplied in the following forms:
Bundled in rings

Order specifications:
- Extraction hose, galvanised steel, with cotton seal
  Type SD-S-B
- Extraction hose, galvanised steel, with rubber seal
  Type SD-S-G
- Extraction hose, galvanised steel, with ceramic seal
  Type SD-S-K
- Extraction hose, stainless steel, with ceramic seal
  Type SD-E-K

Protective hoses

Type SD

Extraction and exhaust hoses, galvanised or stainless steel

Choice of seal: cotton, rubber, ceramic or glass fibre seal

DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
3	3.0	5.0	±0.2	40	0.060
4	4.0	6.0	±0.2	40	0.070
5	5.0	7.0	±0.2	40	0.085
6	6.0	8.0	±0.2	35	0.095
7	7.0	9.0	±0.2	35	0.105
8	8.0	10.0	±0.2	40	0.115
9	9.0	11.0	±0.2	40	0.140
10	10.0	13.0	±0.2	45	0.180
11	10.5	13.0	±0.2	45	0.190
11	11.0	14.0	±0.2	55	0.200
12	12.0	15.0	±0.2	55	0.210
13	13.0	16.0	±0.2	60	0.215
14	14.0	17.4	±0.2	60	0.220
15	15.0	18.0	±0.2	70	0.240
16	16.0	18.7	±0.2	70	0.260
16	16.0	19.2	±0.2	70	0.265
17	17.0	20.0	±0.2	80	0.280
18	18.0	21.3	±0.2	80	0.290
19	19.0	23.0	±0.3	80	0.315
20	20.0	24.0	±0.3	90	0.335
22	21.5	25.5	± 0.3	90	0.370
23	23.0	27.0	±0.3	95	0.395
25	24.5	28.5	±0.3	95	0.415
25	25.0	29.0	±0.3	105	0.430
26	26.0	30.0	±0.4	105	0.460
30	30.0	34.0	±0.4	110	0.525
31	30.5	34.5	±0.4	110	0.540
32	31.5	35.7	±0.4	120	0.570
32	32.0	36.0	±0.4	120	0.580

Protective hoses

Type SD

Extraction and exhaust hoses, galvanised or stainless steel

Choice of seal: cotton, rubber, ceramic or glass fibre seal

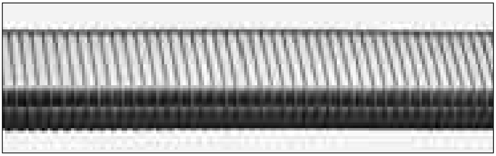
DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
34	34.0	38.5	±0.4	125	0.585
35	35.0	39.5	±0.4	130	0.600
36	36.0	41.5	±0.4	130	0.640
37	37.0	42.5	±0.4	140	0.680
38	38.0	43.5	±0.4	145	0.720
39	38.5	44.0	±0.4	145	0.760
40	40.0	45.0	±0.4	150	0.830
41	40.5	45.7	±0.4	150	0.950
44	44.0	49.5	±0.4	170	1.010
45	45.0	50.5	±0.4	175	1.030
47	46.5	52.5	±0.4	180	1.070
48	48.0	53.5	±0.5	190	1.100
50	50.0	56.0	±0.5	200	1.160
52	52.0	58.0	±0.5	210	1.300
53	53.0	59.0	±0.5	220	1.350
55	55.0	61.0	±0.5	250	1.400
60	60.0	66.0	±0.6	260	1.590
65	65.0	72.0	±0.6	270	1.950
70	70.0	77.0	±0.6	280	2.100
75	75.0	82.0	±0.6	290	2.250
80	80.0	87.0	±0.6	300	2.400
90	90.0	100.0	±0.7	315	2.620
100	100.0	110.5	±0.7	330	2.850
110	110.0	120.5	±0.7	360	3.110
120	120.0	131.5	±0.7	400	3.400
125	125.0	136.5	±0.7	400	3.450

**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*

Protective hoses

Type SV

Rectangular protective hoses



Types:
SV-S-O
SV-S-G
SV-S-B

Application:
Protective hose for energy guide chains, hydraulic lines and for use as conveying hose

Properties:
Highly flexible, good tensile strength, resistant to transversal pressure

Design:
- Stripwound metal hose
- Interlocked profile
- Rectangular cross-section

Materials:
Steel, galvanised (1.0333)

Versions:
- Without seal – O
- With rubber seal – G, available on request
- With cotton seal – B, available on request

Operating temperature:
- With rubber seal: 60°C
- With cotton seal: 120°C
- Without seal: 400°C

Production lengths:
Up to max. 25 m

Supplied in the following forms:
Bundled in rings

Order specifications:
- Rectangular protective hose, galvanised steel, without seal Type SV-S-O
- Rectangular protective hose, galvanised steel, with rubber seal Type SV-S-G
- Rectangular protective hose, galvanised steel, with cotton seal Type SV-S-B

Protective hoses

Type SV-S-O

Rectangular protective hoses

Galvanised steel, without seal

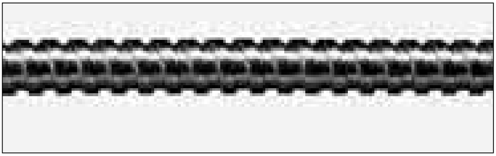
Nominal size	Outside dimensions		Inside dimensions		Minimum bending radius		Weight approx.
NG	D_1 D_2	Perm. tolerance	d_1 d_2	Perm. tolerance	r_{min}	Perm. tolerance	–
mm	mm	mm	mm	mm	mm	–	kg/m
15	30 x 50	+ 1	27.0 x 47.0	-1	70	- 10	0.640
25	50 x 50	+ 1	46.8 x 46.8	-1	120	- 10	0.820
38	45 x 85	+ 1	40.8 x 81.0	1	100	- 10	1.28
42	65 x 65	+ 1	60.8 x 60.8	1	130	- 10	1.26
51	60 x 85	+ 1	55.8 x 81.0	1	130	- 10	1.44
69	60 x 115	+ 1	54.8 x 110.2	-1	130	- 20	2.37
92	80 x 115	+ 1	74.6 x 110.0	1	170	- 20	2.66
126	90 x 140	+ 1	84.6 x 135.0	1	180	- 20	3.15
140	80 x 175	+ 1	74.4 x 169.8	1	170	- 20	3.54
154	110 x 140	+ 1	104.2 x 135.2	1	250	- 20	3.60
193	110 x 175	+ 1	104.2 x 169.6	1	250	- 20	3.97
242	110 x 220	± 1.5	104.4 x 214.4	1	250	- 20	4.60

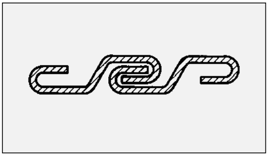
Please quote when ordering: type of hose, nominal size (NG), length

Protective hoses

to DIN EN ISO 15465

Type SA





Types:

SA-S-O
SA-E-O

Application:

- Protective hose to DIN EN ISO 15465 (type DOU)
- Protective hose with high mechanical strength for light conductors, measuring lines and electric cables
- Protective hose for pressure hoses

Properties:

Resistant to torsion, flexible, extremely high tensile strength, high crushing strength

Design:

- Stripwound metal hose
- Engaged profile
- Round cross-section

Materials:

- Steel, galvanised (1.0330): up to DN 18
- Steel, hot-dip galvanised (1.0226): DN 20 and above
- Stainless steel (1.4301)

Versions:

Stainless steel with PVC or silicone coating

Operating temperature:

- Galvanised steel: 400°C
- Stainless steel: 600°C

Production lengths:
Measured in extended position
- Up to DN 9: max. 100 m;
  DN 10 and above: max. 60 m
- DN 15 and above: max. 50 m;
  DN 26 and above: max. 40 m
- DN 45 and above: max. 30 m;
  DN 65 and above: max. 25 m

Supplied in the following forms:
On drums or as bundle

Order specifications:
- Protective hose, galvanised steel
  Type SA-S-O
- Protective hose, stainless steel
  Type SA-E-O

Protective hoses

Type SA-S-O

to DIN EN ISO 15465

Galvanised steel, without seal

DN	Inside diameter	Outside diameter	Permissible tolerance		Minimum bending radius	Weight approx.
–	d	d	d	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
4	4.0	6.1	±0.2	± 0.2	35	0.155
5	5.0	7.1	±0.2	± 0.2	35	0.160
6	6.0	8.2	± 0.2	± 0.4	35	0.085
7	7.0	9.2	± 0.2	± 0.4	40	0.095
8	8.0	10.2	± 0.2	± 0.4	45	0.110
9	9.0	11.2	± 0.2	± 0.4	50	0.120
10	10.0	12.2	± 0.2	± 0.4	55	0.130
11	11.0	13.2	± 0.2	± 0.4	60	0.145
12	12.0	14.2	± 0.2	± 0.4	65	0.155
13	13.0	15.2	± 0.2	± 0.4	70	0.170
14	14.0	16.8	± 0.3	± 0.4	80	0.225
15	14.5	17.3	± 0.3	± 0.4	83	0.250
15	15.0	17.8	± 0.3	± 0.4	85	0.240
16	16.0	18.8	± 0.3	± 0.4	90	0.250
18	18.0	20.8	± 0.3	± 0.4	95	0.280
19	19.0	21.8	± 0.3	± 0.4	98	0.320
20	20.0	22.8	± 0.3	± 0.4	100	0.310
23	23.0	25.8	± 0.3	± 0.4	125	0.355
25	25.0	28.3	± 0.3	± 0.5	135	0.480
28	28.0	31.3	± 0.3	± 0.5	150	0.540
30	30.0	33.3	± 0.3	± 0.5	155	0.575
32	32.0	35.3	± 0.3	± 0.5	170	0.615
35	35.0	38.3	± 0.3	± 0.5	185	0.670
36	36.0	39.3	± 0.3	± 0.5	185	0.685

Protective hoses

Type SA-S-O

to DIN EN ISO 15465

Galvanised steel, without seal

DN	Inside diameter	Outside diameter	Permissible tolerance		Minimum bending radius	Weight approx.
–	d	d	d	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
40	40.0	44.4	± 0.4	± 0.6	210	0.935
45	45.0	49.4	± 0.4	± 0.6	240	1.100
50	50.0	54.4	± 0.4	± 0.6	260	1.160
54	54.0	58.4	± 0.4	± 0.6	270	1.300
55	55.0	59.4	± 0.4	± 0.6	270	1.330
60	60.0	66.0	± 0.4	± 0.6	310	1.870
65	65.0	71.0	± 0.6	± 0.6	315	2.020
70	70.0	76.0	± 0.6	± 0.6	325	2.180
75	75.0	81.0	± 0.6	± 0.6	345	2.340
80	80.0	86.0	± 0.6	± 0.6	370	2.500
85	85.0	91.0	± 0.6	± 0.6	385	2.650
90	90.0	98.0	± 0.8	± 0.6	400	2.800
100	100.0	108.0	± 0.8	± 0.6	440	3.120

Please quote when ordering: type of hose, nominal diameter (DN), length

Protective hoses

Type SA-E-O

to DIN EN ISO 15465, stainless steel, without seal

DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
4	4.0	6.1	±0.2	±0.2	35	0.155
5	5.0	7.1	±0.2	±0.2	35	0.160
6	6.0	8.2	±0.2	±0.4	35	0.085
7	7.0	9.2	±0.2	±0.4	40	0.100
8	8.0	10.2	±0.2	±0.4	45	0.110
9	9.0	11.2	±0.2	±0.4	50	0.125
10	9.5	11.7	±0.2	±0.4	53	0.130
10	10.0	12.2	±0.2	±0.4	55	0.135
11	11.0	13.2	±0.2	±0.4	60	0.145
12	12.0	14.2	±0.2	±0.4	65	0.160
13	13.0	15.2	±0.2	±0.4	70	0.170
14	14.0	16.8	±0.3	±0.4	80	0.225
15	15.0	17.8	±0.3	±0.4	85	0.240
16	16.0	18.8	±0.3	±0.4	90	0.255
17	17.0	19.8	±0.3	±0.4	95	0.290
18	18.0	20.8	±0.3	±0.4	95	0.285
19	19.0	21.8	±0.3	±0.4	98	0.325
20	20.0	22.8	±0.3	±0.4	100	0.315
22	22.0	24.8	±0.3	±0.4	117	0.370
23	23.0	25.8	±0.3	±0.4	125	0.360
25	25.0	28.3	±0.3	±0.5	135	0.490
27	27.0	30.3	±0.3	±0.5	145	0.525
28	28.0	31.3	±0.3	±0.5	150	0.540
30	30.0	33.3	±0.3	±0.5	155	0.575

Protective hoses

Type SA-E-O

to DIN EN ISO 15465, stainless steel, without seal

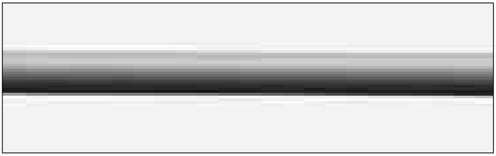
DN	Nominal size	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	PG	d	d	d, D	r_{min}	–
–	DIN 40430	mm	mm	mm	mm	kg/m
32	32.0	35.3	± 0.3	± 0.5	170	0.615
33	33.0	36.3	± 0.3	± 0.5	175	0.635
35	35.0	38.3	± 0.3	± 0.5	185	0.675
40	40.0	44.4	± 0.4	± 0.6	210	0.950
45	45.0	49.4	± 0.4	± 0.6	240	1.100
50	50.0	54.4	± 0.4	± 0.6	260	1.170
54	54.0	58.4	± 0.4	± 0.6	270	1.310
55	55.0	59.4	± 0.4	± 0.6	270	1.330
58	58.0	62.4	± 0.4	± 0.6	272	1.830
60	60.0	66.0	± 0.6	± 0.6	200	1.870
65	65.0	71.0	± 0.6	± 0.6	210	2.025
70	70.0	76.0	± 0.6	± 0.6	240	2.180
75	75.0	81.0	± 0.6	± 0.6	260	2.340
80	80.0	86.0	± 0.6	± 0.6	270	2.500
85	85.0	91.0	± 0.6	± 0.6	290	2.650
90	90.0	98.0	± 0.8	± 0.8	300	2.800
100	100.0	108.0	± 0.8	± 0.8	340	3.120

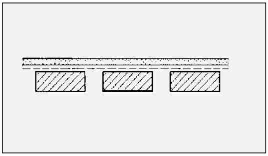
**VDE-compliant version. Please quote when ordering: type of hose, nominal diameter (DN), length*

Protective hoses

Type SZ

Protective hoses for glass fibres





Types:
SZ 111S
SZ 211S

Application:
Protective hose for light conductors in medical and industrial applications, e.g. endoscopy, measuring technology and control engineering

Properties:
- Highly flexible, with limited bending radius
- High tensile strength and very low expansion
- Resistant to torsion and transversal pressure
- Autoclaveable, lightproof and liquid-tight
- Smooth interior surface – completely free of burr

Design:
- Flat wire spiral with fibre glass braiding and grey silicone coating (version for medical applications)
- Round cross-section

Materials:
- Stainless steel (1.4301)
- Aluminium (3.3555)

Versions:
- Type SZ 111S - standard version
- Type SZ 211S - special version, extremely lightweight, German patent DE 43 20 350 C1

Protective hoses for glass fibres

Operating temperature:
From -60°C to +180°C; up to +134°C for steam sterilisation

Production lengths:
Measured in extended position
d: 1.0 - 3.5 approx. 90 % > 50 m, remainder > 15 m
4 - 8 approx. 80 % > 40 m, remainder > 10 m
10 - 13 approx. 70 % > 20 m, remainder > 7 m

Supplied in the following forms:
On drums or as bundle

Order specifications:
- Special protective hose for stainless-steel light conductors
  Type SZ 111S
- Special protective hose for aluminium light conductors
  Type SZ 111S
- Special protective hose for stainless-steel light conductors
  Type SZ 211S

Protective hoses

Type SZ 111S

Protective hoses for glass fibres

DN	Inside diameter	Perm. tolerance	Outside diameter	Perm. tolerance	Minimum bending radius	Weight approx.
–	d	d	D	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
1	1.0	-0.15	2.9	+0.2 / -0.1	5	0.015
2	1.5	-0.15	3.5	+0.2 / -0.1	6	0.019
3	2.5	-0.15	4.4	+0.2 / -0.1	14	0.030
3	3.0	-0.15	5.3	+0.2 / -0.1	20	0.045
4	3.5	-0.15	5.8	±0.2	20	0.050
4	4.0	-0.15	6.5	±0.3	25	0.065
5	4.5	-0.15	7.0	±0.3	25	0.070
5	5.0	-0.15	7.5	±0.3	25	0.080
6	6.0	-0.15	8.9	±0.3	35	0.110
7	6.5	-0.15	9.6	±0.3	35	0.130
7	7.0	-0.15	10.1	±0.3	45	0.140
8	8.0	±0.1	11.6	±0.3	45	0.190
10	10.0	±0.1	13.6	±0.4	65	0.240
11	11.4	±0.1	15.6	±0.4	75	0.325
12	12.0	±0.1	16.2	±0.4	75	0.350

Special version made of aluminium

DN	Inside diameter	Perm. tolerance	Outside diameter	Perm. tolerance	Minimum bending radius	Weight approx.
–	d	d	D	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
3	2.5	-0.15	4.6	+0.2 / -0.1	15	0.018
4	4.0	+0.15 / -0.15	6.5	±0.3	25	0.028
5	4.6	-0.15	7.1	±0.3	25	0.036
6	6.0	±0.15	8.9	±0.3	35	0.058

Please quote when ordering: type of hose, material, nominal diameter (DN), length

Protective hoses

Type SZ 211S

Protective hoses DBP for glass fibres

DN	Inside diameter		Outside diameter		Minimum bending radius	Weight approx.
		Perm. tolerance		Perm. tolerance		
–	d	d	D	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
3	2.7	± 0.15	4.4	+ 0.2 / - 0.1	7	0.020
3	3.3	± 0.15	5.3	+ 0.2 / - 0.1	9	0.030
4	3.8	± 0.15	5.8	± 0.2	11	0.030
5	4.5	± 0.15	6.5	± 0.3	13	0.040
5	5.0	± 0.15	7.0	± 0.3	14	0.040
6	5.5	± 0.15	7.5	± 0.3	16	0.045
7	6.5	± 0.15	8.9	± 0.3	22	0.065
7	7.2	± 0.2	9.6	± 0.3	23	0.070
8	7.7	± 0.2	10.1	± 0.3	25	0.075
9	9.0	± 0.2	11.6	± 0.3	29	0.085
11	10.6	± 0.2	13.6	± 0.4	42	0.160
12	12.4	± 0.2	15.6	± 0.4	55	0.190
13	13.0	± 0.2	16.2	± 0.4	59	0.195

Please quote when ordering: type of hose, material, nominal diameter (DN), length

Connection fittings

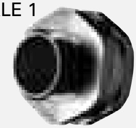
Type KLE 1, ERD 1, SUM

Compression coupling, earthing connection and counter nut for type SG (VDE) and SG

Connection fitting KLE 1
Materials:
Nickel-plated brass, connection thread DIN 40430, without grounding insert ERD 1, without counter nut SUM.

Compression couplings can be used for universally connecting protective hoses SG (VDE)* and SG.

Type KLE 1

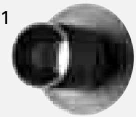


Thread PG	Thread metric	Suitable for SG-S-O (VDE) SG-S-P (VDE)		Width across flats	Clamping width Outside hose diameter	
–	–	DN	DN	s	min.	max.
DIN 40430	mm	–	–	mm	mm	mm
7	12 x 1.5	8	7	19	10.0	12.5
9	16 x 4.5	11	10	22	12.0	15.5
11	20 x 1.5	14	13	27	15.0	18.5
13.5	20 x 1.5	16	15	27	17.0	20.5
16	25 x 1.5	18	17	30	19.5	22.0
21	32 x 1.5	23	22	41	25.0	30.0
29	40 x 1.5	31	29	46	32.0	37.0
36	50 x 1.5	40	38	60	42.0	47.5
42	56 x 1.5	47	45	66	49.0	54.0
48	63 x 1.5	51	49	80	52.0	61.0

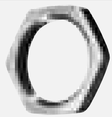
Nominal size PG	Suitable for SG-S-O (VDE) SG-S-P (VDE)	
–	DN	DN
DIN 40430	–	–
7	8	7
9	11	10
11	14	13
13.5	16	15
16	18	17
21	23	22
29	31	29
36	40	38
42	47	45
48	51	49

Nominal size PG
–
DIN 40430
7
9
11
13.5
16
21
29
36
42
48

Type ERD 1



Type SUM



Grounding insert ERD 1 Brass (blank) and **counter nut SUM** nickel-plated brass, suitable for compression coupling KLE 1

Connection fittings

Kroneck threaded socket GBGM

Materials:
Nickel-plated brass

Kroneck threaded sockets

- ensure a metallic connection in accordance with VDE 0113, provided their use complies with these regulations.
- are highly effective space-savers, enabling them to be installed on a junction box with a small distance between boreholes.
- can be removed easily and reused many times.

Thread PG	Series 1400 Suitable for metal hose SG and SD			Series 1600 Suitable for metal hose SG-S-P		
–	d_1		d_2	d_1		d_2
DIN 40430	mm		mm	mm		mm
7	8.0	x	10.2	7.0	x	10.2
9	11.0	x	14.0	10.0	x	14.0
11	14.0	x	17.4	13.0	x	17.4
13.5	16.0	x	19.2	15.0	x	19.2
16	18.0	x	21.3	17.0	x	21.3
21	23.0	x	27.0	21.5	x	27.0
29	31.5	x	35.7	30.0	x	35.7
36	40.5	x	45.7	38.5	x	45.7
42	46.5	x	52.5	44.0	x	52.5
48	50.0	x	56.0	48.0	x	56.0

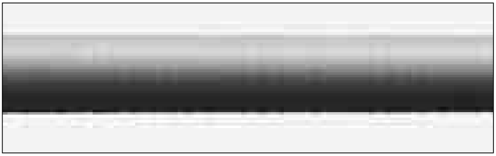
***VDE:** When properly installed using **grounding insert**, this coupling complies with VDE regulations.*

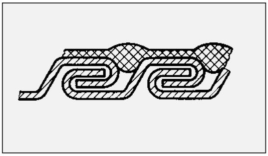
Please quote when ordering: type of hose, nominal size (PG)

Special versions

Type SA-E-S

Protective hoses for glass fibres





Application:
Protective hose for light conductors in medical and industrial applications, e.g. endoscopy, sensor technology, laser technology, optoelectronics, measuring technology and control engineering

Properties:
Resistant to torsion, extremely good tensile strength, flexible, lightproof and liquid-tight, high crushing strength

Design:
- Stripwound metal hose
- Engaged profile
- Round cross-section and grey silicone coating

Materials: Stainless steel (1.4301)

Versions:
Stainless steel with silicone coating

Operating temperature: From - 60°C to +180°C

Production lengths:
Measured in extended position
- Up to DN 9: max. 100 m;
  DN 10 and above: max. 60 m
- DN 15 and above: max. 50 m;
  DN 26 and above: max. 40 m
- DN 45 and above: max. 30 m;
  DN 65 and above: max. 25 m

Supplied in the following forms:
On drums or as bundle

Order specifications: Protective hose, stainless steel with silicone coating Type SA-E-S

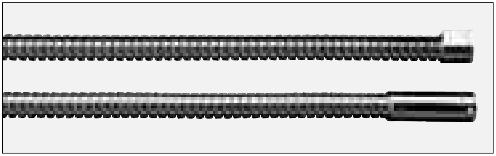
DN	Inside diameter	Perm. tolerance	Outside diameter	Perm. tolerance	Minimum bending radius	Weight approx.
–	d	d	D	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
5	4.8	± 0.2	8.5	± 0.4	35	0.112
6	5.8	± 0.2	9.5	± 0.4	45	0.144
6	6.0	± 0.2	9.6	± 0.4	43	0.115
7	7.0	± 0.2	10.6	± 0.4	48	0.131
8	8.0	± 0.2	11.6	± 0.4	55	0.146
9	9.0	± 0.2	12.6	± 0.4	60	0.162
10	10.0	± 0.2	13.6	± 0.4	66	0.176
11	11.0	± 0.2	14.6	± 0.4	73	0.192
12	12.0	± 0.2	15.6	± 0.4	78	0.208

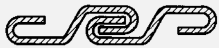
Please quote when ordering: type of hose, material, nominal diameter (DN), length

Special versions

Type SA-E-O

Protective hoses for telephones, measuring devices and alarm systems





Protective hoses type SA-E-O
are made to specific customer requirements. A selection of these special versions is given below.

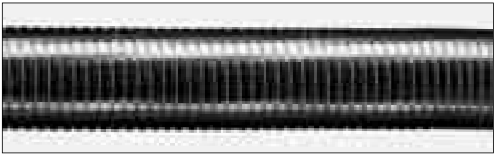
Tensile strength:
This aspect is also defined by customer-specific requirements. Hoses can be supplied with tensile strengths of 2000 N and above.

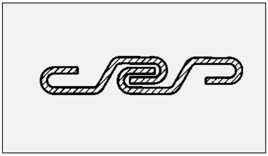
DN	Inside diameter	Inside diameter Perm. tolerance	Outside diameter	Outside diameter Perm. tolerance	Minimum bending radius	Weight approx.
–	d	d	D	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
5	5.1	± 0.2	7.8	± 0.1	30	0.108
6	5.8	± 0.2	8.4	+ 0.1 / - 0.2	35	0.115

Please quote when ordering: type of hose, nominal diameter (DN), length

For solid and gaseous substances

Suction and fan hoses are stripwound metal hoses with polygonal or round cross-sections, engaged or interlocked profiles. Highly flexible, lightweight and easy to install, their heat resistance depends on the materials chosen for both hose and sealing. Fields of application: carrying warm and cold air, fumes, exhaust gases and smoke; conveying dust, wood and metal shavings, granulates, grains, etc; in ventilation engineering; in wood- and metalworking; and in the textile, chemical and automotive industries.





Types:
FA 330S, galvanised steel
or stainless steel

Application:
Exhaust hose for mobile and stationary applications; also useable as extraction hose or conveying hose.

Properties:
- High mechanical strength
- Vibration-resistant
- Good flexibility
- Self-supporting in its bending behaviour
- at high temperatures, owing to metallic sealing

Design:
- Stripwound metal hose
- Engaged profile
- Polygonal cross-section

Materials:
- Steel, galvanised (1.0330 / 1.0333)
- Stainless steel (1.4301)

Operating temperature:
- Galvanised steel: 400°C
- Stainless steel: 600°C

Production lengths:
In extended position
- Up to DN 55, max. 20 m
- DN 60 and above: max. 10 m

Supplied in the following forms:
Bundled in rings

Order specifications:
- Exhaust hose, galvanised steel
  Type FA 330S
- Exhaust hose, stainless steel
  Type FA 330S

Extraction, exhaust and conveying hoses — Type FA 330S

Galvanised steel or stainless steel, metallic sealing

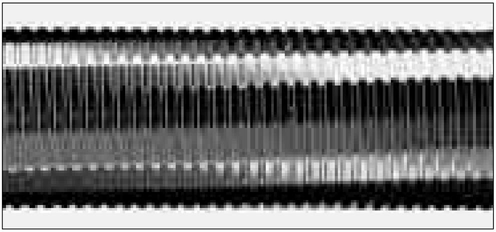
DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
20	20.0	22.5	± 0.4	135	0.318
23	23.0	25.5	± 0.4	155	0.363
25	25.0	27.5	± 0.4	165	0.394
28	28.0	30.5	± 0.4	185	0.439
30	30.0	33.1	± 0.4	180	0.582
32	32.0	35.1	± 0.4	195	0.619
35	35.0	38.1	± 0.4	210	0.674
38	38.0	41.0	± 0.4	230	0.728
40	40.0	43.1	± 0.5	240	0.766
42	42.0	45.1	± 0.5	250	0.799
45	45.0	48.1	± 0.5	270	0.859
50	50.0	53.1	± 0.5	300	0.953
55	55.0	58.1	± 0.5	325	1.04
60	60.0	64.0	± 0.6	335	1.55
65	65.0	69.0	± 0.6	360	1.67
70	70.0	74.0	± 0.6	390	1.80
75	75.0	79.0	± 0.6	415	1.92
80	80.0	84.0	± 0.7	440	2.04
84	84.0	88.0	± 0.7	460	2.10
90	90.0	94.0	± 0.7	495	2.30
100	100.0	104.0	± 0.8	550	2.55
110	110.0	115.0	± 0.8	605	2.81
120	120.0	125.0	± 0.8	660	3.06
125	125.0	130.0	± 0.8	685	3.18

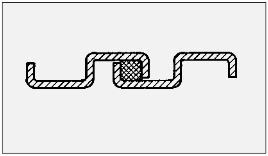
Extraction, exhaust and conveying hoses — Type FA 330S

Galvanised steel or stainless steel, metallic sealing

DN	Inside diameter	Outside diameter	Permissible tolerance	Minimum bending radius	Weight approx.
–	d	d	d, D	r_{min}	–
–	mm	mm	mm	mm	kg/m
130	130.0	137.0	± 1.0	600	4.05
140	140.0	147.0	± 1.0	645	4.34
150	150.0	157.0	± 1.0	690	4.65
160	160.0	167.0	± 1.0	735	4.96
175	175.0	182.0	± 1.0	800	5.42
180	180.0	187.0	± 1.0	825	5.56
185	185.0	192.0	± 1.0	995	5.70
200	200.0	208.0	± 1.5	1085	7.74
225	225.0	233.0	± 1.5	1215	8.68
250	250.0	258.0	± 1.5	1350	9.60
275	275.0	283.0	± 1.5	1480	10.59
300	300.0	308.0	± 2.0	1615	11.49

Please quote when ordering: type of hose, material, nominal diameter (DN), length





Types:
FG-S-O
FG-S-G
FG-S-B
FG-S-K
FG-E-K

Application:
Universal exhaust air, extraction and conveying hose, e.g. for smoke, shavings and waste gases

Properties:
- Flexible
- Resistant to torsion

Design:
- Stripwound metal hose
- Interlocked profile
- Polygonal cross-section

Materials:
- Steel, hot-dip galvanised (1.0226)
- Stainless steel (1.4301)

Versions:
- Without seal – O
- With rubber seal – G
- With cotton seal – B
- With ceramic seal – K

Operating temperature:
- Galvanised, with rubber seal: 60°C
- Galvanised, with cotton seal: 120°C
- Galvanised, with ceramic seal: 400°C
- Stainless steel, with ceramic seal: 600°C

Production lengths:
In extended position
- Up to DN 180: max. 25 m
- DN 200 and above: max. 20 m
- DN 350 and above: max. 8 m

Supplied in the following forms:
Bundled in rings

Order specifications:
- Extraction hose, galvanised steel, without seal
  Type FG-S-O
- Extraction hose, galvanised steel, with cotton seal
  Type FG-S-B
- Extraction hose, galvanised steel, with rubber seal
  Type FG-S-G
- Extraction hose, galvanised steel, with ceramic seal
  Type FG-S-K
- Extraction hose, stainless steel, with ceramic seal
  Type FG-E-K

Extraction, exhaust and conveying hoses

Type FG-S-O, FG-S-G, FG-S-B, FG-S-K, FG-E-K

Galvanised steel or stainless steel, with choice of seals

DN	Inside diameter	Outside diameter	Permissible tolerance		Minimum bending radius	Weight approx.
–	d	d	d	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
20	20.0	24.0	±0.3	±0.5	100	0.350
25	25.0	29.0	±0.3	±0.5	110	0.430
30	30.0	34.0	±0.4	±0.6	130	0.510
32	32.0	36.0	±0.4	±0.6	140	0.545
35	35.0	39.0	±0.4	±0.6	150	0.590
38	38.0	42.0	±0.4	±0.6	155	0.645
40	40.0	44.5	±0.4	±0.5	155	0.675
45	45.0	49.5	±0.4	±0.5	165	0.755
50	50.0	54.5	±0.5	±0.6	180	0.835
60	60.0	65.5	±0.5	±0.8	215	1.01
63	63.0	68.5	±0.6	±1.0	225	1.06
65	65.0	70.5	±0.6	±1.0	230	1.09
70	70.0	75.5	±0.6	±1.0	240	1.17
71	71.0	76.5	±0.6	±1.0	245	1.19
75	75.0	80.5	±0.6	±1.0	255	1.25
80	80.0	85.5	±0.8	±1.2	270	1.34
81	81.5	87.0	±0.8	±1.2	275	1.36
85	85.0	90.5	±0.8	±1.2	275	1.42
90	90.0	97.0	±0.8	±1.2	280	1.85
100	100.0	107.0	±0.8	±1.2	300	2.04
102	102.0	109.0	±0.8	±1.2	300	2.08
110	110.0	117.0	±0.8	±1.2	330	2.24
112	112.0	119.0	±0.8	±1.2	340	2.28

Please quote when ordering: type of hose, material, nominal diameter (DN), length

Extraction, exhaust and conveying hoses

Type FG-S-O, FG-S-G, FG-S-B, FG-S-K, FG-E-K

Galvanised steel or stainless steel, with choice of seals

DN	Inside diameter	Outside diameter	Permissible tolerance		Minimum bending radius	Weight approx.
–	d	d	d	D	r_{min}	–
–	mm	mm	mm	mm	mm	kg/m
120	120.0	127.0	±0.8	±1.2	380	2.44
122	122.5	129.5	±0.8	±1.2	390	2.49
125	125.0	132.0	±0.8	±1.2	400	2.54
130	130.0	138.5	±1.0	±1.5	410	2.92
140	140.0	148.5	±1.0	±1.5	430	3.13
150	150.0	158.5	±1.0	±1.5	460	3.35
160	160.0	168.5	±1.0	±1.5	490	3.57
175	175.0	184.0	±1.0	±1.5	530	3.90
180	180.0	189.0	±1.0	±1.5	540	4.01
200	200.0	210.5	±1.5	±2.0	560	5.51
210	210.0	220.5	±1.5	±2.0	585	5.78
224	224.0	234.5	±1.5	±2.0	625	6.15
225	225.0	235.5	±1.5	±2.0	630	6.18
250	250.0	260.5	±1.5	±2.0	700	6.85
275	275.0	285.5	±1.5	±2.0	770	7.52
280	280.0	291.0	±1.5	±2.0	800	7.66
300	300.0	311.0	±2.0	±2.5	850	8.20
315	315.0	326.0	±2.0	±2.5	890	8.60
350	350.0	367.5	±2.0	±2.5	1420	14.0
355	355.0	327.5	±2.0	±2.5	1440	14.2
400	400.0	417.5	±3.0	±3.5	1620	16.0
450	450.0	467.5	±3.0	±3.5	1820	17.9
500	500.0	517.5	±3.0	±3.5	2020	19.9

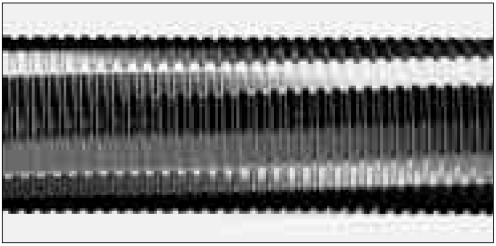
Larger nominal diameters available on request

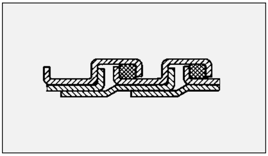
Please quote when ordering: type of hose, material, nominal diameter (DN), length

Conveying hoses

Type FS

With interior abrasion protection





Types:

FS-S-G
FS-S-B
FS-S-K
FS-E-K

Application:

Conveying hose with smooth interior surface, e.g. suitable for granulates, grain and abrasive materials

Properties:

- Flexible
- Resistant to torsion
- Low wear and tear
- Good tightness

Design:

- Stripwound metal hose
- Interlocked profile
- Polygonal cross-section
- With inserted coil as abrasion protection

Materials:

- Hot-dip galvanised steel (1.0226)
- Stainless steel (1.4301)

Versions:

- Also available on request in the combination: galvanised steel with stainless-steel interior helix
- With rubber seal – G
- With cotton seal – B
- With ceramic seal - K

Conveying hoses

Type FS

With interior abrasion protection

Operating temperature:
- Galvanised, with rubber seal: 60°C
- Galvanised, with cotton seal: 120°C
- Galvanised, with ceramic seal: 400°C
- Stainless steel, with ceramic seal: 600°C

Production lengths:
In extended position
- Up to DN 180: max. 25 m
- DN 200 and above: max. 20 m
- DN 350 and above: max. 8 m

Supplied in the following forms:
Bundled in rings

Order specifications:
- Conveying hose, galvanised steel, with rubber seal
  Type FS-S-G
- Conveying hose, galvanised steel, with cotton seal
  Type FS-S-B
- Conveying hose, galvanised steel, with ceramic seal
  Type FS-S-K
- Conveying hose, stainless steel, with ceramic seal
  Type FS-E-K

Conveying hoses Type FS-S-G, FS-S-B, FS-S-K, FS-E-K

With interior abrasion protection

Galvanised steel or stainless steel with choice of seals

Inside diameter	Outside diameter	Permissible tolerance	Bending radius ± 20 %	Weight ± 10 %		
d_1	d_2	±	–	With cotton seal	With ceramic seal	With rubber seal
mm	mm	mm	mm	kg/m	kg/m	kg/m
45	53.5	0.5	200	2.030	2.070	2.060
50	58.5	0.5	215	2.255	2.300	2.290
55	63.5	0.5	230	2.480	2.530	2.520
60	68.5	0.5	240	2.705	2.760	2.750
65	73.5	0.7	250	2.920	2.980	2.970
70	78.5	0.7	260	3.155	3.220	3.205
75	83.5	0.7	275	3.360	3.430	3.415
80	89.0	0.7	285	3.595	3.670	3.655
90	99.5	1.0	345	4.230	4.280	4.390
100	109.5	1.0	380	4.700	4.750	4.870
105	114.5	1.0	400	4.880	4.970	4.915
110	120.0	1.0	410	5.260	5.320	5.450
120	130.0	1.0	450	5.640	5.710	5.850
125	135.0	1.0	470	6.080	6.160	6.100
130	140.0	1.0	485	6.110	6.180	6.350
140	150.0	1.0	515	6.580	6.660	6.840
150	162.5	1.5	545	6.960	7.160	7.460
160	172.5	1.5	570	7.390	7.600	7.910
170	182.5	1.5	590	7.840	8.060	8.390
180	192.5	1.5	620	8.300	8.540	8.900
190	202.5	1.5	650	8.770	9.020	9.400
200	212.5	1.5	680	9.230	9.490	9.890
210	223.0	1.5	715	9.690	9.970	10.380

Inside diameter	Outside diameter	Permissible tolerance	Bending radius ± 20 %	Weight ± 10 %		
d_1	d_2	±	–	With cotton seal	With ceramic seal	With rubber seal
mm	mm	mm	mm	kg/m	kg/m	kg/m
225	238.0	1.5	765	10.400	10.700	11.150
250	265.0	2.0	880	15.470	15.680	16.330
275	290.0	2.0	1010	17.030	17.260	17.980
280	295.0	2.0	1040	17.340	17.570	18.340
300	315.0	2.0	1145	18.590	18.840	19.640
310	325.0	2.0	1200	19.210	19.460	20.270
350	365.0	2.0	1410	21.730	22.020	22.940
380	395.0	2.0	1565	23.580	23.900	24.930
400	415.0	2.0	1670	24.880	25.210	26.260
450	470.0	2.0	1930	28.010	28.420	29.600

Please quote when ordering: type of hose, material, nominal diameter (DN), length

Connection fittings

Type VA20S

For extraction, exhaust and conveying hoses type FA, FG, FS, SD

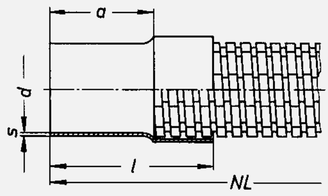
Design:
Cylindrical sleeve

Installation type:
Sealed by compression and riveted, soldered or clamped

Materials:
Stainless steel (1.4301)

Operating temperature:
600°C

Order specifications:
Connection fitting type VA20S



DN	d mm	s mm	a mm	l mm	Weight approx. kg/m
40	40	1.0	45	90	0.09
50	50	1.0	45	90	0.13
60	60	1.0	45	90	0.18
70	70	1.0	45	90	0.22
80	80	1.0	50	105	0.25
100	100	1.0	50	105	0.39
120	120	1.0	60	120	0.46
125	125	1.0	60	120	0.48
150	150	1.25	60	120	0.77
180	180	1.25	80	140	1.03
200	200	1.25	80	140	1.33
250	250	1.25	80	140	1.97
300	300	1.5	80	140	3.18
315	315	1.5	80	140	3.33
350	350	1.5	80	140	3.84

Please quote when ordering:
type of fitting, nominal diameter (DN), installation type. Other sizes available on request.

Connection fittings Type VB20S

For extraction, exhaust and conveying hoses type FA, FG, FS, SD

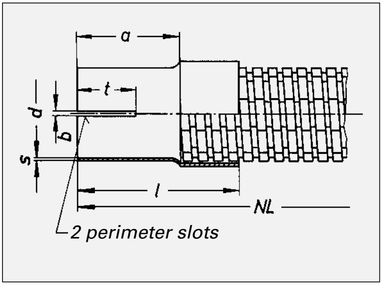
Design:
Sleeve with 2 slots, cylindrical

Installation type:
Sealed by compression and riveted, soldered or clamped

Materials:
Stainless steel (1.4301)

Operating temperature:
600°C

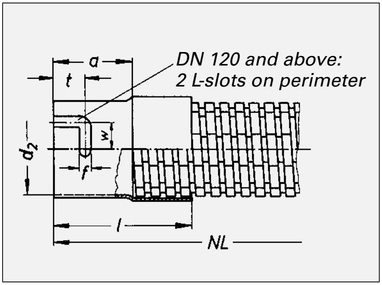
Order specifications:
Connection fitting type VB20S



DN	d mm	s mm	b mm	t mm	a mm	l mm	Weight approx. kg/m
40	40	1.0	2	30	45	90	0.09
50	50	1.0	2	30	45	90	0.13
60	60	1.0	2	30	45	90	0.18
70	70	1.0	2	30	45	90	0.22
80	80	1.0	2	35	50	105	0.25
100	100	1.0	3	35	50	105	0.39
120	120	1.0	3	40	60	120	0.46
125	125	1.0	3	40	60	120	0.48
150	150	1.25	3	40	60	120	0.77
180	180	1.25	3	50	80	140	1.03
200	200	1.25	3	50	80	140	1.33
250	250	1.25	3	50	80	140	1.97
300	300	1.5	3	50	80	140	3.18
315	315	1.5	3	50	80	140	3.33
350	350	1.5	3	50	80	140	3.84

Please quote when ordering:
type of fitting, nominal diameter (DN). Other sizes available on request.

Sleeve for extraction, exhaust and conveying hoses type FA, FG, FS, SD



Design:
Sleeve with L-slot, cylindrical

Installation type:
Sealed by compression and riveted, soldered or clamped

Materials:
Stainless steel (1.4301)

Operating temperature:
600°C

Order specifications:
Fitting type VF20S

DN	d_2 mm	f mm	t mm	w mm	a mm	l mm	Weight approx. kg/m
50	52.5	9	20	15	50	95	0.10
60	63	9	20	15	50	95	0.15
70	73	9	20	15	50	95	0.17
80	83	9	20	15	50	105	0.19
100	103	9	25	25	60	115	0.29
120	123	9	25	25	60	120	0.34
125	128	9	25	25	60	120	0.36
140	144	9	30	25	70	130	0.71
150	154	9	30	25	70	130	0.75
180	184	9	30	25	70	130	0.89
200	204	11	40	30	90	150	1.29
250	255	11	40	30	90	150	2.11
300	305	11	40	30	100	160	2.81
315	320	11	40	30	100	160	2.94
350	355	11	45	30	110	170	3.64

Please quote when ordering:

type of fitting, nominal diameter (DN), installation type. Other sizes available on request.

Connection fittings

Type VF20S

Sleeve for extraction, exhaust and conveying hoses type FA, FG, FS, SD

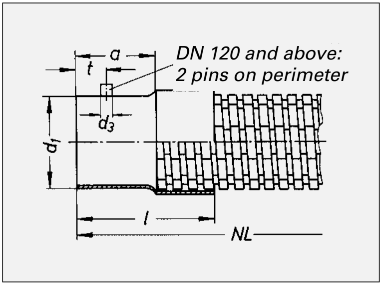
Design:
Sleeve with pin, cylindrical

Installation type:
Sealed by compression and riveted, soldered or clamped

Materials:
Stainless steel (1.4301)

Operating temperature:
600°C

Order specifications:
Fitting type VF20S



DN	d_1 mm	d3 mm	t mm	a mm	l mm	Weight approx. kg/m
50	52	8	20	50	95	0.11
60	62	8	20	50	95	0.16
70	72	8	20	50	95	0.18
80	82	8	20	50	105	0.20
100	102	8	25	60	115	0.30
120	122	8	25	60	120	0.35
125	127	8	25	60	120	0.37
140	143	8	30	70	130	0.73
150	153	8	30	70	130	0.77
180	183	8	30	70	130	0.91
200	203	10	40	90	150	1.33
250	254	10	40	90	150	2.16
300	304	10	40	100	160	2.87
315	319	10	40	100	160	3.00
350	353	10	45	110	170	3.71

Please quote when ordering:

type of fitting, nominal diameter (DN), installation type. Other sizes available on request.

Connection fittings

Type EA

Swivel-type flange joint for extraction, exhaust and conveying hoses

Type FA, FG, FS, SD

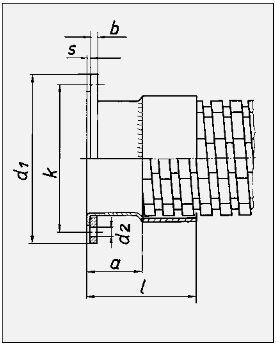
Design:
Swivel-type flange joint

Installation type:
Sealed by compression and riveted,
soldered or clamped

Materials:
- EA20S: Stainless-steel sleeve, stainless-steel-flange (1.4301)
- EA80S: Stainless-steel sleeve (1.4301), flange, galvanised steel

Operating temperature:
- EA20S: 600°C
- EA80S: 480°C

Order specifications:
Fitting type EA20S
or EA8OS



DN	Inside diameter d1	b	k	Number of holes	d2	s	a	l	Weight approx.
	mm	mm	mm	–	mm	mm	mm	mm	kg/m
50	115	6	89	4	9.5	1	40	85	0.48
60	125	6	99	4	9.5	1	40	85	0.55
70*	133	6	110	4	9.5	1	40	85	0.61
80*	142	6	118	4	9.5	1	40	95	0.67
100*	162	6	139	4	9.5	1	50	105	0.87
120*	187	6	165	4	9.5	1	50	110	1.03
125*	187	6	165	4	9.5	1	50	110	1.04
140*	212	6	182	8	11.5	1	60	120	1.34
150*	252	6	219	8	11.5	1.25	60	120	1.83
200*	273	6	241	8	11.5	1.25	60	120	2.10
250*	323	6	292	8	11.5	1.25	60	120	2.58
300	383	8	349	8	11.5	1.5	60	120	4.48
315*	398	8	366	8	11.5	1.5	60	120	4.75
350*	438	8	405	8	11.5	1.5	60	120	5.21
400*	484	8	448	12	11.5	1.5	70	130	6.28
500*	584	8	551	12	11.5	2	70	130	8.86

**Flange dimensions to DIN 241545, 2nd edition July 1990. Other sizes available on request.*

Please quote when ordering: type of fitting, nominal diameter (DN), installation type.

Quick-release coupling for extraction, exhaust and conveying hoses

Type FA, FG, FS, SD

Design:

Type WE20S

- Coupling element with guide and clamp lock
- DN 200 and above: comes with 2 wooden handles

Type WK20S

Flange element with guide suitable for coupling element

Installation type:

Sealed by compression and riveted, soldered or clamped

Materials:

Stainless steel

Operating temperature:

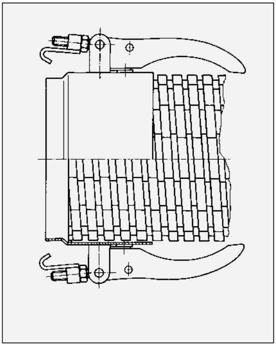
600°C

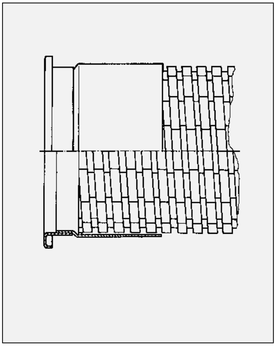
Order specifications:

Fitting type VF20S

Available accessories:

- Screen, galvanised steel
- Lid with chain, galvanised steel
- Handles, 1 pair, wood



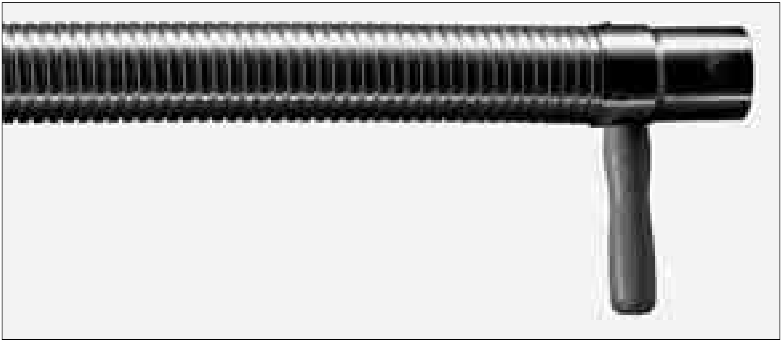


DN	Clamp lock	Wooden handles
100	2 units	–
125	2 units	–
150	2 units	–
200	3 units	2 units
250	3 units	2 units
300	3 units	2 units
315	3 units	2 units

Please quote when ordering: fitting type, nominal diameter (DN), installation type.

Other sizes available on request.

Exhaust hoses to DIN 14572



Application:
Exhaust hoses to DIN 14572 are used for carrying away exhaust gas from portable fire pumps (DIN 14410), from fire brigade vehicles (DIN 14502 part 1) and from power-generating aggregates (DIN 14685). The hoses prevent operating personnel from being hampered by exhaust gases.

Design:
- Round or polygonal cross-section
- Wooden handles
- Sleeve with pin on one side; sleeve with L-slot on the other side

Materials:
Galvanised steel with glass fibre seal
Hot-dip galvanised steel (1.0226): DN 20 and above

Operating temperature:
400°C

Supply:
On stock, prior sale reserved

Order specifications:
Hose, galvanised steel
DN 47: type SD370L
DN 80, 100 and 125: type FG370L

DN	Inside diameter	Outside diameter	Nominal length extended NL	Weight approx.
–	d_1	d_2	mm	–
–	mm	mm		kg/m
47	50	52	1500	2.50
			2500	4.00
80	85	87	2500	6.50
100	102	104	2500	10.00
125	130	132	2500	11.50

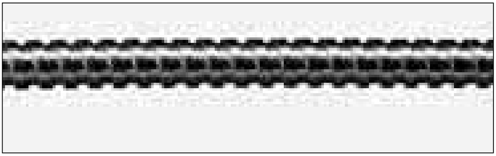
Please quote when ordering: type of hose, nominal diameter (DN), nominal length (NL).
Other sizes available on request.

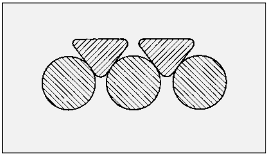
Goosenecks

High load-bearing capacity, flexible yet with high bending resistance, robust and versatile: these are the hallmarks of our "flexible arms" made of stainless steel. Among other applications, goosenecks are used as both microphone and lamp holders, for optoelectronic devices and as cooling hoses for machine tools. The extensive range of versions available is matched by the variety of uses to which they can be put. Flexible arms are available in lacquered, chrome- or nickel-plated finish, in nominal sizes between 6 and 18 mm supplied with suitable connectors.

Flexible arms

Goosenecks





Application:
Flexible arms, popularly known as “goose-necks”, for uses such as lamp bracket hoses or microphone arms. Applications are also standard in fibreoptics (cold light sources, measuring devices), for welding shields, in traffic control technology, car telephones, medical-equipment manufacture etc.

Design:
- Flexible yet resistant to bending
- Combination of interior round wire with a triangular wire coil inserted from outside

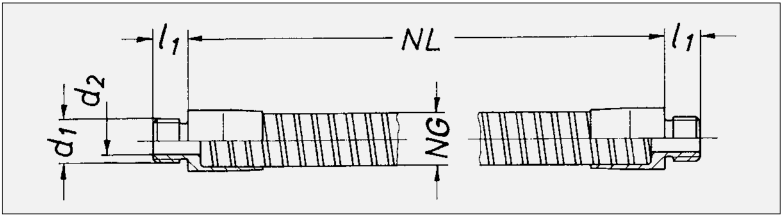
Versions:
In many cases it is our common practice to make customised versions; here we can only list the standard series. If this does not cover your needs and you have application-specific requirements, please let us know. Take advantage of our long experience and expert advice.

Load-bearing capacity:
The load-bearing capacity of flexible arms is a function of their nominal size (NG) and the length of the support coil. The term “carrying length” (l) describes the length at which a vibration-free support coil, horizontally clamped on one side, is permitted to sink under its own weight by a distance not exceeding its own inside diameter. The diagram on the next page shows the relationship between nominal size (NG) and maximum load (p).

Notes on installation:
Flexible arms are to be bent evenly; on no account is the minimum bending radius to be exceeded.

Supply:
Possible at short notice

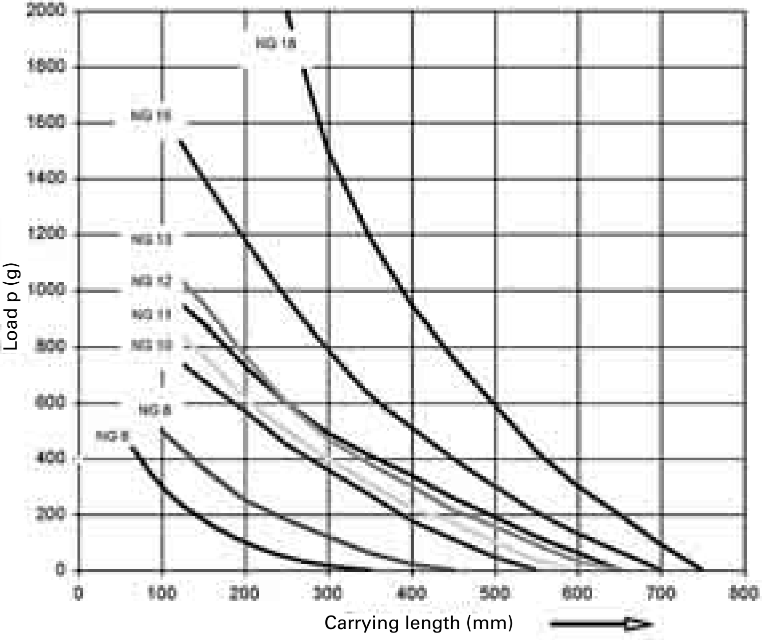
Order specifications:
- Flexible arm, blank, NL 90 up to 4000 mm, Type BA 151L11
- Flexible arm, high-gloss nickel-plated, NL 90 up to 760 mm, Type BA 152L11
- Flexible arm, high-gloss chromium-plated, NL 90 up to 760 mm, Type BA 153L11
- Flexible arm, matt chromium-plated, NL 90 up to 760 mm, Type BA 154L11
- Flexible arm, matt black finish, NL 90 up to 800 mm, Type BA 156L11



NG	Support coil		Connection dimensions			Minimum bending radius	Weight approx.
–	Inner Ø	Tol.	d_1	d_2	l_1	r_{min}	–
mm	mm	mm	mm	mm	mm	mm	kg/m
6	2.6	+0.2 / - 0.1	M8 x 1	3.0	8	35	0.150
8	3.9	+0.1 / - 0.2	M10 x 1	6.5	8	45	0.250
10	5.3	+0.1 / - 0.2	M10 x 1	6.5	8	55	0.350
11	5.3	+0.1 / - 0.2	M10 x 1	6.5	8	50	0.465
12	6.7	+0.1 / - 0.2	M10 x 1	6.5	8	60	0.470
13	7.1	+0.1 / - 0.2	M10 x 1	6.5	8	60	0.590
15	7.3	+0.1 / - 0.2	M10 x 1	6.5	8	65	0.850
18	7.7	+0.1 / - 0.3	M10 x 1	5.0	8	120	1.30

Goosenecks

Load diagram



Flexible arms

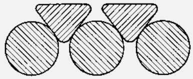
Coolant hoses

Type FR

Type FR 201

Type FR 211

Type FR 400



Application:

Coolant hoses convey liquid and gaseous coolants or lubricants during metal cutting. They can also be used to blow away shavings and metal parts in moulds and workpieces, as well as those arising from use of stamping parts.

Properties:

- Small bending radii, enabling them to be precisely adjusted in the desired direction.
- Reliably maintain alignment even under high pressure, without showing fatigue or vibrating
- Robust and resistant to wear and tear
- Resistant to hot shavings, oils and greases

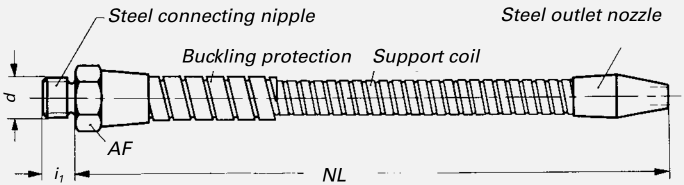
Design:

- Support coil consists of two profilated wires wound one on top of the other
- A PVC hose is inserted inside

DN	Whitworth pipe thread ISO 228/1 d	l mm	AF mm
6	G 1/4	45	22
8	G 3/8	45	22
10	G 1/2	55	27
16	G 3/4	65	32

Versions:
A range of versions is available for different applications:

- Type FR 201:
  Standard versions with fixed threaded pins and outlet nozzles
- Type FR 211:
  Coolant hose with connection for interchangeable nozzles
- Type FR 400:
  High-pressure hose assembly for strong mechanical stresses, as in casting plants, in both machine and tool construction, in plastic injection-moulding machines, and on calendars as separating spray pipes for parting agents.

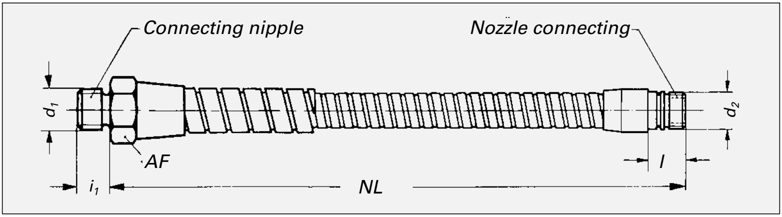


Steel supporting coil with PVC interior hose, threaded pin and steel outlet nozzle, nickel-plated hose surface with additional buckling protection up to and including DN 10.

DN	Connecting nipple DIN 3852-A, part 2		AF	Minimum bending radius	Nominal length approx. NL						
–	d	i_1	–	r_{min}	± 5						
–	inches	mm	mm	mm	mm						
4	G 1/8	8	15	64	200	250	320	400	–	–	–
6	G 1/4	10	19	72	200	250	320	400	500	630	–
8	G 3/8	10	24	88	–	250	320	400	500	630	–
10	G 1/2	12	27	110	–	–	320	400	500	630	800
16	G 3/4	12	36	110	–	–	–	–	500	630	–

On stock – immediately available. Prior sale reserved.

Please quote when ordering: type of hose, nominal diameter (DN) and nominal length (NL).



Steel support coil with PVC interior hose, threaded steel pins, connection with O-ring for interchangeable brass or aluminium nozzles, nickel-plated hose surface, with additional buckling protection up to and including DN 10.

DN	Connecting nipple DIN 3852-A, part 2		AF	Nozzle connecting		Minimum bending radius	Nominal length approx. NL					
–	d	i_1	–	i		r_{min}	± 5					
–	Zoll	mm	mm	mm	mm	mm	mm					
4	G 1/8	8	15	M10 x 1	12.0	64	220	250	320	400	–	–
6	G 1/4	10	19	M12 x 1	15.5	72	200	250	320	400	500	–
8	G 3/8	10	24	M16 x 1	17.5	88	–	250	320	400	500	630
10	G 1/2	12	27	M18 x 1	19.0	110	–	–	320	400	500	630
16	G 3/4	12	36	M26 x 1.5	27.0	110	–	–	–	–	500	630

On stock – immediately available. Prior sale reserved.

Please quote when ordering: type of hose, nominal diameter (DN) and nominal length (NL).

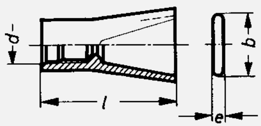
Flexible arms Type DUE 110, DUE 411, DUE 510

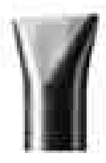
Accessories for coolant hoses; interchangeable nozzles

Flat nozzle type DUE 110

- Aluminium, blank

DN	d mm	l mm	Outlet b x e mm
4	M10 x 1	34	16 x 0.8
6	M12 x 1	40	21 x 1.4
8	M16 x 1	50	26 x 2.0
10	M18 x 1	60	32 x 2.5
16	M26 x 1.5	70	44 x 3.0

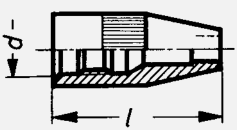




Adjustable nozzle DUE 411

- Nozzle can be turned off
- Nickel-plated brass

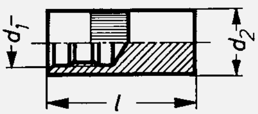
DN	d mm	l mm
4	M10 x 1	28
6	M12 x 1	36
8	M16 x 1	44
10	M18 x 1	52
16	M26 x 1.5	55

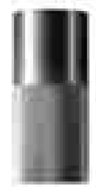


Special nozzle type DUE 510

- Bored nozzle, semi-finished by turning
- For special nozzle exits to be created
- Brass, blank

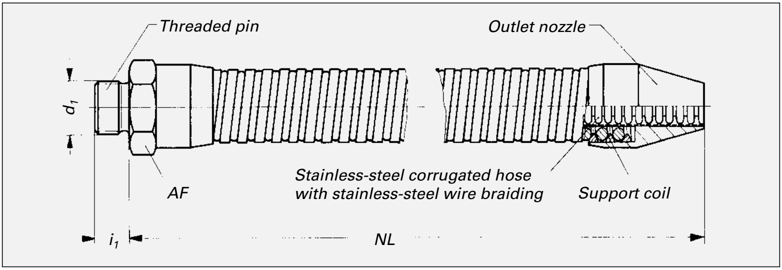
DN	d_1 mm	l mm	d_2 mm
4	M10 x 1	28	12
6	M12 x 1	36	15
8	M16 x 1	44	19
10	M18 x 1	52	23
16	M26 x 1.5	55	31.5





On stock – immediately available. Prior sale reserved. Please quote when ordering: type, nominal diameter (DN)

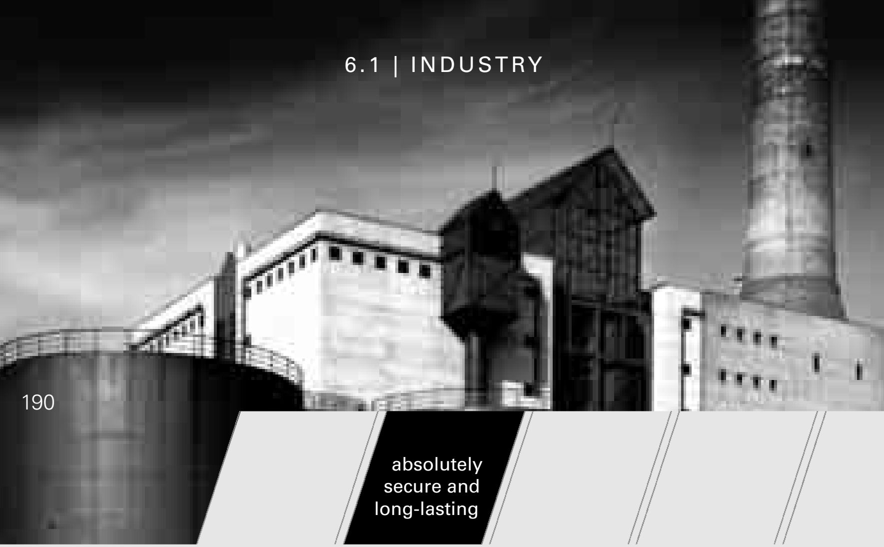
Coolant hoses for high-pressure applications



- Self-supporting high-pressure hose assembly
- Interior annularly corrugated hose with braiding, made entirely of stainless steel
- Outside steel support coils, outlet nozzles and threaded brass pins

DN	Connecting nipple DIN 3852-A, part 2		AF	Minimum bending radius	Nominal length approx. NL					
–	d_1	i_1	–	r_{min}	± 5					
–	inches	mm	mm	mm	mm					
6	G 1/4	12	12	24	110	160	320	400	500	630
10	G 3/8	12	12	30	110	100	320	400	500	630

Available at short notice. Please quote when ordering: type of hose, nominal diameter (DN), nominal length (NL)



absolutely secure and long-lasting

With high pressures, extreme temperatures and aggressive media, the chemical industry is a particularly severe environment for flexible metallic components. Extremely high safety standards demand maximum product reliability in order to guarantee the safety of people and environment.

Safety through experience

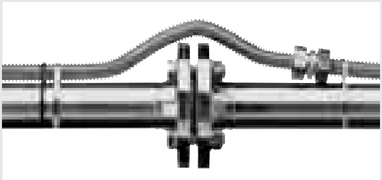
Customers of Witzenmann seeking the right choice for extreme requirements benefit from over 100 years of experience in the production of flexible components. We offer solutions for vacuum and high pressure applications, for critical and aggressive media that have consistently proven themselves in practice. Even under extreme operating conditions, our flexible elements are absolutely reliable.

Extensive expertise in finding solutions

As a system supplier, we can offer our customers extensive expertise in providing advice and appropriate solutions aimed at ensuring lasting, trouble-free operation. The flexible heat trace system from Witzenmann, for example, comes not only with the actual trace heating hoses, but also with flexible insulated feed lines, various assembly and fastening parts as well as computer-based selection tools.

Leader in welding technology and joining systems

A central element of Witzenmann's customer philosophy is support of our customers right through to installation of our components. This also includes experience and mastery of all of the primary welding processes, giving us access to a wide range of technologies for joining hose, braiding and connection fittings. What this means for you is high-quality products manufactured using the latest production techniques that enable installations, machines and units to enjoy a long service life.



The Hydra heat trace system
represents an all-round thoroughly thought-out solution for all applications: easily adaptable and technically perfect, no laborious selecting of individual components, no risk due to components that are not designed to work together. All elements of Hydra system solutions offer a standardised, proven joining system.

The Hydra heat trace system consists of:
- flexible heat tracing hose of stainless steel
- insulated feed line from the main supply to the heat tracing system
- accessories and fastening parts.

The stainless steel hose can be ordered by the metre with separable threaded couplings of stainless steel or brass. The hose is fastened to the pipework with snap-on clips and bands or directly with metal bands. Screw-attached snap-on clips are used for fastening to walls, etc...

Application
The system is generally used where a constant temperature is required.

Application examples
- Heating of product pipework
- Heating of manifolds/valves/pump housings
- Cooling of motors
- Vessel heating
- Heating of emergency showers
- Pipe bridges
- Cooling
- Feed line with pre-insulated annularly corrugated hose assembly from main supply to heat tracing system
- Typical heat transfer medium is steam, but hot and cold water are also used

The benefits

- Cost-saving thanks to easy installation
- No need to measure the pipes, no need for isometric drawings
- Extremely small bending radius
- No welding necessary
- No buckling, no decrease in cross-section
- High pressure resistance
- Thermally stable, resistant to corrosion and ageing
- Non-flamable, resistant to diffusion
- Lower insulation costs thanks to smaller preformed pipe insulation
- Excellent heat transfer due to large corrugated surface area
- Electrically conductive
- DN 12 to DN 25

The pre-insulated feed hose

The pre-insulated feed hose: simply clever. The feed from the main steam/hot water supply to the heat tracing pipe at the respective place of use is a sore point during installation. Frequently, pipes have to be welded, bent or repaired in order to guarantee a reliable connection.

Termination set FAK-7B

for watertight terminations at the ends of the hose with a roll of self-vulcanising silicone rubber tape and RTV sealing compound. The materials are sufficient for installing about 2–4 watertight connections. No special tools are required.

Self-sealing join set FAK-8I

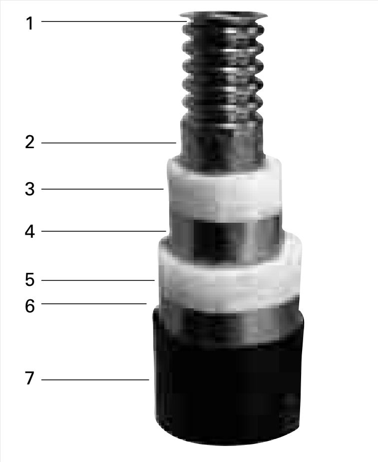
for a waterproof sealing, with insulating material and rubber mat for joins, or repairs to the outer jacket of the line.

Advantages

- External temperature only 60°C when internal temperature is 200°C
- Quicker installation compared to conventional rigid copper/stainless steel feed lines
- Flexible routing with 250 mm bending radius
- Larger nominal diameters can be realised than with pipes
- No need to coordinate progress of installation with insulation work
- No subsequent manual insulation work
- Temperature range -40°C outside to +200°C inside
- Considerable cost saving
- DN 6 and DN 25

The corresponding connection types can be found on page 102-105

Assembly accessories, detailed installation instructions and other technical data is available in our publication 1347.



Insulated feed hose

1 Annularly corrugated hose
2 Heat-reflecting aluminium foil
3 Non-hygroscopic 5 mm glass fibre insulation
4 Heat-reflecting aluminium foil
5 Non-hygroscopic 5 mm glass fibre insulation
6 Heat-reflecting aluminium foil
7 Polymer outer sheath 2 mm

Hose assemblies for chemical substances to DIN 2827:2006 – 01

Components in the chemical industry are expected to satisfy particularly high requirements. This applies to hose assemblies of stainless steel, too, of course. On the one hand, they are frequently required to carry highly aggressive media, and on the other they must meet exceptionally high safety standards.

DIN 2827 "Hose assemblies of stainless steel for chemical substances" contains detailed descriptions and details on

- Applications and purpose
- Design, dimensions and designations
- Additional protective versions
- Requirements and manufacture
- Materials
- Specification in conformity with the Pressure Equipment Directive 97/33/EC, DIN EN ISO 10380 and 14585-1

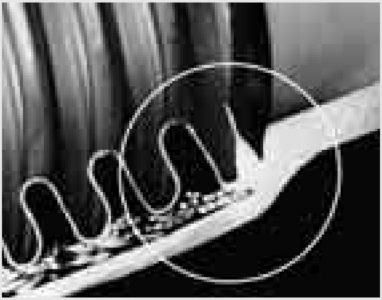
Application

DIN 2827 applies to hose assemblies with parallel/annularly corrugated hoses of stainless steel with single braiding and a maximum operating pressure of 25 bar at max. 300 °C operating temperature.

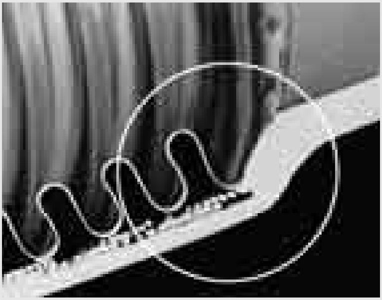
Connection fittings
In the past, it was impossible to rule out crevices inside the hose at the attachment point of fittings. At these positions, adhering residual fluids present in stronger concentrations could cause crevice and/or pinhole corrosion. With burr and crevice-free connection systems, this is out of the question.

The following pictures show cross-sections through the connection end of a metal hose, one of DIN 2827 design, the other of conventional design. The connection parts have to be inert gas welded to the hose by certified welders (DIN EN 287-1) using suitable fillers.

Under DIN 2827, burr and crevice-free connection systems are required from DN 10 to DN 100. Witzenmann also offers this system from DN 6 upwards, because we believe safety and reliability is essential for all nominal diameters.



Cross-section of connection fitting of conventional technology.



Cross-section of connection fitting complying with the DIN standard and avoiding burrs and crevices.

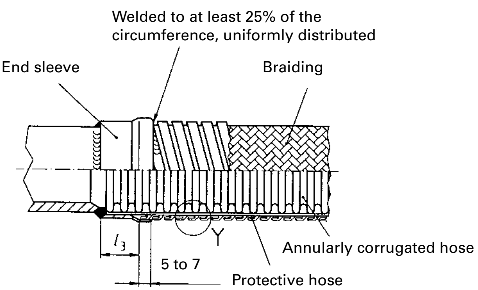
Hose assemblies for chemical substances to DIN 2827:2006 – 01

Protective versions
Additional protective versions to DIN 2827 are available for various purposes:

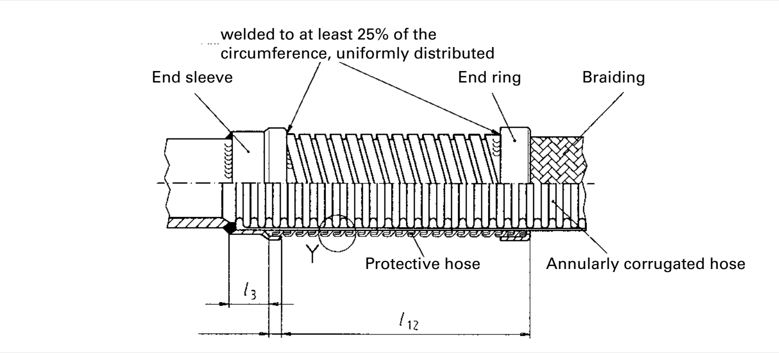
Protective hose
For the entire length as protection from special external influences.

Buckling protection
Prevents buckling of the hose.
The hose assembly is protected by a protective hose with a length of 5 DN.

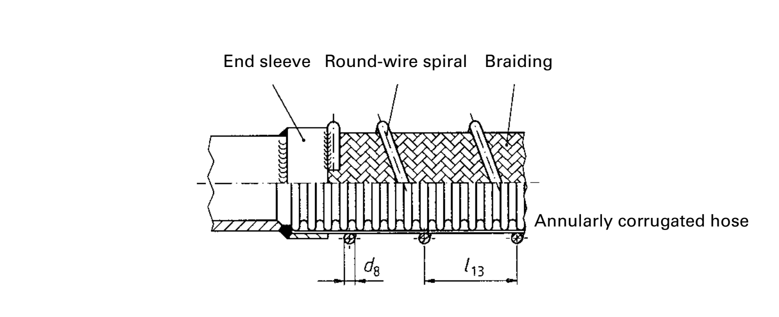
Braiding protection
Round-wire spiral over the entire length of the hose to protect braiding from damage due to external friction during handling.



Protective hose

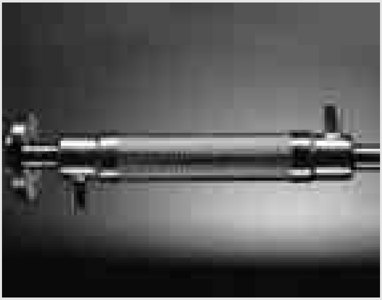


Buckling protection



Braiding protection

Conectoflex double hose assembly



Application
Conectoflex is a double hose assembly in which typically the inner hose carries a medium, while the outer – the annular cavity – carries a heating or cooling medium or serves as a protective hose. Below are a few applications.

Heatable element
For conducting viscous or temperature-sensitive media, the Conectoflex is primarily used in the chemical, petrochemical, pharmaceutical and food industries. In this case, the annular cavity carries a heating medium. Such hoses are typically used wherever normal insulating sleeves are inadequate or given temperatures must be maintained for the conveying of media.

Coolable element
The Conectoflex is most frequently used for cooling of air and exhaust gas in compressors and motors.

Controllable safety element
Wherever a controlled zone must be created around an inner pipe with hazardous media, use of the Conectoflex double hose is recommended. Test devices such as manometers or leak detectors are connected to the outer hose.

Insulating element
For the conveying of very low temperature media, e.g. liquid gas in cryogenic applications, the Conectoflex can be used as an insulating element. Here, the annular cavity between inner and outer hoses is evacuated.

Characteristics
The Conectoflex hose has angular and lateral flexibility. It is pressure resistant, vacuum-tight, temperature resistant and corrosion-proof.

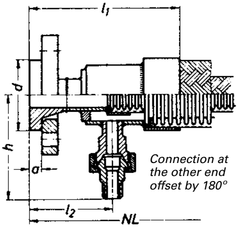
Construction
For the inner and outer hose, our type RS stainless steel corrugated hoses with stainless steel braiding are used, please refer to section 4. For connection of the heating or cooling medium, welding neck flanges or threaded couplings are generally provided at both ends of the hose assembly – offset by 180°. For vacuum-insulated hose assemblies, a vacuum small flange or cryo valve is used.

Designs
The permissible operating temperature for the standard version is a maximum of 400 °C. Special versions are available for operating temperatures of up to 550 °C.

The standard versions provide different connection fittings, please refer to the data sheets on the following pages.

In addition, we manufacture versions entirely of stainless steel.

Conectoflex double hose assembly, connection fittings at both ends



Flange version DIN PN 16 or 40, threaded fitting

Inner hose: loose flange DIN PN 16 or 40, welded
Outer hose: threaded coupling, male thread, malleable cast iron, cone seal, with Whitworth pipe thread DIN 2999 (ISO 7/1), brazed

Fitting type	Material		Max. operating temperature	
	Flange Inner hose	Thread coupling Outer hose	Inner hose	Outer hose
1AA1RR0	Steel	Malleable cast iron	300 °C	300 °C
1AA8RR0	Stainless steel 1.4541 oder 1.4571	Malleable cast iron	450 °C	300 °C

With type 1AA8RR0, all parts coming into contact with the medium of the inner hose are of stainless steel

Dimensions in mm, weight G in kg

DN Inner hose	10	16	20	25	32	40	50	65	80	100	150
DN outer hose	25	32	40	50	50	65	80	100	125	150	200
d Threaded coupling	R 3/8	R 3/8	R 1/2	R 1/2	R 1/2	R 1/2	R 3/4	R 3/4	R 3/4	R 3/4	R 1
d	40	45	58	68	78	88	102	122	138	158	212
a	10	10	12	12	12	12	14	14	16	16	18
l1	108	110	122	135	140	148	160	167	191	205	235
l2	65	65	75	80	80	80	90	90	100	100	115
h	85	90	105	110	115	120	135	145	155	170	210
G approx.	1.1	1.3	1.7	2.3	3.0	3.5	4.7	5.8	7.8	9.7	17.0

Please quote when ordering:

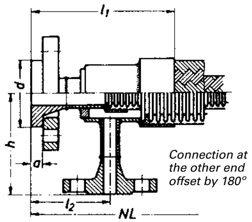
1. Nominal width (DN) of inner hose, material no., nominal length (NL) 2. Type of connection fitting, material no.

3. Max. operating pressure, max. operating temperature 4. Flow medium for inner and outer hoses

5. Installation situation and movement 6. Classification under the PED

Other connection fittings on request.

Conectoflex double hose assembly, connection fittings at both ends



Flange version DIN PN 16 or 40, flanged end

Inner hose: loose flange DIN PN 16 or 40

Outer hose: welding neck flange DIN PN 16 or 40, welded in each case

Fitting type	Material		Max. operating temperature	
	Flange Inner hose	Thread coupling Outer hose	Inner hose	Outer hose
1AA1GG1	Steel	Seel	300 °C	300 °C
1AA8GG1	Stainless steel 1.4541 oder 1.4571	Steel	450 °C	400 °C

With 1AA8GG1, all parts coming into contact with the medium of the inner hose are of stainless steel.

Dimensions in mm, weight G in kg

DN Inner hose	10	16	20	25	32	40	50	65	80	100	150
DN outer hose	25	32	40	50	50	65	80	100	125	150	200
DN fixed flange	10	10	15	15	15	15	20	20	20	20	25
d	40	45	58	68	78	88	102	122	138	158	212
a	10	10	12	12	12	12	14	14	16	16	18
l1	108	110	122	135	140	148	160	167	191	205	235
l2	65	65	75	80	80	80	90	90	100	100	115
h	90	95	95	100	105	110	125	135	145	160	195
G approx.	1.5	1.7	2.1	2.7	3.4	4.0	5.3	6.5	8.5	10.5	17.8

For choice of steel materials: please see "Appendix A – Materials".

Please quote when ordering:

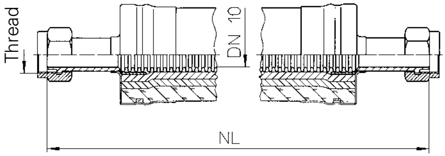
1. Nominal width (DN) of inner hose, material no., nominal length (NL) 2. ype of connection fitting, material no.

3. Max. operating pressure, max. operating temperature 4. Flow medium for inner and outer hoses

5. Installation situation and movement 6. Classification under the PED

Other connection fittings on request.

Hydratherm insulation hose



The Hydratherm insulation hose is characterised by the following features:

- high insulation performance, temperature resistant to 300°C, external temperature at this temperature max. 60°C (touch guard required)
- vacuum and diffusion tight
- medium-carrying pipe of stainless steel
- maximum operating pressure up to 12 bar at +20°C

Application

The Hydratherm insulation hose enables flexible connection, for example:

- between temperature equalisation unit and bath vessel
- between dosing unit and temperature control for reactors
- in distillation plants

Characteristics

Assembly is quick and simple because the hoses are easy to bend and are available in different lengths. Connection is done with a union nut.

Construction

The Hydratherm insulation hose consists of annularly corrugated hose of stainless steel 1.4404, insulating hose, glass-fibre hose, silicone foam hose. The insulation is held and sealed at both ends by a shrink-fit hose, connection of the hose is done with stainless steel union nuts with M 16 x 1 thread.
The welded joint is burr and crevice free.

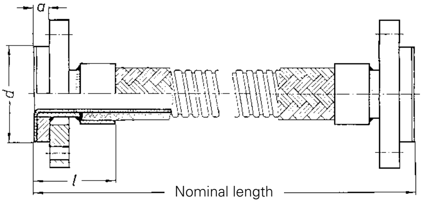
DN	Thread	Maximum operating pressure at 20°C	Outside diameter	Nominal length NL			
–	–	P_{zul} bar	mm	mm			
10	M 16 x 1	12	40	500	1000	1500	2000

Please quote when ordering: type, nominal length (NL), differing DN connection fittings and NL on request.

Description
Hydratherm insulation hose
Type HT 317
DN 10 NL ...
Annularly corrugated hose of 1.4404
with triple insulation
union nut at both ends
stainless steel M 16 x 1
ready to install

Delivery
Ex stock, subject to prior sale

Hydraflon PTFE-lined metal hose



Application
Flexible PTFE pipes are frequently used in the chemical industry where the chemical resistance of other materials is no longer adequate.

Through their smooth interior, PTFE-lined hose assemblies are especially suitable for use as conveying or filling hoses.

Characteristics
Use of Hydraflon hose means trouble-free operation since:

- inner surface of the metal hose is completely protected by PTFE, even at sealing faces
- smooth interior guarantees residue-free conveying of the flow medium
- wall thickness of the PTFE liner at least 1.8 mm. If required, thicknesses of 3,4 or 5 mm are also possible – depending on nominal width
- manufacture of Fluoroflex PTFE liner by an ISO 9000 series certified company. Optimal production process means maximum flexural fatigue strength and minimal permeation, i.e. long life and minimised gas permeability
- temperature resistance -40 °C to +230 °C
- DN 15 to DN 200

The hose is unsuitable for isolation of large-amplitude or continuous vibrations.

Constructions
The PTFE liner of the combined metal hose assembly is radially supported by a protective stainless steel interlocked-profile hose. The additional wire braiding serves to absorb the longitudinal force generated by the internal pressure.

The combination of protective interlocked-profile hose and wire braiding increases the pressure resistance and offers protection from external mechanical stresses. The interlocked-profile hose also prevents buckling of the PTFE hose.

Design
- PTFE-lined metal hose assembly
- Hydraflon type HN inner liner of PTFE to ASTM D 4895
- With protective interlocked-profile hose and wire braiding, both of stainless steel 1.4301
- Collar pipe and loose flange of steel or stainless steel at both ends

Electrostatic discharge
The flow of media in electrically non-conductive pipes can give rise to electrostatic charges. These can lead to arc discharge (sparks) and therefore to the ignition of gas-air mixtures.

To prevent electrostatic charges, the PTFE liner must be electrically conductive. On special request, Hydraflon hose assemblies with electrostatically discharging PTFE liner can be supplied. The discharge resistances are in the range 10^6 to 10^8 ohms.

Length tolerance

NL up to	1000	+15/-10 mm
NL over	1000	+1.5%/-1%

Hydraflon PTFE-lined metal hose

Description

PTFE-lined metal hose assembly
Hydraflon type HN
DN… NL…
PTFE inner liner with wall thickness min. 1.8 mm external protective interlo-cked-profile hose with single braiding both 1.4301
collar pipe and loose flange at both ends
DIN 2501/DIN EN 1092-1
PN … Material…
classified under Pressure Equipment Directive 97/23/EC

DN	d	a	l	Minimum bending radius	Operating pressure at 20°C	Negative pressure at 20°C	Weight approx. hose	Weight approx. end fitting for one side	Max. nominal length
–	–	–	–	r_{min}	P_{zul}	–	–	–	–
–	mm	mm	mm	mm	bar	10^5 Pa abs.	kg/m	kg	m
15	45	10	36	325	25	0.35	0.350	0.770	6
20	58	12	40	325	25	0.35	1.00	1.05	6
25	68	12	43	350	25	0.35	1.29	1.34	6
32	78	12	48	400	25	0.35	1.52	1.97	6
40	88	12	52	550	25	0.35	2.40	2.25	6
50	102	14	62	750	25	0.35	2.79	2.74	6
65	122	14	64	1000	20	0.5	4.80	3.70	6
80	138	16	70	1300	16	0.5	5.73	4.55	6
100	158	16	73	1500	12.5	0.7	8.06	5.17	6

Please quote when ordering:

1. Type, nominal diameter (DN), nominal length (NL)

2. Medium, operating pressure, operating temperature

3. Material of connection fittings, PN of flanges

Versions on request: annularly corrugated hose with single braiding, nominal diameters up to DN 200

Hydra high-pressure safety hose assembly for 400 bar, produced to customer specification.

Application
The conveying of high-purity gases, technical gases at high pressure, hazardous or toxic gases requires stainless steel corrugated hose assemblies of the highest quality and absolute reliability. Even after years of use, such hoses must continue to function perfectly, they may neither age nor suffer leaks. Filler hoses for gas cylinders often experience added stresses from frequent movement and pressure changes combined with frequent assembly/disassembly and consequent stresses on the connection fittings.

Hydra high-pressure hoses of RS 531 series from DN 5 to DN 16 perfectly satisfy these requirements.

Construction
The RS 531 high-pressure hose is optimised in respect of profile geometry, connection systems, braiding design and design of the connection fittings. RS 531 – please refer to the technical data on page 58-59.

Designs
The maximum operating pressure for the most often used nominal diameter DN 6 is 380 bar for a hose assembly with 2 braids, the bursting pressure is over 1140 bar. Despite these very high pressures, the RS 531 shows outstanding flexibility and is therefore easy to handle during installation.

High-pressure hoses for technical gases

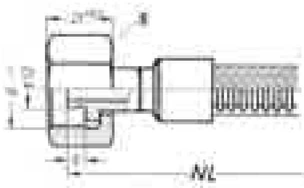
Customised solutions have given reliable operation for many years. Witzenmann hose assemblies are certified to the highest safety standard by producers of technical gases of international standing. Not least because the safety of operating personnel is a particular concern of ours.

Hose assemblies manufactured by Witzenmann combine the following features and characteristics:

- reliable operating pressure of max. 400 bar at 20°C
- resistance to pressure cycles
- absolutely UHV proof
- long service life under extreme pressure and movement stresses
- non-ageing
- use for very low temperatures
- high standard of quality assurance, internal and external cleanness, dimensional accuracy of connection fittings

Gas cylinder filler hoses
Stainless steel hose assemblies of type RS 531 are frequently used as gas cylinder filler hoses. The connection fittings most suitable for the individual gases conform to DIN 477-1. To rule out the possibility of mis-connection during filling and emptying, the DIN standard specifies connections with left-hand thread on the side connection pieve of the gas cylinder valve for all flammable and highly flammable gases, and right-hand thread for all other gases.

The following table gives some of the most common gases and the corresponding valve connections. For gases not covered in the table, please check or ask about the suitability or chemical resistance of filler hoses before ordering.



Design of gas cylinder filler hoses DN 6
Operating temperature/max. operating pressure: 400 bar at +20 °C. For reduction factors at higher operating temperature and/or dynamic stress, see page 251.

Hose with braiding
HYDRA annularly corrugated hose RS 531S22 of stainless steel 1.4541 or 1.4571 with double stainless steel braiding 1.4301.

Connection fittings
e.g. for nitrogen, flat sealing connection piece with neck of stainless steel 1.4541 or 1.4571, union nut of stainless steel 1.4301, fitting no. 10 to DIN 477-1, our type NR26S, inert gas welded, threaded fitting one end/other end to customer specification.
Maximum test pressure as per DIN 477-1: 300 bar.

Gas cylinder valve connections (side connection piece) for the given gases to DIN 477-1

Valve type	Connection at side socket	Fitting no.	Gases		Size
–	d	–	–		mm
NR26S	W 21.80 x $^1/_{14}$ LH	1	ethylene, butadiene, butylene, butane, dimethylether, ethane, illuminating gas, methane, propane, hydrogen	flammable, highly flammable gases	30
	W 21.80 x $^1/_{14}$	6	ammonia, argon, helium, carbon dioxide (carbonic acid)	non-flammable or hardly flammable gases	
	G $^3/_4$	9	oxygen		32
	W 24.32 x $^1/_{14}$	10	nitrogen		

Please quote when ordering:

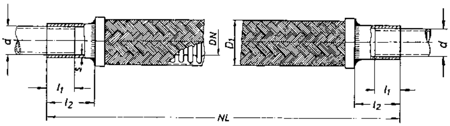
1. Hose type, material, fitting type with thread designation, nominal length (NL)

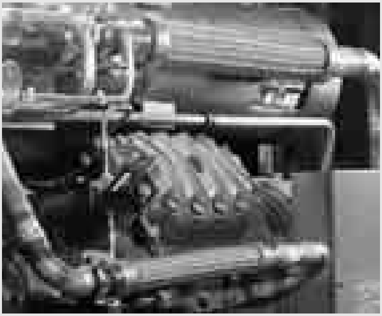
2. Medium, operating pressure, operating temperature

Metal hose assemblies for ammonia NH_3

Selection information
Special care must be taken when selecting metal hose assemblies for conveying ammonia. The safety requirements of TRD 452 and other regulations must be taken into account:

- hose assemblies for ammonia are to be designed for at least PN 25 (vapour pressure of ammonia)
- connections must be made by welding, the guidelines of TRD 452 apply to the welded joint and filler material
- flange connections must be designed with projection and recess or tongue and groove. Alternatively, seals that can not be squeezed out with metal outer ring are allowed
- materials/connection system: only materials that are resistant to NH_3 may be used
- approval certificate 3.1 to EN 10204 must be supplied for the medium-carrying components of the hose assembly
- hose assemblies must at least be marked with the manufacturer and/or trademark, type designation, maximum nominal pressure level, date of manufacture





Application and characteristics
Vibraflex vibration absorbers are primarily used in refrigeration, e.g. cooling units, air-conditioning units, refrigeration systems, heating pumps. Vibraflex vibration absorbers prevent transmission of vibrations and also absorb noise. Vibraflex vibration absorbers are resistant to typical refrigerants such as R12, R22, R114, R123, R134a, R502 and similar non-corrosive refrigerating fluids. Vibraflex vibration absorbers of bronze must not be used for the refrigerant ammonia NH_3 – a stainless steel type is advised for this. Please also note the section "Metal hose assemblies for ammonia" –> page 210.

Construction
Vibraflex vibration absorbers are manufactured from an annularly corrugated all-metal hose with single braiding and internal soldering ends of copper. Up to DN 50, bronze is used for hose and braid, stainless steel for DN 65 or larger.

The internal soldering ends are designed so that they can be pushed directly onto the copper pipe without the use of fittings and joined by capillary soldering.

Vibraflex vibration absorbers are designed for a nominal pressure of 30 bar, the bursting pressure is at least three times the value of the nominal pressure. The nominal temperature range is -70 °C to +200 °C. All Vibraflex vibration absorbers are frost-proof.

Vibraflex vibration absorbers

Designs

Vibraflex vibration absorbers are supplied with different connection ends, either in metric or inch sizes. Vibraflex vibration absorbers are optionally available with extended internal soldering ends. The following designs are available ex stock:

- **VX 11** connection dimensions to DIN 2856, standard soldering ends
- **VX 12** connection dimensions to DIN 2856, extended soldering ends
- **VX 21** connection dimensions to ASME/ANSI/B 16.22, standard soldering ends
- **VX 22** connection dimensions to ASME/ANSI/B 16.22, extended soldering ends

Planning, installation, assembly

The installation instructions contain a full description of these essential points. The installation instructions in various languages are included with every consignment; further copies are available free of charge on request.

Description

Vibraflex vibration absorbers
Type VX … DN …
designed for a nominal pressure of PN 30
internal soldering ends to … (DIN or ASME/ANSI)
sealed in plastic film

Marking

Vibraflex vibration absorbers are marked with manufacturer’s mark, type, nominal pressure, year of manufacture, connection for outside diameter of pipe and, if relevant, PED marking.

Packaging

Individually in environmentally friendly plastic film.

Delivery

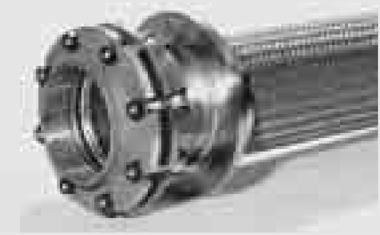
Ex stock, subject to prior sale.

Connection dimensions to DIN 2856					Type VX 11 standard soldering ends		Type VX 12 extended soldering ends	
DN	Connection for pipe OD							
–	d	s	l_1	D_1	NL ± 6	l_2	NL ± 6	l_2
–	mm	mm	mm	mm	mm	mm	mm	mm
8	10	1	9	14.0	200	16	280	56
10	12	1	10	16.5	220	20	320	65
12/15	15	1.5	12	19.1	250	23	360	78
12/16	16	1	12	19.1	250	25	360	78
16	18	1	14	23.6	250	29	360	80
20	22	1	17	28.5	280	32	400	92
25	28	1.5	20	35.5	320	38	450	103
32	35	1.5	25	44.3	360	41	500	110
40	42	2	29	53.8	450	50	560	105
50	54	2	34	66.2	500	65	630	130
65	76.1	2.5	37	84.2	630	71		
80	90	3	42	101.5	710	90		
100	108	3.5	55	121.0	800	110		

Connection dimensions to ASME/ANSI/B 16.22						Type VX 21 standard soldering ends		Type VX 22 extended soldering ends	
DN	Connection for pipe OD								
–	d		s	l_1	D_1	NL ± 6	l_2	NL ± 6	l_2
–	inches	mm	mm	mm	mm	mm	mm	mm	mm
8	$^3/_8$	9.5	1	8	14.0	200	16	280	56
10	$^1/_2$	12.7	1	10	16.5	220	20	320	70
12	$^5/_8$	15.9	1	13	19.1	250	23	360	78
16	$^3/_4$	19.1	1	16	23.6	250	25	360	80
20	$^7/_8$	22.2	1	19	28.5	280	32	400	92
25	$1^1/_8$	28.6	1.5	23	35.5	320	38	450	103
32	$1^3/_8$	34.9	1.5	25	44.3	360	41	500	110
40	$1^5/_8$	41.3	1.5	28	53.8	450	50	560	105
50	$2^1/_8$	54.0	2	34	66.2	500	65	630	130
65	$2^5/_8$	66.7	2.5	37	84.2	630	71		
80	$3^1/_8$	79.4	3	42	101.5	710	90		
100	$4^1/_8$	104.8	3.5	55	121.0	800	110		

Please quote when ordering: type, nominal diameter (DN)

Lance hoses for steel mills



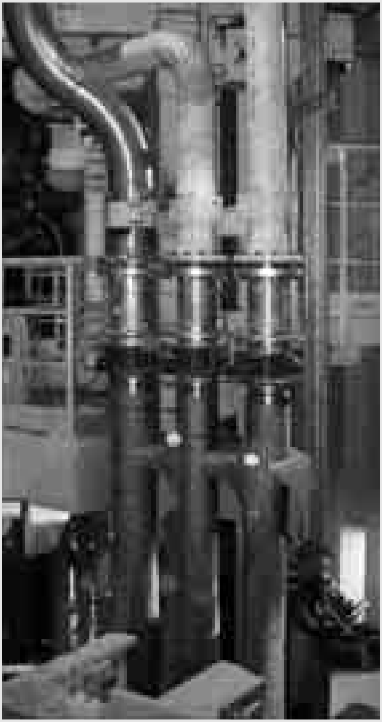
HYDRA annularly corrugated hose of stainless steel as flexible oxygen hose for blast lances in LD steel mills, with double braiding of stainless steel wire and inner interlocked-profile hose of stainless steel, flange connections at both ends with hinged bolts, sealing face with tongue or groove, support flanges at both ends if required. All parts coming into contact with oxygen of stainless steel, oil and grease-free.

Application

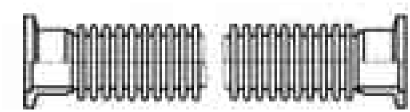
In steel production, the pig iron produced in the blast furnace is tempered to form steel in the converter. To do this, the so-called oxygen lance process is used in which a water-cooled lance blasts oxygen onto the melt at regular intervals.
This encourages combustion of excess carbon and part of the unwanted companion elements. This process is also referred to as oxidation.

The required movement of the lance over several metres in both vertical and horizontal direction is made possible by metal hoses that are installed in a 180° bend. The lance is fed cooling water and oxygen via separate hoses.
For the tough operating conditions in the steel mills, our special design HYDRA metal hoses guarantee the required endurance and safety.

Construction
The heavy-duty version RS 430 with braided braiding is almost always used for such applications because it is leak-proof against pressure and vacuum. If required, additional mechanical protection can be achieved by use of an outer interlocked profile hose. An inner hose with interlocked profile is predominantly used for the oxygen supply to improve the flow conditions and reduce pressure loss. It goes without saying that all parts in contact with the medium are made of stainless steel and have the necessary cleanliness. These hose assemblies have a length of around 20 metres in the nominal diameter range DN 80–300.
For the extremely important joint seam between connection fitting and corrugated hose, we have developed a special TÜV-tested welding process. The connection fittings are made individually to customer requirements, e.g. with support and hinged bolt flanges.



Hose assemblies for vacuum systems



Application

In vacuum systems, there are many applications for HYDRA annularly corrugated hoses. The high degree of flexibility of these hoses and the standardised design of the small flange connections allow easy and fast assembly and exchanging of hose assemblies on vacuum equipment in laboratories, test stands, research and development departments.

Construction

HYDRA annularly corrugated hose RS 331L00 of stainless steel 1.4541 and 1.4404, welded-on small flanges to DIN 28403 of stainless steel at both ends (special welding process without filler material).
Optionally, the high-flexibility hose types RS 321L00 of stainless steel 1.4541 or 1.4404 can be used.

Use for vacuum or positive pressure

HYDRA annularly corrugated hoses can also be used in ultra high vacuum applications. Stainless steel versions are heatable to 450°C (without seal). The hose assemblies are tested with a helium leakage test device, smallest verifiable leakage rate $\leq 5 \times 10^{-11}$ mbar l/s (vacuum method). Connection of HYDRA annularly corrugated hoses with small flanges is suitable for pressures of down to 10^{-9} mbar. Use of an additional supporting ring makes the hose assemblies suitable for positive pressures up to 1.5 bar.

Designs

According to customer specification: hose assemblies for vacuum applications can generally be supplied to customer specifications. E.g. with normal corrugation, high flexibility, annealed, non-annealed, tested according to requirement with the permissible maximum leakage rate.

Typical version

HYDRA annularly corrugated hose assembly RS 331L00, material 1.4404 stainless steel small flange at both ends to DIN 28403 with leakage test, leakage rate $\leq 10^{-9}$ mbar l/s (vacuum method) with approval certificate 3.1 (EN 10204), ultrasonically cleaned, closed ends, sealed in plastic film.

Cross-section of the connection end, burr and crevice-free design

Application

HYDRA stainless steel hoses type RS 341 are also especially suitable for use in the food and beverage industries. The ease of cleaning required for food and beverage applications is confirmed in an assessment carried out by the Faculty of Mechanical Engineering of the Technical University of Munich.
The need for easy, residue-free cleaning of the stainless steel hose was satisfied by optimising the corrugation geometry. All parts in contact with the medium are made of stainless steel. The hose is resistant to ageing, diffusion-proof, sterilisable, electrically conductive and welded to the connection fittings using a special joining process to ensure absence of burrs and crevices – see picture. It goes without saying that the threaded coupling for liquid foodstuffs to DIN 11851 is also included in the range. Please refer to page 94 for a detailed description and the available designs.
Please tell us your needs and requirements relating to your hose application in the food and beverage industry. Benefit from our years of experience and expertise with providing advice – we can quote and offer you the right hose from our large range of stainless steel hoses.

Miniature hoses

Witzenmann is the world's only manufacturer to produce metal hoses in very small diameters of 1.5 mm to 6 mm and very high quality. Both stripwound and pressure and diffusion-proof annularly corrugated hoses are available.

Depending on the field of application, miniature hoses are sheathed (for minimal invasive surgery), provided with an inner liner (for laser or optoelectronic applications) or special connections. Our miniature hoses are highly flexible, extremely resistant and absolutely non-ageing.

Versatility with maximum quality

The leader in quality

Heating, ventilation and air conditioning – an area in which Witzenmann has been supplying quality products for many years. Every day, Witzenmann products ensure reliable operation of heating and sanitary installations, guarantee the safety of gas services and enable the trouble-free air-conditioning of offices. Products as inconspicuous as they are indispensable.

The following is just a brief overview of our products for the heating, ventilation and air conditioning sector. We will be glad to send you more detailed information on request.

Stainless steel gas hoses to DIN 3384 with DIN-DVGW approval

Applications

According to the code of practice for gas installations (see DVGW leaflet G 260), gas appliances may also be connected using hoses of stainless steel with a nominal pressure of up to PN 16. The standard does not apply to gas services laid in the ground.

DIN 3384 contains details on

- hoses
- fittings
- braiding
- jackets, sleeves
- minimum bending radius
- nominal pressure categories, materials
- connections
- marking

Approvals
HYDRA RS series annularly corrugated hoses in the sizes DN 6 to DN 150 to DIN 3384 are approved for nominal pressures up to 16 bar (depending on diameter, type of connection and fittings). Owing to the very wide range of nominal diameters and the high nominal pressures, these flexible hoses are ideal for numerous applications.

All HYDRA annularly corrugated hoses for gas installations are tested to DIN 3384 and approved to DIN-DVGW standards. The technical specifications of these hoses can be found in section 4. Please note the nominal pressure categories prescribed in the DIN standard (see next page).

Reduction factor, service life, pressure loss
Details of reduction factors for calculating the permissible operating pressure in the case of higher operating temperatures or dynamic loads, plus service life and pressure loss figures can be found in section 7 “Selection, calculation, installation” (page 251).

Fittings
Fittings to DIN 3384 must be used to connect the flexible hose to the gas pipe. The table on page 223 is an extract from DIN 3384 which shows the permissible types of connection. This extract has been supplemented by those Witzenmann types described in detail in the section on corrugated hoses.

Stainless steel gas hoses to DIN 3384 with DIN-DVGW approval

Permissible operating pressures

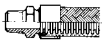
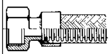
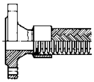
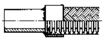
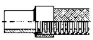
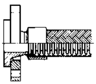
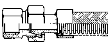
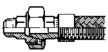
DN	standard corrugations Type	Connection Technique welded	 soldered
–		PN	PN
6	RS 331L00 RS 331L12	16 16	4 4
8	RS 331L00 RS 331L12	16 16	4 4
10	RS 331L00 RS 331L12	10 16	4 4
12	RS 331L00 RS 331L12	10 16	4 4
16	RS 331L00 RS 331L12	4 16	4 4
20	RS 331L00 RS 331L12	4 16	4 4
25	RS 331L00 RS 331L12	4 16	4 4
32	RS 331L00 RS 331L12	1 16 (4)*	1 1
40	RS 331L00 RS 331L12	1 16 (4)*	1 1
50	RS 331L00 RS 331L12	1 16 (4)*	1 1
65	RS 330L00 RS 330L12	1 16 (1)*	– –
80	RS 330L00 RS 330L12	1 16 (1)*	– –
100	RS 330L00 RS 330L12	1 16 (1)*	– –
125	RS 330L00 RS 330L12	1 16	– –
150	RS 330L00 RS 330L12 RS 330L42 RS 330L52	1 10 16 16	– – – –

DN	narrow corrugations/highly flexible Type	Connection Technique welded	 soldered
–		PN	PN
6	RS 321L00 RS 321L12	16 16	4 4
8	RS 321L00 RS 321L12	16 16	4 4
10	RS 321L00 RS 321L12	4 16	4 4
12	RS 321L00 RS 321L12	4 16	4 4
16	RS 321L00 RS 321L12	4 16	4 4
20	RS 321L00 RS 321L12	1 16	1 4
25	RS 321L00 RS 321L12	1 16	1 4
32	RS 321L00 RS 321L12	1 16 (4)*	1 1
40	RS 321L00 RS 321L12	1 16 (4)*	1 1
50	RS 321L00 RS 321L12	1 16 (4)*	1 1
65	RS 320L12	16 (4)*	–
80	RS 320L12	10 (1)*	–
100	RS 320L12	10 (1)*	–
125			
150			

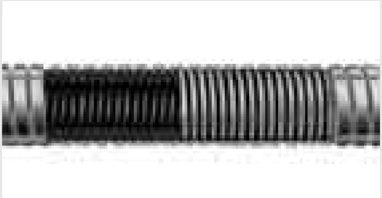
The figures in brackets apply to connections sealing in the thread.

Stainless steel gas hoses to DIN 3384 with DIN-DVGW approval

Extract from DIN 3384, May 1998 edition

No.	Type of connection		Remarks	Type of fitting	Page
1		Male thread to DIN 2999-1	PN 16 for ≤ DN 25 PN 4 for ≤ DN 50 PN 1 for > DN 50	**MH02S** **MH12S** **MH22S** **MH52S**	73 74 74 74
2		Female thread to DIN 2999-1	PN 16 for ≤ DN 25 PN 4 for ≤ DN 50 PN 1 for > DN 50	**LA12S** **LA22S** **LA52S**	71 71 71
3		Fixed flange, dimensions to DIN 2501-1	Flange thickness depends on nominal pressure and flange form	**GB12E** **GB22E**	70 70
4		Weld end to DIN 2559-1	Only for welded connection between hose and connection fitting	**UA12S** **UA22S** wall thickness to DIN 3239-1	95 95
5		Spigot, dimensions to DIN 2391-1	For non-soldered screw joint with tapping ring to DIN 2353	**UD12Q** **UD22Q**	96 96
7		Loose flange with collar or lap joint to DIN 2501-1	Flange thickness depends on nominal pressure and flange form	**AB12E** **AB22E** **AB82E** **CA82E**	67 67 69
8		3-part screw joint, conical seal, with female thread insert based on DIN EN 10242	PN 16 for ≤ DN 25 PN 4 for ≤ DN 50 PN 1 for > DN 50	**QB02S** **QB12W** **QB22W** **QB52W**	83 84 84 84
9		3-part screw joint, conical seal, with male thread insert based on DIN EN 10242	PN 16 for ≤ DN 25 PN 4 for ≤ DN 50 PN 1 for > DN 50	**RF02S** **RF12W** **RF22W** **RF52W**	88 89 89 89

Gas hose assemblies to G 260



HYDRA gas hose assembly
to DIN 3383-1, version M
inner hose stainless steel 1.4571,
outer hose stainless steel 1.4301
to DIN 3383-1

Properties, design

Absolutely gastight, flexible, rustproof and resistant to ageing. Outer hose protects against mechanical damage, soiling, excessive bending, buckling and tension.
Inner hose: all-metal stainless steel hose with helical corrugations.
Outer hose: stripwound metal hose, folded interlocked profile.

Approvals

HYDRA gas hose assemblies are approved for gases to DVGW leaflet G 260 and operating pressures of up to 100 mbar. These hose assemblies can be used to provide a flexible connection for gas appliances.
Gas hose assembly type GA is approved in more than 10 countries; we shall be delighted to provide you with a list on request.

Nominal lengths

The following standard lengths are available: NL 500, 800, 1000, 1250, 1500 mm.
Special lengths for industrial purposes are available on request.

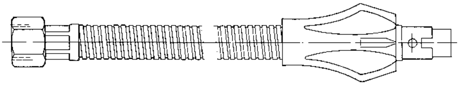
Marking

HYDRA safety gas hose assemblies are marked as follows:
manufacturer's ID
test ID (DIN-DVGW, ÖVGW, SVGW, ...)
type
version "M"

Packing

Packed individually in environmentally friendly PE film, complete with installation instructions, 50 pieces of the same length in cardboard box.

Safety gas hose assemblies to DIN 3383-1, version M, type GA 621

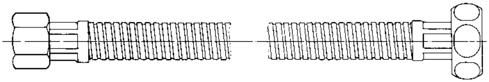


Type GA 621, one standard fitting, one hexagon socket
HYDRA safety gas hose assembly
to DIN 3383-1
version M
inner hose stainless steel 1.4571
outer hose stainless steel 1.4301

Gas supply end
Standard fitting with plastic grip, fits all connections to DIN 3383-1.

Gas appliance end
Nickel-plated brass hexagon socket
Rp $^{1}/_{2}$, to DIN EN 10226-1 (ISO 7/1), 24 AF.

Safety gas hose assemblies to DIN 3383-2, version M, types GA 611 and GA 641



HYDRA universal gas hose assembly
to DIN 3383-2
version M
inner hose stainless steel 1.4571
outer hose stainless steel 1.4301

Universal gas hose assemblies to DIN 3383-2, version M, types GA 611 and GA 641

Gas supply end
Type GA 611 with flat seal
Brass fitting with nickel-plated union nut G $^{7}/_{8}$ (ISO 228/1), 34 AF, with seal approved for universal gas use, fits conical shut-off valve to DIN 3533 or DIN 3534.

Type GA 611 with flat seal

Type GA 641 with conical seal
Brass fitting with nickel-plated union nut G $^{7}/_{8}$ (ISO 228/1), 34 AF, with O-ring seal approved for universal gas use, fits spherical shut-off valve to DIN 3435.

Type GA 641 with conical seal

Gas appliance end
Nickel-plated brass hexagon socket Rp $^{1}/_{2}$, to DIN EN 10226-1 (ISO 7/1), 24 AF.

Please note
These universal gas hose assemblies are available with different seal forms on the gas supply side. The gas supply valve governs the type of seal required.

Flat seal
universal gas hose assembly type GA 611 conical shut-off valve to DIN 3533 or DIN 3534, with flat seal

Conical connection
universal gas hose assembly type GA 641 spherical shut-off valve to DIN 3435, with conical connection

For further information, please request our publication 3356.

Drinking water supply hose

The HYDRA stainless steel safety supply hose (HY series) is approved by the DVGW for drinking water installations and hence provides an ideal connection between water supply and appliance in food and beverage applications.

The special design – inside a pressure-tight hose with annular corrugations, outside a protective interlocked profile hose plus standardised fittings – make these hoses very versatile. Bursting or leaks are impossible.

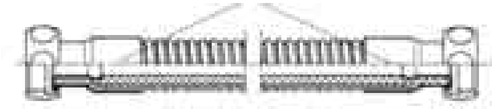
The corrugated profile of the inner hose causes turbulence in the water flow, which prevents deposits of lime or bacteria – the hose cleans itself!

Applications
- Washing machines
- Dishwashers
- Refrigerators with ice cube maker
- Food steamers
- Coffee and espresso vending machines

Advantages
- 10-year safety guarantee
- Suitable for drinking water
- Free from bacteria thanks to self-cleaning effect
- Flexible, pressure-tight and resistant to ageing
- Outer interlocked profile hose prevents buckling
- No reduction in cross-section when forming bends
- Excessive bending/buckling is impossible

For further information, please request our publication 3333.

Aspor hoses for kitchen and bathroom



Nickel- and chromium-plated high-performance shower hoses and accessories are marketed under the Aspor name. Their quality and efficiency has made them very popular with customers. Aspor hoses are extremely sturdy. Conceived for everyday professional applications, they can withstand pressures of up to 80 bar and tensile loads of up to 800 N while being twisted through 360°! They are also designed for use in constant operating temperatures of up to 70°C. And the Aspor hose also demonstrates outstanding performance in terms of buckling resistance. The inside bending radius of just 90 mm is possible without the hose deforming or losing its strength.

International approvals
One key element in our guarantee pledge is our comprehensive quality management. All processes are transparent and efficient. That begins with development, continues through the selection of suppliers and ends at accreditation to DIN EN ISO 9001:2000 and other standards. And because our products are used worldwide in all important markets, international approvals are standard for our products.

Hoses for the bathroom

Aspor Designline
Unusual, imaginative, futuristic – the new product line from Aspor adds a real eye-catcher to any bathroom or kitchen. Whether in the form of rectangular or triangular shower hoses or other, completely new technical concepts.

Triangular hose

Rectangular hose

Hoses for the kitchen

Applications
This sturdy spray hose is suitable for rinsing crockery in kitchens for restaurants, canteens, hospitals, etc.

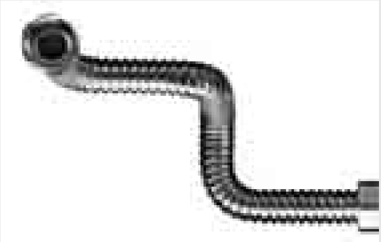
Properties
The following properties characterise the spray hose type GB 1:
- operating pressure 10 bar (max. 16 bar)
- operating temperature up to 90° C, approved for drinking water
- flexible, non-twisting, tension-resistant, high resistance to transverse compression

Design
The visible feature of the HYDRA spray hose type GB 1 is its stable, protective interlocked profile outer hose made from stainless steel 1.4301. The elastomer inner hose made from butyl rubber has KTW approval. The G 1/2 brass union nuts at both ends are chromium-plated.
Special versions are available on request.

The following standard lengths are available:
NL 1000, 1250, 1500, 1750, 2000, 2500 mm
Special lengths are available on request.

For further information, please request our publications 8303 and 8701.

Appliance pipework – connecting hoses



Applications

Flexible and semi-flexible connecting lines for supercharging pumps, furnaces, boilers, expansion vessels, storage tanks, roof hatches and solar energy pipework.

Design

- Version HX: flexible hose with annular corrugations, ideal for tight and multiple radii, easy to fit.
- Version IX: semi-flexible hose with high flexural stiffness which, once bent, remains in its bent form, patented corrugation form.

Technical features

- Nominal diameters optimised to reduce pressure losses
- Optimised corrugation form, ideal for use on furnaces and boilers
- Resistant to ageing and diffusion
- Supplied pre-bent in series: individually adapted to the respective application
- 3D bends possible at any point
- PE or EPDM insulation over the full length

For further information, please request our publication 3603.

Appliance pipework – flexible connections for solar connectors

Technical features

- Temperature range from -20°C to +200°C
- Can accommodate movement in all directions (axial, lateral, rotational)
- Supplied ready to install
- Guaranteed min. 10 000 load cycles
- Very simple installation: fast, no previous experience required
- Fewer seals
- Can be connected to standard copper pipe
- Suitable for any application (pressurised, unpressurised, large systems, single collectors, etc.)
- Non-soldered connection between flexible hose and copper pipe

Applications

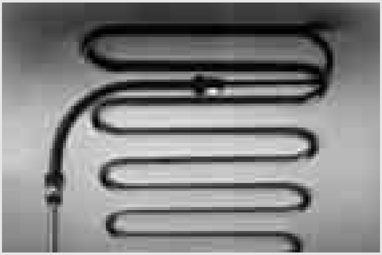
Flexible connections between individual solar collectors and between pipework and solar collector installation.

Design

Various components are used depending on the particular application and the specification of the solar energy system.

For further information, please request our publication 3604.

Cooling ceiling hoses



Properties

These cooling ceiling hoses – specially devised for hinged panels in cooling ceilings – unite all the advantages required for the pipework of such systems.

Witzenmann cooling ceiling hoses are characterised by the following special properties:

- cost-saving and flexible installation
- no buckling, no reduction in cross-section, high transverse compressive strength
- hose ends especially resistant to buckling, patented design
- medium-conveying lines fabricated entirely from stainless steel
- flame-resistant, thermally stable, no ageing and no embrittlement
- diffusion-resistant, hence trouble-free operation of control systems, no corrosion due to oxygen diffusion, no clogging
- interlocking fittings, no soldering/ welding – surfaces thus not spoiled by paint runs and scale
- supplied as a set, i.e. fittings do not need to be sealed subsequently

Design
Rustproof, austenitic stainless steel 1.4571/1.4404 is used for HYDRA cooling ceiling hoses.
The geometry of the corrugations – narrow, standard or wide – depends on the type of installation. Any nominal length can be supplied.

Hose rim with flat seal and brass union nut to both ends, non-asbestos seal and sealed push-in coupling are all standard. Brass threaded inserts with female or male threads or inserts with brass spigots (for push-in coupling DN 10/DN 12) can be supplied on request.
The complete hose assembly is factory-tested.

Sprinkler mounting systems
Time-consuming, rigid positioning of sprinklers is a thing of the past with the HYDRA sprinkler mounting systems. The flexibility of the stainless steel hose enables easy positioning within a radius determined by the length of the hose. In addition, it is easy to avoid obstacles near the sprinkler nozzle. A clamping collar enables the exact vertical and horizontal adjustment according to the specification of the nozzle manufacturer.

The benefits
The Witzenmann system permits the installation of the entire sprinkler system plus a leak test at operating pressure before the building finishes are applied. The sprinkler nozzles are positioned with the help of the special mounting immediately prior to completing the suspended ceiling. This system offers considerable advantages in terms of quality and time and hence reduces installation costs considerably. Costly water damage can be ruled out.

Design
HYDRA sprinkler mounting systems for suspended ceilings consist of a HYDRA stainless steel hose and a special mounting plus – if required – two adapter plates made from galvanised steel sheet.

The designs with FM and UL approval are available in size DN 25. HYDRA sprinkler hoses are factory-fitted with threaded fittings for connecting to the water supply pipes plus reducing sleeves for connecting to the sprinkler nozzles. Two versions for connecting to 3/8 inch and 1/2 inch nozzles are available.

Applications

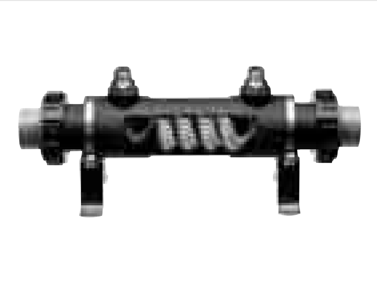
The VdS-approved system is available for:

- T-section lay-in ceilings
- plasterboard ceilings
- sheet metal panel ceiling systems
- clean-room ceiling systems
- diverse grid ceiling forms

The geometry of mounting and sheet metal adapters is adjusted to suit the respective ceiling system. Special solutions for other ceiling systems are available on request.

For further information, please request our publication 3360.

Heat exchangers



The type of metal hose corrugation influences the degree of efficiency, or rather the flow rate. Whether a deep corrugation for maximum efficiency or a shallow corrugation for good form stability, or a combination of both in one component, Witzenmann can satisfy all specifications.

Flexible stainless steel hoses for heat exchangers

The efficiency of Witzenmann heat exchangers with corrugated hoses offers several advantages over models with conventional, plain pipes, primarily because of the larger surface area due to the corrugations, which enables a better heat transfer. The large surface area and ribbed geometry offer good condensation characteristics (e.g. for condensing boilers).

Better performance in less space

Furthermore, the metal hose results in a more compact and hence lighter design because the use of a corrugated hose leads to an approx. 50% improvement in efficiency. This means that a much smaller heat exchanger can match the performance of a large model, or considerably more output is possible from an exchanger of the same size.

Turbulence to combat deposits

Apart from that, the corrugated profile leads to turbulence that constantly swirls and varies the flow of water. This means that the heat exchanger is further optimised and hence also its efficiency. Other advantages: deposits of lime and dirt have no chance to accumulate because particles are constantly rinsed away by the turbulence. The result is a constant output over the entire life of the heat exchanger.

Stability at high temperatures

Heat exchangers with corrugated stainless steel hoses can be used over a wide range of temperatures. From 90°C in swimming pool heat exchangers to more than 1000°C when used as primary heat exchangers in the flame zone. These heat exchangers are also unaffected by temperature shocks.

Bespoke housing

The housing has a considerable influence on the degree of efficiency of a heat exchanger. As a manufacture of complete systems, Witzenmann is in the position to adapt the housing to the customer's specification. Whether with the length scaled up or down, in metal or plastic, with various connections for different inlets and outlets.

Heat exchanger applications

The main applications for Witzenmann compact heat exchangers are:

- heating of process water (drinking water)
- heating or cooling in recirculating systems
- heating of swimming pool water
- system isolation in underfloor heating systems
- conversion in district heating and solar energy systems
- cooling and condensing exhaust gases

For further information, please request our publication 1347.

From prototypes up to large-scale production

Vehicles with diesel or petrol engines require flexible metal hose assemblies for a wide range of different applications. Installed in the exhaust system or used as conduits right on the engine, they absorb thermal expansion and isolate vibrations and movements from the rest of the piping system.

Exhaust gas decoupling elements
Short, supporting elements are used for installation chiefly close to the engine in order to achieve almost total isolation, with highly flexible elements available in a range of specifications. If requirements in terms of leak-tightness are less exacting, then stripwound hoses (in various designs) can be used.

Exhaust and oil return pipes
These are used for reducing harmful emissions from engines and to keep both engines and turbochargers supplied with oil and water. They compensate for thermal expansion, for assembly tolerances, for vibrations and for movements of the assembly – even at extreme temperatures.

Flexible piping systems
These are a combination of both rigid and flexible components for use as a pressure-tight system in gas and/or liquid circuits. They combine simple fitting with reliable compensation for assembly tolerances and movements of the assembly in situations where safety is at a premium.

Decoupling elements for vehicle engineering
Special metal hoses are used in motor vehicles to achieve isolation from large movements and engine vibrations. Usable throughout the entire exhaust system, they absorb angular, lateral and axial movements.

Design forms
Hose assembly with:
- exterior braiding
- outside wire mesh
- liner
- interior braiding

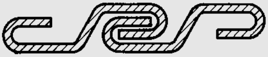
Technical properties
- Gas-tight (to defined technical levels)
- Element with damping properties thanks to stripwound-hose liner
- Flow routing by means of stripwound-hose liner / interior braiding
- Thermally stable through selection of suitable materials
- Currently available in all standard connection diameters and lengths
- Geometric and technical properties can be adjusted to suit each customer's specific installation situation

Stripwound hose with interlocked profile type FA

Stripwound hose with interlocked profile Type FA

This hose type is an especially cost-effective version for applications where slight leakage is permissible. The advantage of this hose lies in its lack of susceptibility to torsional movements. It is used in the exhaust systems of lorries, buses, construction machines and forklifts.

Design



The special interlocked profile makes the hose highly robust and gives it a defined bending radius.

Technical properties

- Isolation from large movements of the exhaust system and from angular, lateral and axial vibrations of the engine
- Not susceptible to torsional movements Optimized, interlocked profile for minimum leakage
- Element with damping properties
- Currently available in all standard nominal widths and lengths
- Geometric and technical properties can be adjusted to suit each customer's specific installation situation

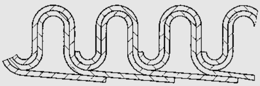
Stripwound hose with interlocked profile type SW 310

Stripwound hose with corrugated profile Type SW 310

These special designs are used in lorries. Provided with fitting end connections, they absorb movements and vibrations.

Design

Exhaust gas stripwound hose with corrugated profile



With its special overlapping profile, the hose effectively routes the flow of exhaust gas.

Technical properties

- Isolation from movements of the exhaust system and from angular, lateral and axial vibrations of the engine
- Not susceptible to torsional movements
- Corrugated profile for minimum leakage
- Profile with integrated flow routing
- Element with damping properties
- Currently available in all standard nominal widths and lengths
- Geometric and technical properties can be adjusted to suit each customer's specific installation situation

Stripwound hose with interlocked profile type SW 380

Stripwound hose with corrugated profile Type SW 380

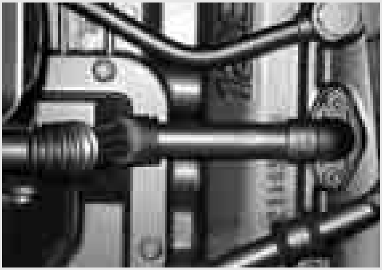
The SW 380 is used where greater gas-tightness is required. Serving as a flexible element in vans, tractors, construction machines and lorries, it absorbs movements and vibrations.

Design

The continuous corrugated profile ensures gas-tightness (to defined technical levels).

Technical properties

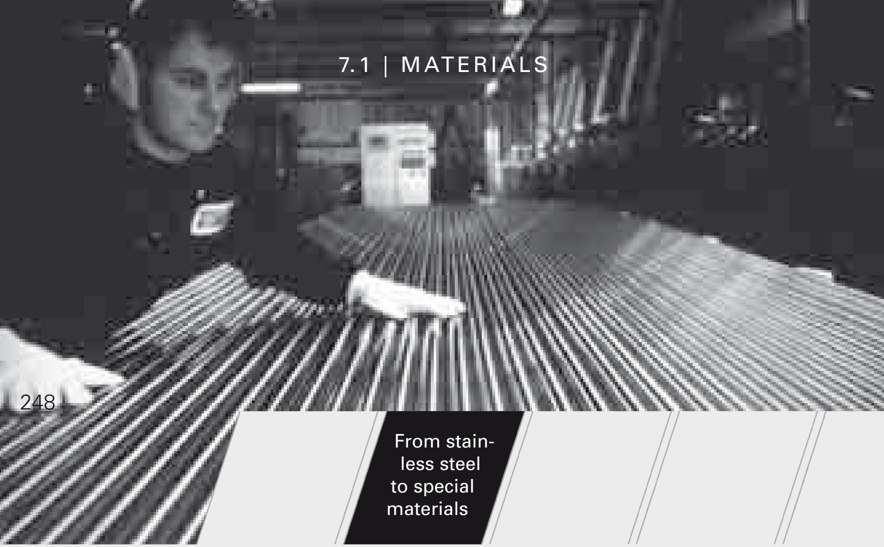
- Isolation from movements of the exhaust system and from angular, lateral and axial vibrations of the engine
- Not susceptible to torsional movements
- Corrugated profile makes it sufficiently gas-tight (to defined technical levels)
- Currently available in all standard nominal widths and lengths
- Geometric and technical properties can be adjusted to suit each customer's specific installation situation



Exhaust and oil return pipes
Flexible and semi-flexible exhaust and oil return pipes are used especially for applications close to the engine (in both diesel and spark-ignition engines). They are diffusion- and pressure-tight, and resistant to both heat and corrosion.

Design
- Version as per customer specification, usually with corrugated section
- Elbow serves as plain pipe elbow or as bend in corrugated section
- Connection by means of flange, V-shaped rim connection or as per customer specification
- With or without insulation

Technical properties
- Compensation for vibrations, thermal expansion, assembly tolerances
- Gas-tight (to defined technical levels) thanks to metal bellows
- Thermally stable through selection of suitable materials
- Corrosion-resistant through selection of suitable materials
- Lightweight design



From stainless steel to special materials

The choice of material is particularly important for the metal hose. As a flexible conducting system, it is frequently required to work elastically under extreme operating conditions and – with its smaller wall thicknesses compared to rigid pipes – must be especially resistant to corrosion.

Suitable materials for manufacture of metal hoses must, depending on the application, therefore meet the following requirements:
- particularly suitable for cold forming
- good strength characteristics
- high temperature resistance
- optimal corrosion resistance
- high operational reliability.

There is no single material that meets all of the demands that arise in practice. Previous experience shows that the materials used in our HYDRA range of hoses cover a broad spectrum of needs, especially the stainless steel grades with material nos. 1.4541 and 1.4404. Furthermore, it is generally possible to find a hose material that is suitable for applications in which corrosion is a particular concern.

For information about the corrosion resistance of individual materials, we recommend that you refer to the DECHEMA material data sheets, the data sheets of the manufacturers of steel and non-ferrous metals and the resistance table in Appendix B of this manual.

All the materials are cold formed; the work hardening that occurs during this process supports the development of properties relating to flexibility. Subsequent heat treatment is therefore unnecessary and can even be disadvantageous.

For all combinations of materials, appropriate brazing and welding filler materials are available for joining the hose to the connection fittings.

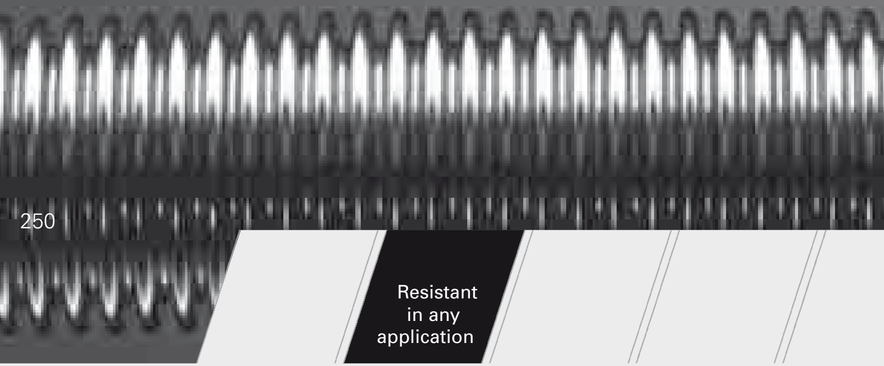
Appendix A of this manual gives a summary of the most common materials for the manufacture of metal hose assemblies, both for standard and special applications. The list is divided into:

- Designations, available types
- Upper temperature limits
- Strength values at ambient temperature
- Chemical composition
- Comparable international standards
- Strength values at higher temperatures.

The list is not complete, but serves approximate comparison and gives a general overview. The standards listed are extracts, the respective latest version of the stated standards is binding.

Welding of corrugated hoses

Selection of length, permissible deviations



Resistant in any application

The following guidelines are recommended for selection of the length of individual hoses:

Corrugated metal hoses
Annularly corrugated hoses with or without braiding are measured when laid out straight and without internal pressure.

Metal stripwound hoses

Protective hoses
Types SA, SD, SG, SV, SZ are measured in the extended position (up to the stop).

Feed and suction hoses

- Types FA, FG, FS with or without seal are measured in the extended position (up to the stop).
- Types SD, SV, FG, FS with rubber seal are measured in the mean position of the movable profile convolutions.

(The hose is rolled together as far as the stop and then stretched out straight again).

Permissible deviations
The nominal length (NL) relates to a hose provided with connection fittings and describes the overall length of the hose. Unless otherwise agreed when ordering, the following permissible length deviations should be taken into account when determining the nominal length:

Nominal length in mm	Permissible length deviation
up to 500	+ 10 mm – 5 mm
over 500 up to 1000	+ 15 mm – 10 mm
over 1000	+ 1.5% – 1.0%

Smaller length tolerances are possible but must be specifically agreed when ordering.

Reduction factors for higher operating temperature
The permissible operating pressures given for metal hoses and connection fittings in the tables of this manual apply to operating conditions at ambient temperature (20 °C). At higher operating temperatures, these operating pressures must be reduced.

In many cases, metal hose assemblies must be of a design that conforms to PED 97/23/EC, the associated product standard EN 14585 as well as supporting standards such as DIN EN ISO 10380. Among other materials, the latter specifies reduction factors for stainless steels at higher operating temperatures. For metal hose assemblies for which the reduction is not specified in ISO 10380, the reduction in operating pressure needs to be calculated by means of the fall in high-temperature strength, the strength characteristic values being those specified by the material manufacturer or validated measurements from our own material tests.

The following table gives an overview of the respective pressure reduction factors for the most frequently used materials. Strength values for other materials can be found in Appendix A.

Parameter		Temperature °C											
		20	50	100	150	200	250	300	350	400	450	500	550
		Reduction factors											
Material	**1.4306**	1.00	0.89	0.72	0.64	0.58	0.54	0.50	0.48	0.46	0.44	0.43	0.43
	1.4301	1.00	0.90	0.73	0.66	0.60	0.55	0.51	0.49	0.48	0.46	0.46	0.46
	1.4541	1.00	0.93	0.83	0.78	0.74	0.70	0.66	0.64	0.62	0.60	0.59	0.58
	1.4404 **1.4435**	1.00	0.90	0.73	0.67	0.61	0.58	0.53	0.51	0.50	0.49	0.47	0.47
	1.4401	1.00	0.91	0.78	0.70	0.65	0.61	0.57	0.55	0.53	0.52	0.51	0.50
	1.4571	1.00	0.92	0.80	0.76	0.72	0.68	0.64	0.62	0.60	0.59	0.58	0.58
	Bronze	1.00	0.95	0.90	0.80	0.75	0.70						

Reduction factors at higher temperatures

Material requirements for low-temperature applications
EN 14585 essentially permits the use of stainless steels down to -200 °C in accordance with the following table, although the material 1.4301 is allowed only as braiding material. In addition, only the materials 1.4306 and 1.4435 may be used down to -270 °C.

Note 1: The revision of product standard EN 14585 has already been started with its publication.

Note 2: The regulations harmonized in accordance with PED include, among others, the AD 2000 set of rules. Under AD 2000-W10, the materials 1.4541 and 1.4571 can be used down to -270 °C, while a notched bar impact test at -196 °C is specified. When applying the AD 2000 set of rules, it is important to understand its overall concept.

Conversion of operating pressure to standard conditions at 20 °C

$$\boxed{p_{20\,°C} = PS/k_t}$$

$p_{20\,°C}$ = operating pressure converted to standard conditions at 20 °C in bar

PS = permissible operating pressure at operating temperature TS in bar

k_t = temperature reduction factor; values from table on page 251

Calculation example
HYDRA annularly corrugated hose, DN 50
Operating temperature TS: 200 °C
Operating pressure PS: 13 bar

Temperature reduction factor
for 1.4301 : k_t = 0,60
(apply lowest value of hose or braiding, table on page 251)

$$\boxed{p_{20\,°C} = PS/k_t}$$

$p_{20\,°C}$ = 13/0.60 = 20.7 bar

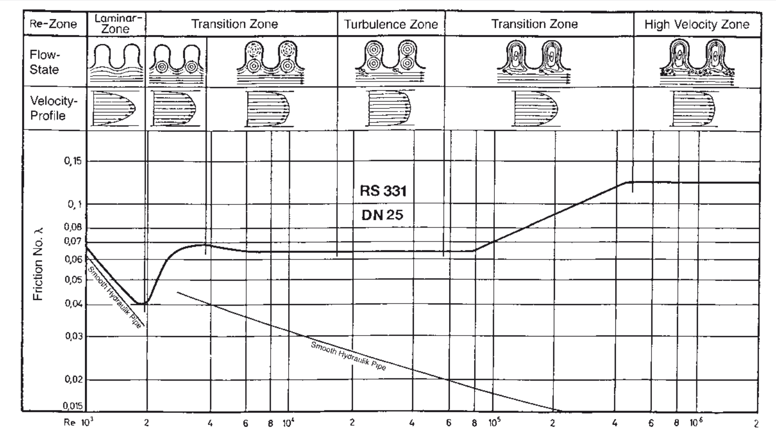
The nominal pressure level of a suitable metal hose must be at least as great as the converted operating pressure, e.g. RS331L12, DN 50, **PN 25**.

Pressure loss
Metal hoses are used to transport substances of different consistency (solid, liquid, gaseous). Pressure loss is an important factor for the configuration and dimensioning of such conducting systems. Under equal flow conditions, pressure loss in metal hoses is significantly greater than in rigid pipe systems. This is due to the profiling of the hoses in the circumferential direction, which – depending on the Reynolds number – can have a decisive influence on the flow characteristics. The theoretical model distinguishes three flow states (above the laminar zone):

- The **turbulence zone** where primary and secondary vortices form in the corrugation spaces
- The **transition zone** where turbulence drag arises at the inner rims and having a decisive influence on the central flow.
- The **high-velocity zone** where the individual zones of turbulence drag between the inner rims interact with each other.

Primary and secondary vortices in the turbulence zone of a HYDRA annularly corrugated hose (factory image).

Pressure loss



Coefficient of friction depending on flow state

The pressure loss is calculated according to the formula:

$$\Delta p = \left(\lambda \frac{l}{d} + \zeta_b\right) \cdot \frac{\rho}{2} c^2$$

Δp	= pressure loss	in pascal	ζ_b	= resistance number in bent state	–
λ	= coefficient of friction	–	ρ	= density of the fluid	in kg/m³
l	= real hose length	in mm	c	= flow velocity	in m/s
d	= hose inside diameter	in mm			

The coefficient of friction λ depending on flow state was determined experimentally for HYDRA corrugated hoses.

In the following diagrams, λ is stated as a function of the Reynolds' number for various hose types. This comparison characteristic describes the flow state through geometry, velocity and medium. The coefficient of friction can be calculated using the following equation:

$$\boxed{Re = \frac{c \cdot d}{10^3 \cdot \nu}}$$

Re	= Reynolds' number	–
ν	= kinematic viscosity	in m^2/s

The particular significance of the Reynolds' number lies in the fact that it can be used to define the flow state of any medium you wish at a wide range of temperatures and flow velocities.

The resistance number ζ for additional deflection losses describes the resistance of bent hoses due to shape. It is primarily dependent on the deflection angle.

$$\boxed{\zeta_b = \zeta \frac{\alpha}{180}}$$

ζ	= resistance number in a 180° bend	–
ζ_b	= resistance number in the bent state	–
α	= deflection angle of the hose	$\measuredangle$ °

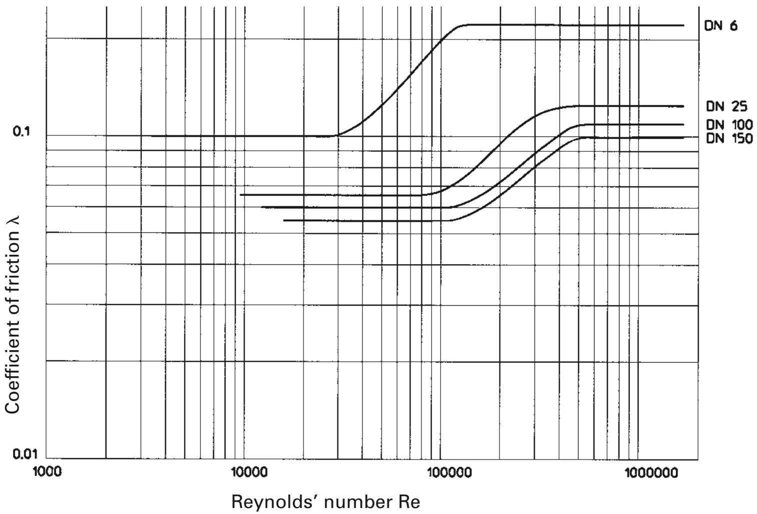
The resistance number ζ depending on the ratio of bending radius to nominal diameter was determined experimentally for HYDRA corrugated hoses. This is true for the 180° bend and is portrayed in the following diagrams.

For a rough estimate, it can be assumed that the pressure loss in corrugated hoses in the turbulence zone is around 150% higher than in new welded steel pipes. I.e. the diameter of a corrugated hose would have to be increased by 20% to equal the pressure loss of steel pipe. In the high-velocity zone, corrugated hoses are around 450% higher due to the marked vortex activities; in this case, a diameter increase of 41% would be necessary.

Pressure loss

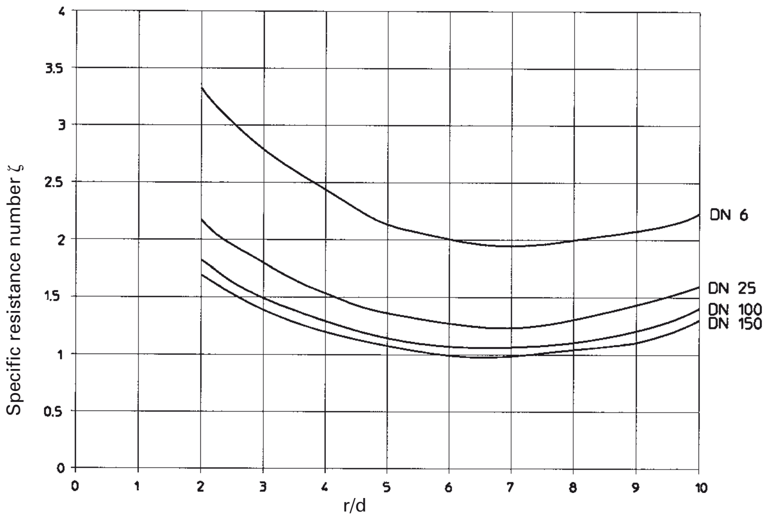
Coefficient of friction λ for type RS 331/330

Diagram for determining the coefficient of friction λ for calculation of pressure loss



Specific resistance number ζ for type RS 331/330

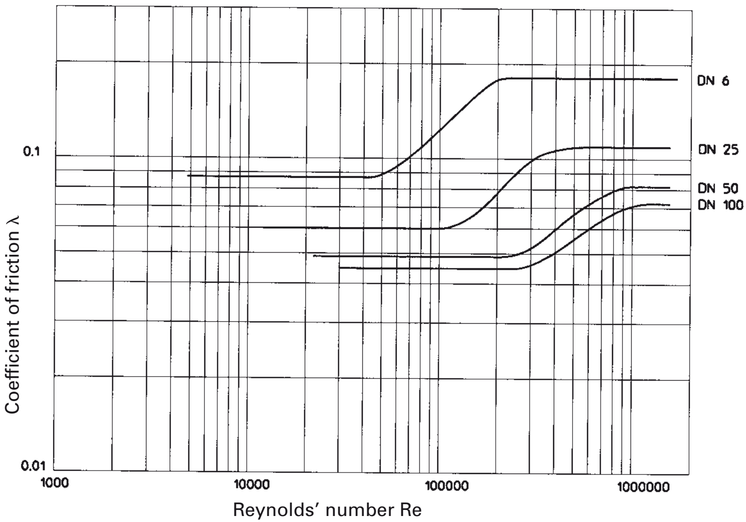
Diagram for determining the specific resistance number ζ for calculation of pressure loss



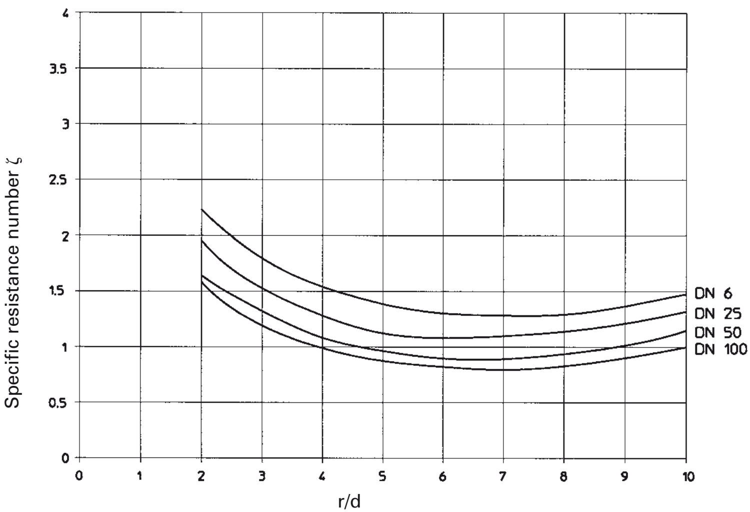
Pressure loss

Coefficient of friction λ for type RS 321/320

Diagram for determining the coefficient of friction λ for calculation of pressure loss



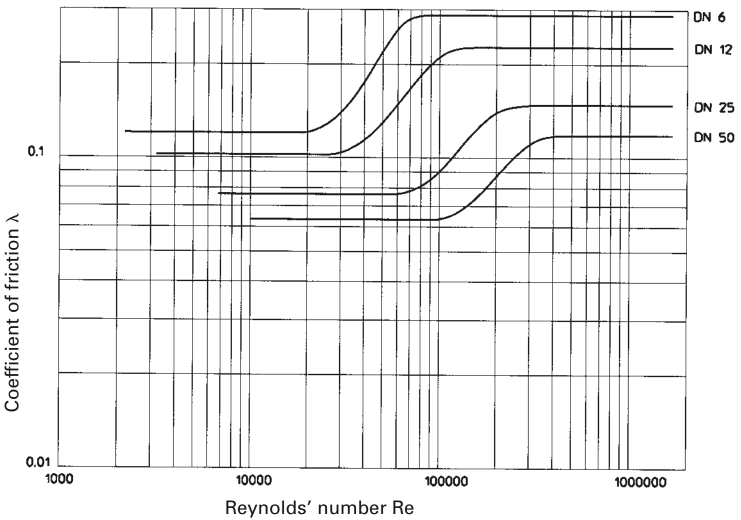
Specific resistance number ζ for type RS 321/320
Diagram for determining the specific resistance number ζ for calculation of pressure loss



Pressure loss

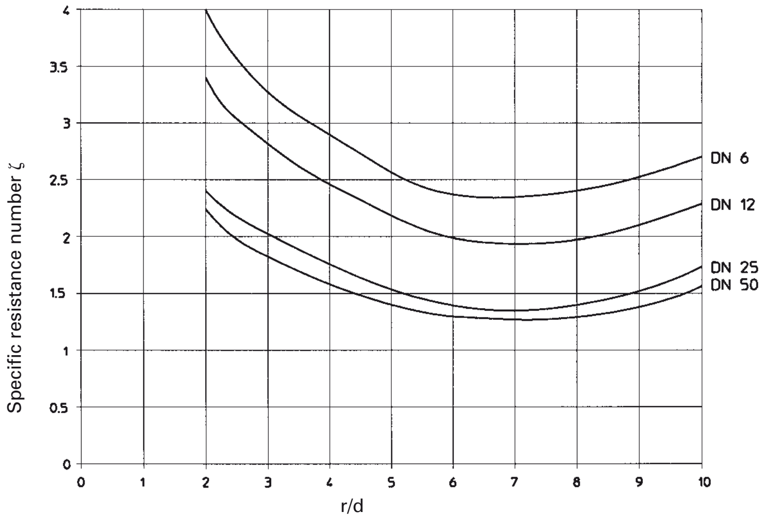
Coefficient of friction λ for type RS 341

Diagram for determining the coefficient of friction λ for calculation of pressure loss



Specific resistance number ζ for type RS 341

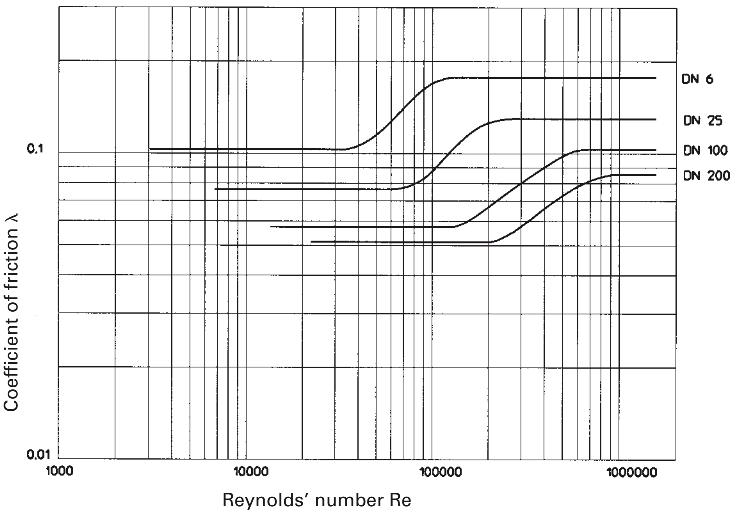
Diagram for determining the specific resistance number ζ for calculation of pressure loss



Pressure loss

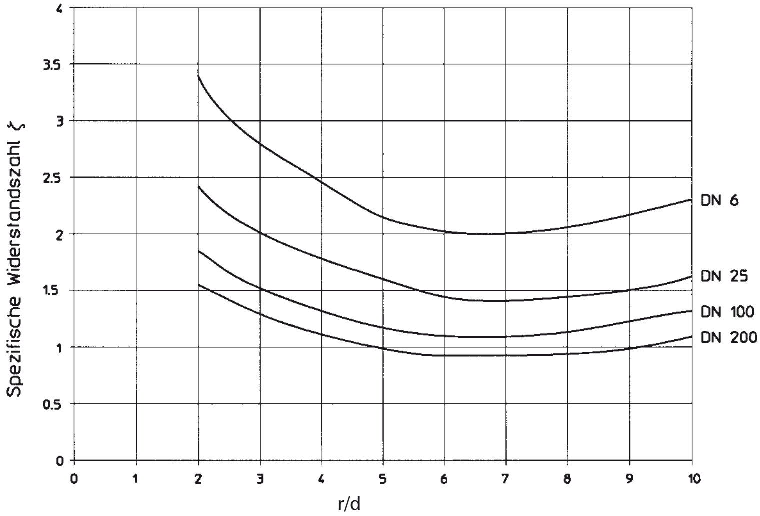
Coefficient of friction λ for type RS 531/430

Diagram for determining the coefficient of friction λ for calculation of pressure loss



Specific resistance number ζ for type RS 531/430

Diagram for determining the specific resistance number ζ for calculation of pressure loss



Pressure loss

Calculation example

Operating conditions
Fluid: organic thermal medium
Flow velocity: $c = 1$ m/s
Operating temperature: $t = 300$ °C
Density at operating temperature:
$\rho = 827$ kg/m^3
Kinematic viscosity at
operating temperature: $\nu = 0{,}5 \cdot 10^{-6}$ m^2/s

Installation conditions
Hose type: RS 331 DN25
Hose inside diameter: $d = 25.5$ mm
Real hose length: $l = 1300$ mm
Deflection angle: $\alpha = 90°$
Bending radius: $r = 260$ mm

Wanted is the pressure loss in pascal

Coefficient of friction λ

$$\boxed{Re = \frac{c \cdot d}{10^3 \cdot \nu} = 51000}$$

From the diagram of coefficients of friction λ for RS 331, the result for Re 51000 and DN 25 is
$\lambda = 0.067$

Resistance number ζ

From the diagram of specific resistance numbers ζ, the result for RS 331 is:

$$\frac{r}{d} = 10.2 \text{ and DN } 25$$

$$\zeta = 1.6$$

The resistance number ζ_b is therefore

$$\zeta_b = \zeta \cdot \frac{\alpha}{180} = 0{,}8$$

Pressure loss Δp

$$\Delta p = \left(\lambda \cdot \frac{l}{d} + \zeta_b\right) \cdot \frac{\rho}{2}\, c^2 = 1743 \text{ pascal}$$

Absorption of mechanical movements
To absorb larger mechanical movements, metal hose assemblies are installed in a 180° bend (U-bend). To achieve correct functioning and a long service life of corrugated hose assemblies installed in a 180° bend, it is particularly important to observe the following points:

1. **Correct nominal length**

2. **Required installation distance** taking account of permissible bending radius

3. **Proper installation**

Essentially, hose assemblies installed in a 180° bend can cope with mechanical movements in two directions, horizontal and vertical movement. In addition, the hose assembly installed in a 180° bend can be in a vertical or horizontal arrangement, depending on the installation situation, although the vertical arrangement is preferable. With the horizontal arrangement, it is necessary in most cases to provide support to prevent sagging of the hose.

To determine the nominal length, it is first necessary to check what installation arrangement is best for the particular situation. The appropriate formula is then used to calculate the required nominal length. The formulae take account of a sufficient length allowance for neutral hose ends for preventing movement and bending stress immediately after the connection fittings. To take full advantage of the length of the hose assembly, the fixed end of the hose assembly should lie exactly in the middle of the movement.

The installation distance
($e = 2 \cdot r$) of the 180° bend has a major effect on the service life of hose assemblies. Bends of less than the permissible bending radius always reduce the number of load cycles and therefore service life of the hose can withstand. The permissible bending radius depends on the pressure and the required number of load cycles.

Absorption of mechanical movements

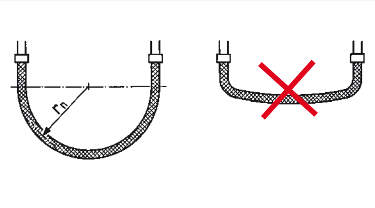
On installation, it is essential to ensure the hose assembly is installed without any twisting stress. It must not be subjected to twisting forces through assembly or through the subsequent movements, otherwise service life can be dramatically shortened. It is important to make sure the two ends of the hose assembly and the movement are all in one plane.

To guarantee installation without twisting stress, the hose assembly should in the first instance be only loosely fastened at one of the ends. The subsequent mechanical movement should then be performed 2 to 3 times with the hose empty to allow the hose assembly to settle into a torsion-free position, and only then tighten the fitting. If you are using threaded fittings, it is essential to use a second spanner to brace the end of the hose.

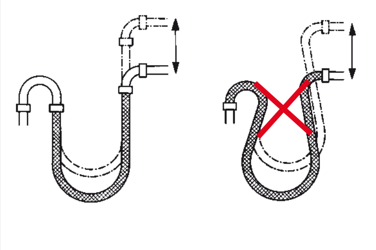
It is especially important to make sure the hose assemblies do not come into contact with each other or surrounding objects (parts of the machine, concrete shaft, etc.) during operation.

Corrugated hoses in a multiplaten press

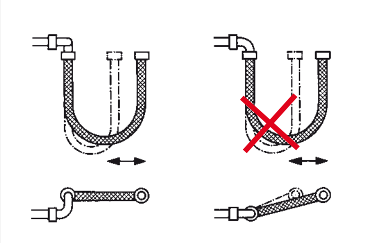
Example 1
Install hose assembly as 180° bend with sufficient neutral hose ends. The length is determined in accordance with the HYDRA formula for 180° bends. Determine the installation distance in accordance with the permissible bending radius.



Example 2
Rigid pipe can be used immediately after the connection fittings to avoid tight bends. Take account of the permissible bending radius.

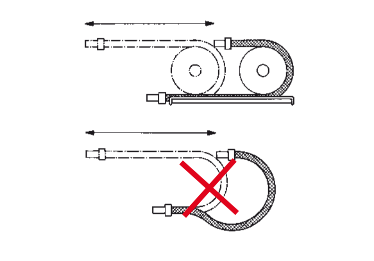


Example 3
Direction of movement and hose axis must be in one plane. This arrangement avoids damaging torsional stress.

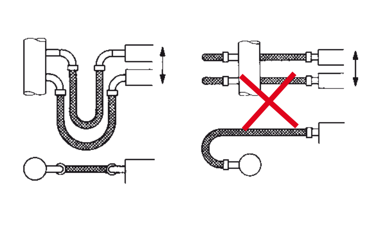


Absorption of mechanical movements

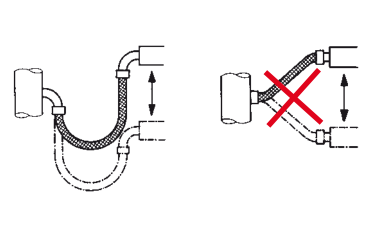
Use a support to protect the hose assembly from sagging and to prevent kinks after the connection fittings. A travelling roller or guide chain may be necessary.



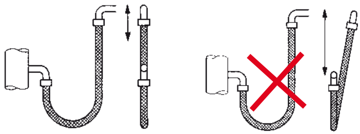
Example 5
Use rigid pipes to minimise bending stress and prevent torsion.



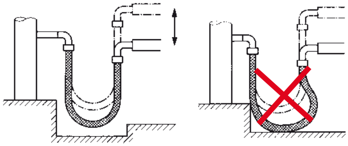
Example 6
Use rigid pipes to avoid alternating bending stresses and tight curves immediately after the connection fittings.



Example 7
Direction of movement and hose bend lie in one plane. This arrangement avoids damaging torsional stress.



Example 8
Arrange hose assembly as freely hanging bend so that it does not come into contact with the wall or other objects or with the floor during the movement.

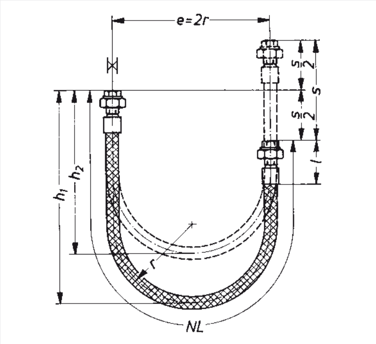


Calculation of metal hose assemblies for installation as 180° bend for large amplitude and low frequency. **Vertical 180° bend for vertical movement.**

$$NL = 4\,r + \frac{s}{2} + 2\,l$$

$$h_1 = 1.43\,r + \frac{s}{2} + l$$

$$h_2 = 1.43\,r + l$$



Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, threaded fitting at both ends with cone seal type QB02S

r = 190 mm
s = 320 mm
l = 88 mm

$$NL = 4 \cdot 190 + \frac{320}{2} + 2 \cdot 88 = 1096 \text{ mm}$$

rounded up = 1100 mm

e = 2 · 190 = 380 mm

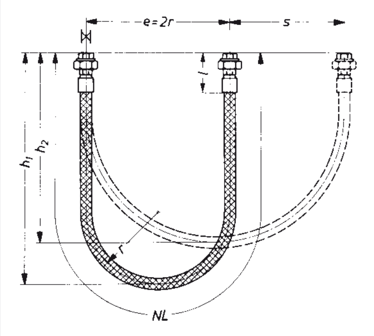
r	=	bending radius (the values can be found in the tables of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h_1	=	max. height of the 180° bend	mm
h_2	=	min. height of the 180° bend	mm
s	=	stroke	mm
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 180° bend for large amplitude and low frequency. **Vertical 180° bend for horizontal movement.**

$$NL = 4\,r + 1.57\,s + 2\,l$$

$$h_1 = 1.43\,r + 0.785\,s + l$$

$$h_2 = 1.43\,r + \frac{s}{2} + l$$



Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, threaded fitting at both ends with cone seal type QB02S

$r = 190$ mm

$s = 300$ mm

$l = 88$ mm

$NL = 4 \cdot 190 + 1.57 \cdot 300 + 2 \cdot 88$
$= 1407$ mm
rounded up = 1410 mm

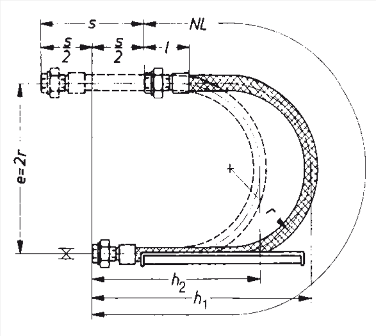
r	=	bending radius (the values can be found in the tables of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h_1	=	max. height of the 180° bend	mm
h_2	=	min. height of the 180° bend	mm
s	=	stroke	mm
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 180° bend for large amplitude and low frequency. **Vertical 180° bend for horizontal movement.**

$$NL = 4\,r + \frac{s}{2} + 2\,l$$

$$h_1 = 1.43\,r + \frac{s}{2} + l$$

$$h_2 = 1.43\,r + l$$



Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, threaded fitting at both ends with cone seal type QB02S

r = 190 mm
s = 320 mm
l = 88 mm

$$NL = 4 \cdot 190 + \frac{320}{2} + 2 \cdot 88$$

= 1096 mm
rounded up = 1100 mm

e = 2 · 190 = 380 mm

r	=	bending radius (the values can be found in the tables of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h_1	=	max. height of the 180° bend	mm
h_2	=	min. height of the 180° bend	mm
s	=	stroke	mm
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 180° bend for absorption of mechanical movements from 2 directions for large amplitude and low frequency.
Vertical 180° bend for absorption of mechanical movements from 2 directions.

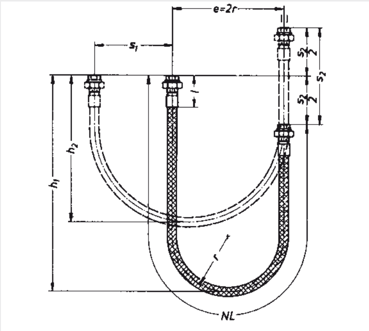
$$NL = 4\,r + 1.57\,s_1 + \frac{s_2}{2} + 2\,l$$

$$h_1 = 1.43\,r + 0.785\,s_1 + \frac{s_2}{2} + l$$

$$h_2 = 1.43\,r + \frac{s_1}{2} + l$$

Example
Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, threaded fitting at both ends with cone seal type QB02S

r = 190 mm
s_1 = 100 mm
s_2 = 210 mm
l = 88 mm
$NL = 4 \cdot 190 + 1.57 \cdot 100 + \frac{210}{2} + 2 \cdot 88$
= 1198 mm
rounded up = 1200 mm



r	=	bending radius (the values can be found in the tables of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h_1	=	max. height of the 180° bend	mm
h_2	=	min. height of the 180° bend	mm
s_1	=	stroke	mm
s_2	=	stroke	mm
NL	=	nominal length	mm

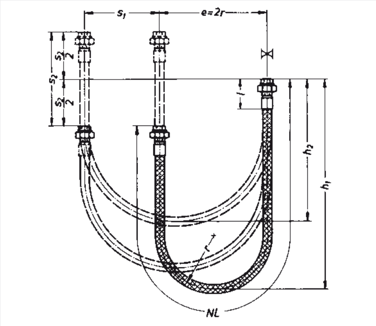
Absorption of mechanical movements

Calculation of metal hose assemblies for installation as 180° bend for absorption of mechanical movements from 2 directions for large amplitude and low frequency.
Vertical 180° bend for absorption of mechanical movements from 2 directions.

$$NL = 4\,r + 1.57\,s_1 + \frac{s_2}{2} + 2\,l$$

$$h_1 = 1.43\,r + 0.785\,s_1 + \frac{s_2}{2} + l$$

$$h_2 = 1.43\,r + \frac{s_1}{2} + l$$



Example
Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, threaded fitting at both ends with cone seal type QB02S

r	=	190 mm
s_1	=	100 mm
s_2	=	210 mm
l	=	88 mm
NL	=	$4 \cdot 190 + 1.57 \cdot 100 + \frac{210}{2} + 2 \cdot 88$
	=	1198 mm
		rounded up = 1200 mm

r	=	bending radius (the values can be found in the tables of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h_1	=	max. height of the 180° bend	mm
h_2	=	min. height of the 180° bend	mm
s_1	=	stroke	mm
s_2	=	stroke	mm
NL	=	nominal length	mm

Absorption of thermal expansion
Expansion through temperature increase is a physical process that causes an increase in length and volume in solid bodies, liquids and gases. It is reversible (contraction on cooling) and can be repeated any number of times. Length changes that occur in nature as a result of diurnal and seasonal temperature changes are mostly small and can generally cancel each other out.

The situation is different with pipes that carry hot or cold media. In this case, there can be large length changes, which must be taken into account in the planning of pipe networks in addition to the correct dimensioning of pipe sections depending on flow volume, pressure and temperature.

If longitudinal expansion is not compensated, considerable compressive strains can occur in the wall of a pipe fixed at both ends in the hot state, irrespective of the operating pressure. Pipes of small diameter can bend sideways to an unacceptable degree. Larger pipes with thicker walls may cause the forces exerted on the fixed end points to be so high that it is virtually impossible to construct fixed points that are sufficiently strong to handle them.

In some cases, thermal expansion can be absorbed by arranging pipe limbs that branch off or form a U-bend in the pipe run. This is perfectly acceptable when the pipe has plenty of deflections and the opportunity arises to form additional limbs. Such arrangements must take account of the basic operating stresses that arise and the fact that large forces may be exerted at the fixed points.

Modern installations are often required to handle higher pressures and higher temperatures, however. Not least in the interests of the operational reliability and efficiency, it then becomes necessary to install expansion joints or metal hose assemblies to absorb expansion without causing stresses.

Absorption of thermal expansion

Compensation with axial expansion joints is the first port of call and has the advantage of requiring little additional installation space. However, such an arrangement requires that the longitudinal forces of the pipework released by the installation of axial expansion joints can be absorbed by sufficiently strong fixed points. In cases in which it is impossible or uneconomic to install strong support points, braided metal hoses or, with larger dimensions, anchored lateral or angular expansion joints are installed. For further details on axial, lateral and angular expansion joints, please refer to the Expansion Joints manual.

With metal hose assemblies, the compressive forces caused by the internal pressure are absorbed by close-fitting wire braiding, the hose assembly is then capable of absorbing the longitudinal expansion. This means that in contrast to axial expansion joints, only light fixed points are required to absorb the thermal expansion. The best solution for fixing the hose assembly in the installed position is to attach support points or pipe guides right near the end of the hose assembly.

When installing metal hose assemblies, it is essential to ensure that they are not arranged axially, but, depending on the installation situation (size and direction of movement), **as a 90° bend, 180° bend** or for **lateral absorption of expansion**, at right angles to the direction of expansion. Our installation instructions and examples should be noted.

Metal hose assemblies for lateral absorption of expansion installed at right angles to the direction of expansion should generally be preloaded by around half of the occurring expansion in order to make full use of the hose assembly's scope for movement either side of the perpendicular. Such arrangements should be used to absorb movement of up to ±100 mm with low movement frequency (e.g. thermal expansion). The length of the hose assembly must be correctly calculated and must on no account be too short, otherwise the hose will be severely stretched or even destroyed at maximum deflection.

The required nominal length is calculated with the help of the “HYDRA formula for lateral installation”. This takes account of a certain natural elasticity in the longitudinal direction depending on the length of the hose assembly. It is important to install the hose assembly in the mid-position in a relaxed slightly hanging state so that it is not subjected to impermissible tensile stress in the maximum elevation situation.

The shortening of length in the mid-position should, however, generally be no more than 0.5% of the nominal length. On no account should the hose assembly be axially compressed since this will cause the wire braid to lift away and the pressure resistance is no longer guaranteed.

Metal hoses as flexible link between pipe and machine

Absorption of thermal expansion

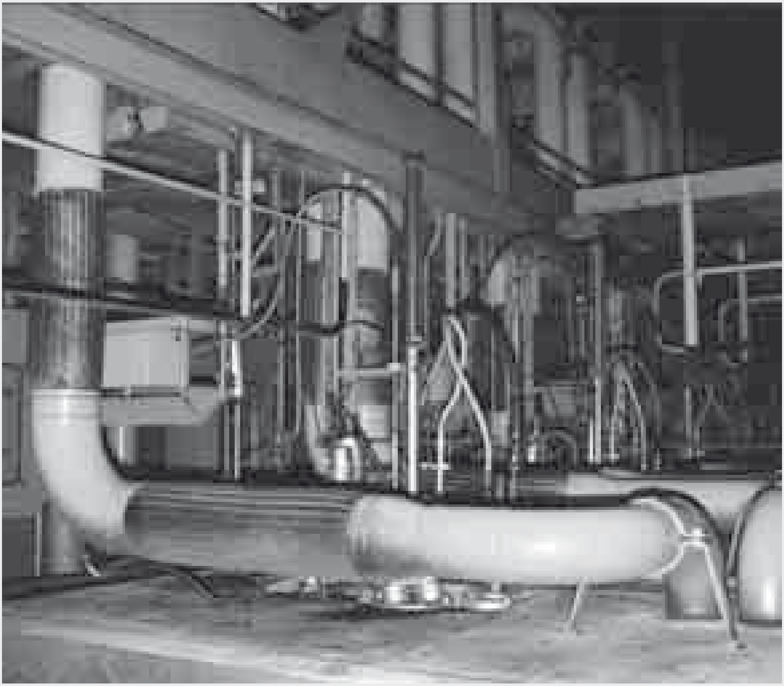
Metal hose assemblies installed in a 90° bend can absorb movements from 1 or 2 directions. Besides the correct choice of hose version, workmanlike installation appropriate for the hose assembly's function is essential. The hose should preferably be installed at naturally occurring 90° bends that are part of the planned pipe run (at corners or change of levels).

To prevent damaging torsional stresses, it is essential to ensure that the direction of expansion and hose bend lie in one plane. Moreover, it is advisable to arrange pipe guides so that they guide the pipe in the axial direction of the pipe to be compensated and prevent lateral deflection. To fix the hose assembly in the installed position, a light support point should be mounted on the following section of rigid pipe close to the end of the hose assembly.

Where the hose assembly is required to absorb expansion in 2 directions, pipe guides must be mounted after both ends of the hose to ensure that the expansion movements are performed exactly at right angles to each other.

The precise calculation of minimum installation dimension, nominal lengths and expansion absorbed can be done in accordance with the calculation formulae on pages 286-294.

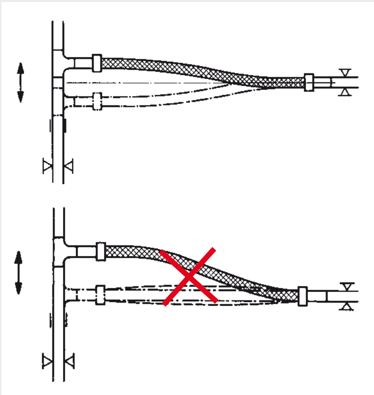
Metal hose assemblies installed in a 180° bend are used for absorption of thermal expansion in only a few cases. This is mostly done to absorb large amounts of expansion in long and straight pipes. Just as in the 90° bend arrangement, it is important to ensure that the direction of expansion and hose axis lie in one plane and that rigid pipe and hose assembly are appropriately guided or fixed through the use of pipe guides or support points. The calculation of nominal length and minimum installation dimension can be done with the help of the calculation formulae on page 295 and 296.



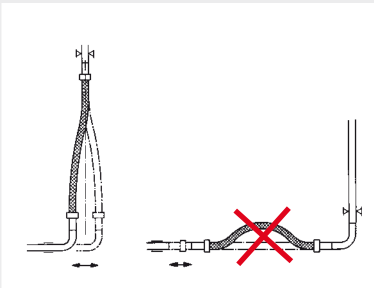
Metal hoses in a power station

Absorption of thermal expansion

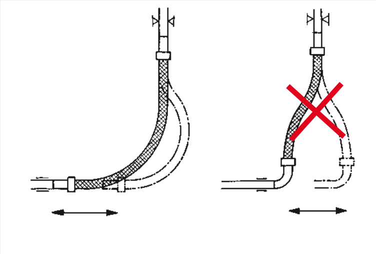
Example 9
For lateral absorption of expansion, install hose assembly at right angles to the direction of expansion. Preload the hose assembly by around half of the occurring expansion in order to make full use of the lateral movement scope of the hose assembly. Determine the required nominal length and installation length with the help of the HYDRA formula. Be careful not to stretch or compress the hose assembly.



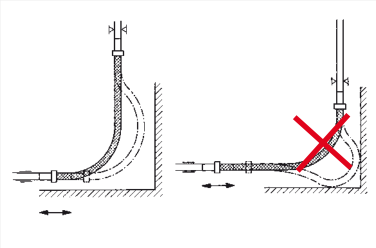
Example 10
Lateral installation for absorption of small expansion movements. Take note of the selection advice on page 284-285.
Be careful not to stretch or compress the hose assembly.



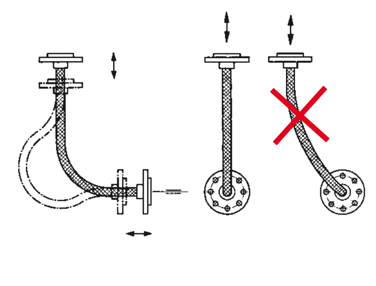
Example 11
For absorption of larger expansion movements, install hose assembly in a 90° bend. Lateral installation is no longer permissible.



Example 12
For absorption of expansion movements, the limb of the 90° bend at right angles to the direction of expansion must be lengthened accordingly. Determine the required nominal and limb lengths in accordance with the HYDRA formula “90° bend for absorption of expansion”. When installing, make sure the hose assembly has sufficient freedom of movement.

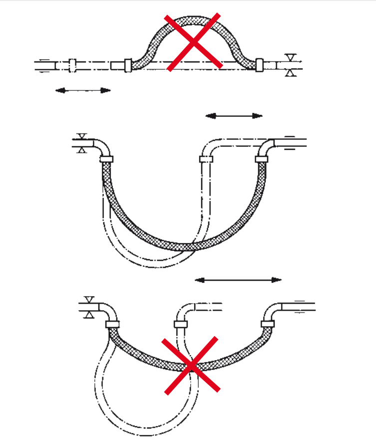


Example 13
For absorption of expansion movements from 2 directions, plan installation of a 90° bend with sufficient straight length of the limbs. Determine the required nominal and limb lengths in accordance with the HYDRA formula “90° bend for absorption of expansion from two directions”. Hose bend and direction of movement must lie in one plane.

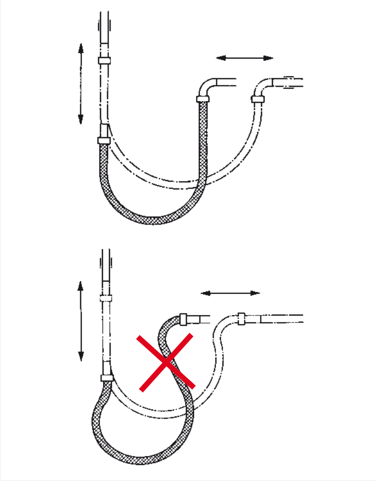


Example 14
For absorption of large axial expansion movements in long straight pipe sections, install hose assembly in a 180° bend. Be careful to avoid axial stretching or compression of the hose assembly.

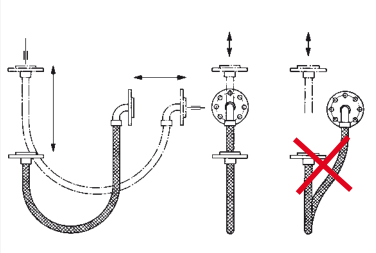
Example 15
Determine the required installation distance and nominal length in accordance with the HYDRA formula “180° bend for absorption of expansion from one direction”. Be careful to avoid excessive bending or stretching of the hose assembly.



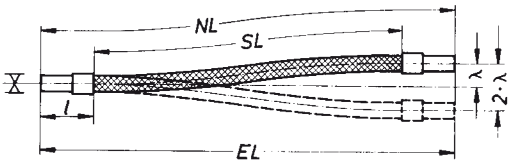
Example 16
Determine the required installation distance and nominal length in accordance with the HYDRA formula "180° bend for absorption of expansion from two directions".
Use rigid pipe elbows to prevent impermissible bending after the connection fittings.



Example 17
Direction of expansion and hose bend must lie in one plane. Lateral deflection must be prevented by the use of suitable pipe guides, which will prevent damaging torsional stresses.



Absorption of thermal expansion



Install the hose assembly in the mid-position in a relaxed, slightly sagging arrangement so that it is not subjected to impermissible tensile stress in the maximum deflection situation.

Installation and calculation of HYDRA annularly corrugated hose assemblies for lateral absorption of expansion.

$$NL = \sqrt{20\,r \cdot \lambda} + 2\,l$$

$$\lambda = \frac{SL^2}{20r}$$

Hose assembly installed at right angles to the direction of movement, for lateral absorption of movement up to max. ±100 mm, with low movement frequency (e.g. thermal expansion movements). **Not for vibrations!**

Installation length EL $\approx$ NL · 0.995

Hose length SL = NL – 2 l

Minimum hose length $SL_{min} = 6 \cdot \lambda$

Example
Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25 weld end of steel tube type UA12S at both ends

$r = 190$ mm

$\lambda = 26$ mm

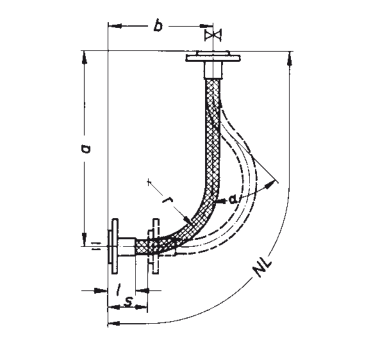
$l = 83$ mm

$NL = \sqrt{20 \cdot 190 \cdot 26} + 2 \cdot 83 = 480$ mm

$EL = 480 \cdot 0.995$
$= 478$ mm, i.e. in the mid-position the hose must be installed shortened by 2 mm.

$2 \cdot \lambda$	=	overall lateral movement	mm
λ	=	lateral movement from centre axis (max. 100 mm)	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
SL	=	free-moving length of hose	mm
EL	=	installation length	mm
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 90° bend for absorption of expansion from one direction, with low movement frequency (e.g. through thermal expansion). **Not for vibrations!**



$$NL = 0.035\, r\, \alpha + 1.57\, r + 2\, l$$

$$a = r + 2\, r \cdot \sin \alpha + l$$

$$b = r + r\, (0.035\, \alpha - 2 \sin \alpha) + l$$

$\alpha = \dfrac{s}{r}$ Value can be found in bending angle table page 294.

The bending angle α must not exceed the maximum value of 60°.

Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25 welding collar and loose flange type AB12E at both ends

r = 190 mm

s = 78 mm

l = 58 mm

$$\alpha = \frac{78}{190} = 0.4105 \triangleq 34°$$

NL = 0.035 · 190 · 34 + 1.57 · 190 + 2 · 58
= 640 mm

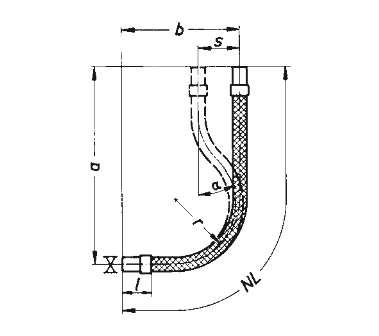
a = 190 + 2 · 190 · 0.559 + 58
= 460 mm

b = 190 + 190 (0.035 · 34 – 2 · 0.559)
+ 58 = 262 mm

s	=	absorbed expansion	mm
a	=	installation distance	mm
b	=	installation distance	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
α	=	bending angle	∢ °
NL	=	nominal length	mm

Absorption of thermal expansion

Calculation of metal hose assemblies for installation as 90° bend for absorption of expansion from one direction, with low movement frequency (e.g. through thermal expansion). **Not for vibrations!**



$$NL = 0.035\, r\, \alpha + 1.57\, r + 2\, l$$

$$a = r + 2\, r \cdot \sin \alpha + l$$

$$b = r + r\,(0.035\, \alpha - 2 \sin \alpha) + l$$

$\alpha = \frac{s}{r}$ Value can be found in bending angle table page 294.

The bending angle α must not exceed the maximum value of 60°.

Example
Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25 weld end of steel tube type UA12S at both ends

r = 190 mm

s = 78 mm

l = 83 mm

$\alpha = \frac{78}{190} = 0.4105 \triangleq 34°$

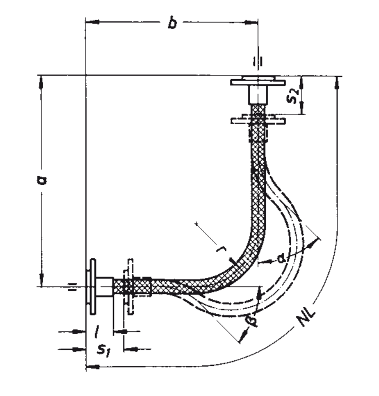
NL = 0.035 · 190 · 34 + 1.57 · 190 + 2 · 83
= 690 mm

a = 190 + 2 · 190 · 0.559 + 83
= 485 mm

b = 190 + 190 (0.035 · 34 – 2 · 0.559)
+ 83 = 287 mm

s	=	absorbed expansion	mm
a	=	installation distance	mm
b	=	installation distance	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
α	=	bending angle	$\sphericalangle$°
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 90° bend for absorption of expansion from two directions, with low movement frequency (e.g. through thermal expansion). **Not for vibrations!**



$$NL = 0.035\, r \cdot \alpha + 0.035\, r \cdot \beta + 1.57\, r + 2\, l$$

$$a = r + 2\, r \cdot \sin\alpha + r\,(0.035\,\beta - 2\sin\beta) + l$$

$$b = r + 2\, r \cdot \sin\beta + r\,(0.035\,\alpha - 2\sin\alpha) + l$$

$$\alpha = \frac{s_1}{r}$$

Value can be found in bending angle table page 294.

$$\beta = \frac{s_2}{r}$$

The bending angles α and β must not exceed 45° each.

Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25 welding collar and loose flange type AB12E at both ends

$r = 190$ mm
$s_1 = 78$ mm
$s_2 = 48$ mm
$l = 58$ mm

$$\alpha = \frac{78}{190} = 0.4105 \triangleq 34°$$

$$\beta = \frac{48}{190} = 0.2526 \triangleq 27°$$

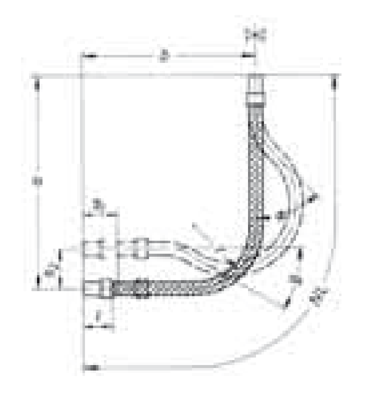
$$NL = 0.035 \cdot 190 \cdot 34 + 0.035 \cdot 190 \cdot 27 + 1.57 \cdot 190 + 2 \cdot 58 = 820 \text{ mm}$$

$$a = 190 + 2 \cdot 190 \cdot 0.559 + 190\,(0.035 \cdot 27 - 2 \cdot 0.4540) + 58 = 467 \text{ mm}$$

$$b = 190 + 2 \cdot 190 \cdot 0.4540 + 190\,(0.035 \cdot 34 - 2 \cdot 0.559) + 58 = 434 \text{ mm}$$

s_1	=	absorbed expansion	mm
s_2	=	absorbed expansion	mm
a	=	installation distance	mm
b	=	installation distance	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
α	=	bending angle	∢ °
β	=	bending angle	∢ °
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 90° bend for absorption of expansion from two directions, with low movement frequency (e.g. through thermal expansion). **Not for vibrations!**



$$NL = 0.035\ r \cdot \alpha + 0.035\ r \cdot \beta + 1.57\ r + 2\ l$$

$$a = r + 2\ r \cdot \sin \alpha + r\ (0.035\ \beta - 2 \sin \beta) + l$$

$$b = r + 2\ r \cdot \sin \beta + r\ (0.035\ \alpha - 2 \sin \alpha) + l$$

$\alpha = \frac{s_1}{r}$

$\beta = \frac{s_2}{r}$

Value can be found in bending angle table page 294.

The bending angles α and β must not exceed 45° each.

Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25 weld end of steel tube type UA12S at both ends

r = 190 mm
s_1 = 78 mm
s_2 = 48 mm
l = 83 mm

$$\alpha = \frac{78}{190} = 0.4105 \triangleq 34°$$

$$\beta = \frac{48}{190} = 0.2526 \triangleq 27°$$

$$NL = 0.035 \cdot 190 \cdot 34 + 0.035 \cdot 190 \cdot 27 + 1.57 \cdot 190 + 2 \cdot 83 = 870 \text{ mm}$$

$$a = 190 + 2 \cdot 190 \cdot 0.559 + 190\,(0.035 \cdot 27 - 2 \cdot 0.4540) + 83 = 492 \text{ mm}$$

$$b = 190 + 2 \cdot 190 \cdot 0.4540 + 190\,(0.035 \cdot 34 - 2 \cdot 0.559) + 83 = 459 \text{ mm}$$

s_1	=	absorbed expansion	mm
s_2	=	absorbed expansion	mm
a	=	installation distance	mm
b	=	installation distance	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
α	=	bending angle	∡ °
β	=	bending angle	∡ °
NL	=	nominal length	mm

Absorption of thermal expansion

Bending angle table

for determining the bending angle for the calculation of 90° bend for absorption of expansion, bending angle = $\frac{s}{r}$

0° – 30°

Bending angle	Expansion absorption / Bending radius $\frac{s}{r}$		
Degree \ Min.	0′	30′	60′
0	0.0000	0.0001	0.0003
1	0.0003	0.0007	0.0012
2	0.0012	0.0019	0.0028
3	0.0028	0.0038	0.0050
4	0.0050	0.0063	0.0078
5	0.0078	0.0095	0.0113
6	0.0113	0.0133	0.0155
7	0.0155	0.0179	0.0204
8	0.0204	0.0231	0.0259
9	0.0259	0.0289	0.0322
10	0.0322	0.0355	0.0391
11	0.0391	0.0428	0.0468
12	0.0468	0.0509	0.0551
13	0.0551	0.0596	0.0643
14	0.0643	0.0690	0.0741
15	0.0741	0.0793	0.0847
16	0.0847	0.0903	0.0961
17	0.0961	0.1020	0.1082
18	0.1082	0.1145	0.1211
19	0.1211	0.1278	0.1347
20	0.1347	0.1418	0.1491
21	0.1491	0.1567	0.1644
22	0.1644	0.1723	0.1804
23	0.1804	0.1887	0.1972
24	0.1972	0.2059	0.2148
25	0.2148	0.2239	0.2332
26	0.2332	0.2428	0.2525
27	0.2525	0.2624	0.2725
28	0.2725	0.2829	0.2934
29	0.2934	0.3042	0.3151

30° – 60°

Bending angle	Expansion absorption / Bending radius $\frac{s}{r}$		
Degree \ Min.	0′	30′	60′
30	0.3151	0.3263	0.3377
31	0.3377	0.3493	0.3611
32	0.3611	0.3731	0.3853
33	0.3853	0.3977	0.4104
34	0.4104	0.4232	0.4363
35	0.4363	0.4495	0.4630
36	0.4630	0.4767	0.4906
37	0.4906	0.5048	0.5191
38	0.5191	0.5337	0.5484
39	0.5484	0.5634	0.5786
40	0.5786	0.5940	0.6096
41	0.6096	0.6255	0.6415
42	0.6415	0.6578	0.6743
43	0.6743	0.6910	0.7079
44	0.7079	0.7250	0.7424
45	0.7424	0.7599	0.7777
46	0.7777	0.7957	0.8139
47	0.8139	0.8323	0.8510
48	0.8510	0.8698	0.8889
49	0.8889	0.9082	0.9277
50	0.9277	0.9474	0.9673
51	0.9673	0.9874	1.0078
52	1.0078	1.0284	1.0491
53	1.0491	1.0701	1.0914
54	1.0914	1.1128	1.1344
55	1.1344	1.1563	1.1783
56	1.1783	1.2006	1.2230
57	1.2230	1.2457	1.2686
58	1.2686	1.2918	1.3150
59	1.3150	1.3386	1.3623

The bending angle must not exceed a maximum value of 60°. For absorption of expansion from 2 directions, max. 45°. If the calculated value $\frac{s}{r}$ is greater than 1.3623, the bending angle must be re-calculated with a correspondingly larger bending radius r.

Calculation of metal hose assemblies for installation as 180° bend for absorption of expansion from one direction, with low movement frequency (e.g. through thermal expansion). **Not for installation on presses** (for this, see installation instructions "Absorption of mechanical movements", page 265-269.

$$NL = \pi \cdot r + 1.57\ s + 2\ l$$

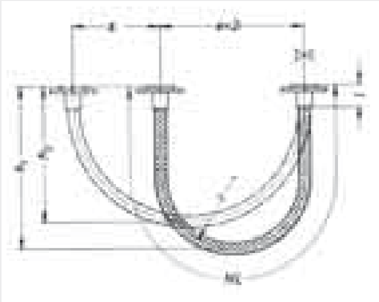
$$h_1 = r + 0.785\ s + l$$

$$h_2 = r + \frac{s}{2} + l$$

Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, welding rim and loose flange type CA82D at both ends

r = 190 mm
s = 125 mm
l = 33 mm
NL = $\pi \cdot 190 + 1.57 \cdot 125 + 2 \cdot 33$
= 859 mm
rounded up 860 mm



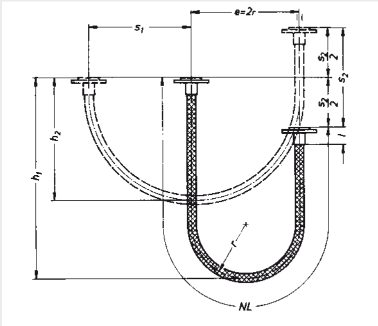
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h1	=	max. height of the 180° bend	mm
h2	=	min. height of the 180° bend	mm
s	=	stroke	mm
NL	=	nominal length	mm

Calculation of metal hose assemblies for installation as 180° bend for absorption of expansion from 2 directions, for low movement frequency (e.g. through thermal expansion).

$$NL = \pi \cdot r + 1.57\, s_1 + \frac{s_2}{2} + 2\, l$$

$$h_1 = r + 0.785\, s_1 + \frac{s_2}{2} + l$$

$$h_2 = r + \frac{s_1}{2} + l$$



Example
Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, welding rim and loose flange type CA82D at both ends

r	=	190 mm
s_1	=	125 mm
s_2	=	80 mm
l	=	33 mm
NL	=	$\pi \cdot 190 + 1.57 \cdot 125 + \frac{80}{2} + 2 \cdot 33$
	=	899 mm
		rounded up = 900 mm

r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
e	=	installation distance	mm
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
h1	=	max. height of the 180° bend	mm
h2	=	min. height of the 180° bend	mm
s	=	stroke	mm
NL	=	nominal length	mm

Compensation of parallel pipework offset
To simplify assembly and to achieve stress-free connection of parallel offset pipes, hose assemblies can be installed in an S-shape.

In contrast to the installation handled on the previous pages, in which lateral movements about the centre axis are permissible, in this installation, the hose assembly may, due to its shorter length, only be bent into the required position once (to compensate assembly inaccuracies, pipe offsets, etc.). In addition, the shortening of the hose as a result of the axial misalignment must be taken into account in the installation position: axial stretching or compression of the hose assembly is not permissible.

The required length of the hose assembly is calculated from the amount of axial misalignment, the permissible bending radius and the bending angle.

Compensation of parallel pipework offset

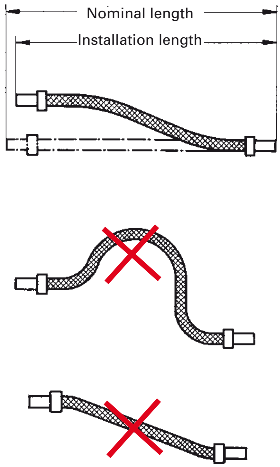
The calculation is done in accordance with the HYDRA formula for a one-off lateral bending movement. To ensure that the installation guarantees operational reliability and correct functioning, make sure the hose assembly is not bent too severely. The bending angle for braided hoses should not exceed 45°. In the case of hoses without braiding, a bending angle of up to 60° is permissible. If the bending angle calculated for braided hoses is greater than 45°, the installation and nominal lengths must be recalculated with the help of the factors given in the formulae. Where space conditions permit, the bending radius and length of the hose assembly should however be accordingly increased in favour of a smaller bending angle.

On installation, make sure the hose assembly is not bent directly after the connection fittings. Endeavour to achieve an easy transition from the connection fitting to the hose bend by ensuring a straight neutral hose assembly end. To simplify assembly with larger hose dimensions or large axial misalignment, the hose assembly can be pre-bent to the required shape.

As a matter of principle, installation of the hose assembly should be done so that the hose is not subjected to tensile and torsional stresses during assembly and operation. If additional vibrations or small movements are to be absorbed in the installed state, the bending radius and the length of the hose assembly must be increased accordingly or a different installation shape (90° bend) chosen. In this case, please ask for the necessary data.

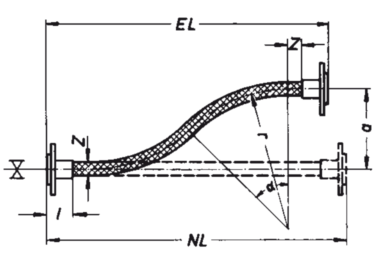
Example 18
Install hose assembly free of stresses. Axial compression is not permissible as it causes the braiding to lift away from the hose and the pressure resistance is no longer guaranteed.

Example 19
Install hose assembly with correctly determined length and adequate neutral hose ends. Over-bending or stretching is not permissible. Determine the nominal length and installation length in accordance with the HYDRA formula for one-off lateral bending.



Compensation of parallel pipework offset

Calculation and installation of metal hose assemblies for one-off lateral bending.
Hose assembly installed in S-shape to compensate parallel pipes with offset. **Only for static stress.** Not for absorption of expansion or vibrations.



$$NL = \frac{r \cdot \pi \cdot \alpha}{90} + 2\ (l + z)$$

$$EL = 2\ r \cdot \sin \alpha + 2\ (l + z)$$

$$a = 2\ r\ (1 - \cos \alpha)$$

$$\cos \alpha = \frac{2\ r - a}{2\ r}$$

The bending angle α for braided hoses must not exceed 45°. With hoses without braiding, up to max. 60° is possible in exceptional cases.

If the calculated bending angle α is greater than 45°, the installation length and nominal length must be calculated with the help of the following formulae:

$$EL = 2.414\ a + 2\ (l + z)$$

$$NL = 2.680\ a + 2\ (l + z)$$

Example

Annularly corrugated hose assembly of stainless steel type RS 331 L12, DN 25, collar pipes and loose flange type BB82E at both ends

r = 85 mm
a = 30 mm
l = 69 mm
z = 35 mm

$$\cos\alpha = \frac{2 \cdot 85 - 30}{2 \cdot 85} = 0.824 \triangleq 34° \, 30'$$

$$NL = \frac{85 \cdot \pi \cdot 34.5}{90} + 2\ (69 + 35) = 311 \text{ mm}$$

$$EL = 2 \cdot 85 \cdot 0.5664 + 2\ (69 + 35) = 304 \text{ mm}$$

a	=	amount of axial misalignment	mm
r	=	bending radius (the values can be found in the nominal bending radius column of the selected hose type)	mm
α	=	bending angle	∢ °
l	=	length of the connection fitting (the values can be found in the table of connection fittings)	mm
z	=	neutral hose end $z \triangleq$ outside diameter D1 of the selected hose	mm
EL	=	installation length	mm
NL	=	nominal length	mm

Compensation of parallel pipework offset

Absorption of vibration
Oscillations, vibrations and the noise caused by them are not only burdensome, they also cause substantial fatigue in the materials exposed to them. With fixed mounted pipes within machines and units exposed to vibrations, fractures and failures can soon occur posing a risk to the operational reliability and efficiency of an installation.
HYDRA metal hoses and HYDRA expansion joints are thoroughly proven as elements capable of absorbing vibration and structure-borne noise. To do this, however, they have to be selected and installed appropriately for their function in terms of operating pressure, temperature, magnitude and direction of vibration.

The following flexible metallic elements are suitable for such applications:

- Annularly corrugated hose assemblies positively mounted in a 90° bend (Installation shape A) for absorption of vibrations, for stress-free connection to pumps, compressors, motors, etc. Type RS HYDRA annularly corrugated hose assemblies of stainless steel are especially suitable for this. The nominal and leg lengths are calculated with the help of the formulae on page 306 . The primary applications are in the size range **DN 10–100.**

- Annularly corrugated hose assemblies positively mounted in a 90° angle (Installation shape B). Type and function of hose assemblies as above. The primary applications are in the size range **DN 125–200.**
  The required leg lengths of hose assemblies with loose flange connections are given in the table on page 307 .

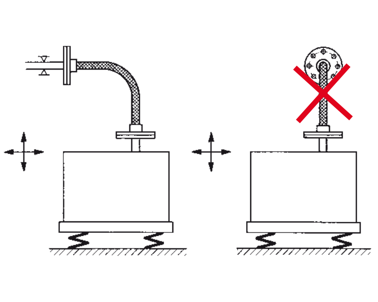
- Type Vibraflex DN 6–100 vibration compensators. Used primarily in refrigeration engineering, within cooling units, air-conditioning equipment, refrigeration plants, etc. For explanations and technical description –> Vibraflex page 211.

- Axial expansion joints for absorption of axial and lateral vibrations. However, the range of applications is limited to lower operating pressures since, with greater pipe diameters and higher operating pressures, the compressive forces (product of effective bellow cross-section and operating pressure) become considerable. This compressive force must be absorbed by the fixed points. Since however one of the fixed points is formed by the machine, it is essential to check whether its pipe socket is capable of handling these forces, or whether the stability of the often elastically supported machine is adequate.

- Lateral expansion joints are especially suitable for higher pressures and large nominal diameters. They are used when axial expansion joints are unsuitable due to the higher pressures and metal hoses are ruled out due to overall size.

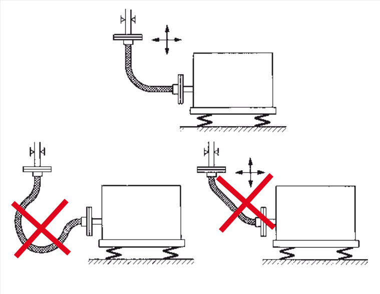
If an axial or lateral expansion joint is to be used, please refer to the Expansion Joints manual.

Example 23
Install hose assembly as close as possible to the vibrating machine. Connect the hose assembly free of stresses. The principal direction of movement of the vibrations and hose bend must lie in one plane to prevent damaging torsional stress. A fixed point must be mounted on the pipe after the hose assembly. Hose assembly must not bear the weight of the pipe.

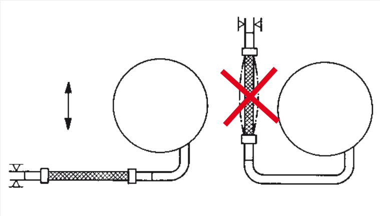


Absorption of vibrations

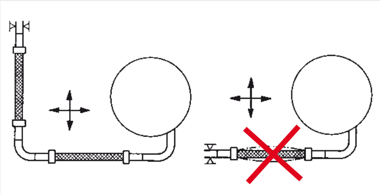
Example 24
Install hose assembly as 90° bend with permissible bending radius and adequate neutral hose assembly ends. Calculate nominal length and leg length with the help of the HYDRA formula: “90° bend for absorption of vibrations”. Overbending and stretching of the hose bend are not permissible.

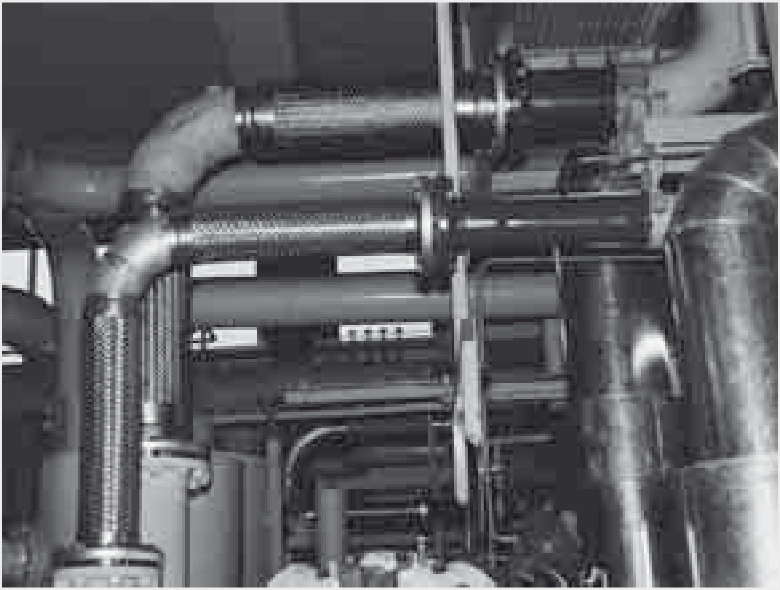


Example 25
Install hose assembly at right angles to the direction of vibration.



Example 26
For absorption of two or three-dimensional vibrations, install hose assemblies to create a 90° angle. Hoses cannot absorb axial vibrations.

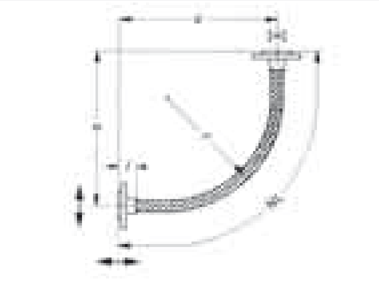




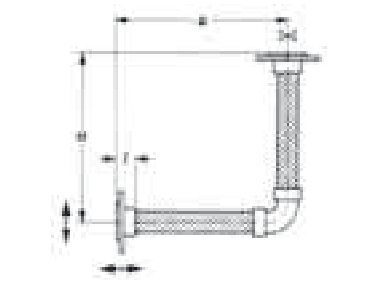
Isolation of vibrations of a compressor with type RS braided metal hose

Selection and calculation of metal hose assemblies for installation as 90° bend for absorption of vibrations (for small amplitude and high frequency).

Installation shape A (DN 10–100)
90° bend



Installation shape B (DN 125–200)
90° angle



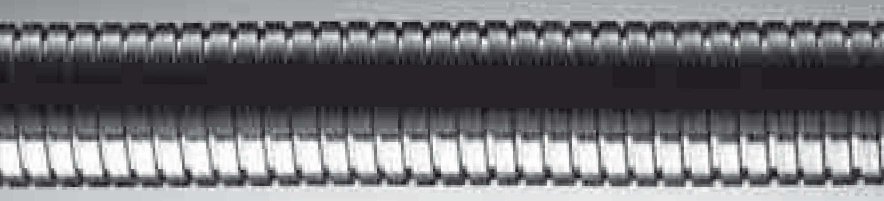
The nominal and leg lengths of a positively mounted 90° bend for absorption of vibration (installation shape A) is calculated in accordance with the following formulae:

$$NL = 2.3\ r + 2\ l$$

$$a = 1.365\ r + l$$

Permissible amplitude in continuous operation: ±1 mm, at starting/stopping max. 10 mm; with greater amplitudes, please inquire.

Installation shape A 90º bend												Installation shape B 90º angle		
RS 331												RS 330		
DN	10	12	16	20	25	32	40	50	65	80	100	125	150	
r	80	90	110	150	170	200	240	280	300	350	400	–	–	
a	155	170	200	255	285	340	400	460	490	575	635	700	800	
l_{max}	50	50	50	50	55	70	75	80	80	95	95	120	130	
NL	280	300	350	450	500	600	700	800	850	1000	1100	–	–	
	RS 531			RS 430								RS 430		
r	140	160	180	230	260	290	310	360	400	470	580	–	–	–
a	255	285	315	375	405	460	520	580	635	750	875	850	1000	1150
l_{max}	55	60	60	60	60	70	80	85	90	95	95	120	130	140
NL	450	500	550	650	700	800	900	1000	1100	1300	1500	–	–	–



Universal, light, robust

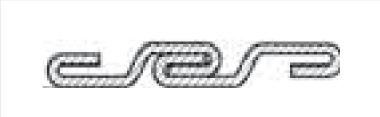
Resistance to leakage through pressure or vacuum is normally not required of stripwound hoses. Stripwound hoses suffer leakage losses through their design. This means that the users must choose between the different types and properties of seals depending on the operating conditions and determine the best possible seal, taking economy into account. Leakage losses are not permissible if the medium to be transported is hazardous to the health and/or explosive.

In sealed stripwound hoses with hook-shaped profile, the inserted sealing thread is a dynamically stressed contact seal. The service life of this seal is primarily determined by how long the hose is used. To satisfy the operational requirements in respect of leak resistance, temperature resistance, chemical resistance, wear resistance, resistance to ageing, etc., sealing threads of rubber, cotton, glass fibre, special thermal fibres, etc. are used.

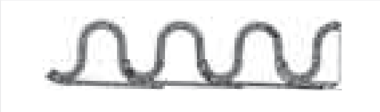
The leakage loss of stripwound hoses with rubber sealing thread is less than 1‰ of the leakage loss experienced with the special thermal seal, but the maximum operating temperature is then reduced from 600 °C to 60 °C.

Besides the operating conditions and the properties of the hose, the density and viscosity of the flow medium also have an influence on the leakage loss. For example, the leakage loss for a stripwound hose with special thermal seal for the flow medium water is less than 5‰ of the leakage loss for air. For the transport of gaseous or solid media, especially at high temperatures, both stripwound hoses with sealing thread and metallically sealing stripwound hoses without sealing thread are used.

There are essentially two designs of stripwound hose:



Metallically sealing stripwound hose with interlocked profile

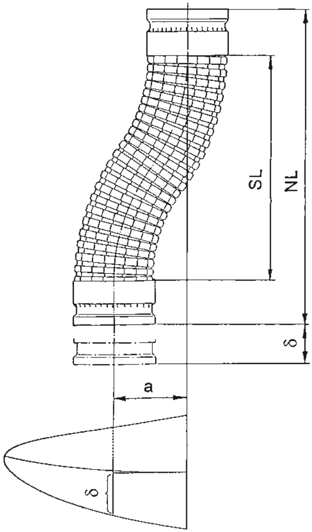


Metallically sealing stripwound hoses with corrugated profile

Compensation of parallel pipe offset / isolation of vibrations

Besides the take-up and compensation of assembly inaccuracies, stripwound hose assemblies are suitable for isolation or absorption of vibrations. The many versions of stripwound hoses make it impossible to apply a standard formula.

Witzenmann has calculation programs in which variables such as geometric shape, hose position, type of seal, etc. can be taken into account. We prefer to use the type FA exhaust hose of stainless steel described on page 159. Among other things, selection of the correct hose requires precise details on the free hose length SL, deflection and axial movement ‰; please refer to the following sketch.



Contents

Appendix A – Materials

Appendix A

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027	Short name to DIN EN 10 027	Short name to DIN (old)	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Unalloyed steel	1.0254	P235TR1	St 37.0	Welded tube Seamless tube	DIN EN 10217-1 DIN EN 10216-1	DIN 1626 DIN 1629	300
	1.0255	P235TR2	St 37.4	Welded tube Seamless tube	DIN EN 10217-1 DIN EN 10216-1		
	1.0427	C22G1	C 22.3	Flanges	VdTÜV-W 364		350
Common structural steel	1.0038	S235JRG2	RSt 37-2	Steel bar, flat products, wire rod, profiles	DIN EN 10025		300
	1.0050	E295	St 50-2				
	1.0570	S355J2G3	St 52-3		AD W1		
Heat resistant unalloyed steel	1.0460	C22G2	C 22.8	Flanges	VdTÜV W 350		450
Heat resistant steel	1.0345	P235GH	HI	Sheet	DIN EN 10028	DIN 17155	480
				Seamless tube	DIN EN 10216		450
	1.0425	P265GH	HII	Sheet	DIN EN 10028	DIN 17155	480
	1.0481	P295GH	17 Mn 4	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	500
	1.5415	16Mo3	15 Mo 3	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	530
	1.7335	13CrMo4-5	13 CrMo 4 4	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	570
	1.7380	10CrMo9-10	10 CrMo 9 10	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	600
	1.0305	P235G1TH	St 35.8	Seamless tube	DIN 17175		480
Fine-grained structural steel Standard	1.0562	P355N	StE 355	Sheet Strip Steel bar	DIN EN 10028	DIN 17102	
heat resist.	1.0565	P355NH	WStE 355				400
cold resist.	1.0566	P355NL1	TStE 355				(-50) [1]
special	1.1106	P355NL2	EStE 355				(-60) [1]

1) Cold resistant limit

Appendix A

Strength values at room temperature (RT)

(guaranteed values [1])

Material no. to DIN EN 10 027	Yield point min. R_{eH} N/mm^2	Tensile strength R_m N/mm^2	Breaking elongation, min. A_5 %	A_{80} %	Notched bar impact strength min. A_V (KV [2]) 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 RT: 31	s ≤ 70
1.0038	235	340 -470	21 - 26 [1]	17 - 21 [3]	at RT: 27	3 ≤ s ≤ 100 (R_m)
1.0050	295	470 - 610	16 - 20 [1]	12 - 16 [3]		10 ≤ s ≤ 150 (KV)
1.0570	355	490 - 630	18 - 22 [1]	14 - 18 [3]	at -20°C: 27	s < 16 (R_{eH})
1.0460	240	410 - 540	20		at RT: 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	295 270	460 - 580	22		at 0° C: 27	s ≤ 16
1.5415	275 270	440 - 590	24		at RT: 31	s ≤ 16
1.7335	300 290	440 - 600	20		at RT: 31	s ≤ 16
1.7380	310 280	480 - 630	18		at RT: 31	s ≤16
1.0305	235	360 - 480	23		at RT: 34	s ≤ 16
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

1) Smallest value of longitudinal or transverse test
2) New designation to DIN EN 10045; average of 3 specimens in DIN EN standards
3) Dependent on product thickness

Appendix A

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027	Short name to DIN EN 10 027	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Stainless ferritic steel	1.4511	X3CrNb17	Strip	DIN EN 10088 VdTÜV-W422	DIN 17441 2)	200 nach VdTÜV
	1.4512	X2CrTi12	Strip	DIN EN 10088 SEW 400		350
Stainless austenitic steel	1.4301	X5CrNi18-10	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 300 1)
	1.4306	X2CrNi19-11	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 350 1)
	1.4541	X6CrNiTi18-10	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4571	X6CrNiMoTi17-12-2	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4404	X2CrNiMo17-12-2	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4435	X2CrNiMo18-14-3	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4565	X2CrNiMnMoNbN25-18-5-4	Strip, Strip Sheet	SEW 400 / 97	SEW 400 / 91	550 / 400 1)
	1.4539	X1NiCrMoCu25-20-5	Strip Sheet, Strip Seamless tube	DIN EN 10088 VdTÜV-W421		550 / 400 1) 400
	1.4529	X1NiCrMoCuN25-20-7	Strip Sheet, Strip Seamless tube	DIN EN 10088 VdTÜV-W 502		400
Austenitic steel of high heat resistance	1.4948	X6CrNi18-10	Strip Sheet strip Forgin Seamless tube	DIN EN 10028-7 DIN EN 10222-5 DIN 17459	DIN 17460 DIN 17460	600 600 600
	1.4919	X6CrNiMo17-13	Sheet, strip, bar Forging	DIN 17460		600
			Seamless tube	DIN 17459		600
	1.4958	X5NiCrAlTi31-20	Sheet, strip, bar Forging	DIN 17460		600
			Seamless tube	DIN 17459		600

1) Temperature limit where risk of intercrystalline corrosion
2) Earlier standard DIN 17441 7/85

Appendix A

Strength values at room temperature (RT)

(guaranteed values [3)])

Material no. to DIN EN 10 027		Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. > 3 mm Thickness A_5 %	< 3 mm Thickness A_{80} %	Notched bar impact strength > 10 mm thickness, transverse min. KV in J	Remarks
1.4511		230		420 - 600		23		s ≤ 6
1.4512		210		380 - 560		25		s ≤ 6
1.4301	q	230	260	540 - 750	45	45	at RT: 60	s ≤ 6
	l	215	245		43	40		
1.4306	q	220	250	520 - 670	45	45	at RT: 60	s ≤ 6
	l	205	235		43	40		
1.4541	q	220	250	520 - 720	40	40	at RT: 60	s ≤ 6
	l	205	235		38	35		
1.4571	q	240	270	540 - 690	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4404	q	240	270	530 - 680	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4435	q	240	270	550 - 700	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4565	q	420	460	800 - 1000	30	25	at RT: 55	s ≤ 30
1.4539	q	240	270	530 - 730	35	35	at RT: 60	s ≤ 6
	l	225	255		33	30		
		220	250	520 - 720	40	40		
1.4529	q	300	340	650 - 850	40	40	at RT: 60	
	l	285	325		38	35		s ≤ 75
		300	340	600 - 800	40	40	at RT: 84	
1.4948	q	230	260	530 - 740	45	45	at RT: 60	s ≤ 6
	q	195	230	490 - 690	35		at RT: 60	s ≤ 250
	q	185	225	500 - 700	30		at RT: 60	
1.4919		205	245	490 - 690	35	30	at RT: 60	
		205	245	490 - 690	30		at RT: 60	
1.4958		170	200	500 - 750	35	30	at RT: 80	
		170	200	500 - 750	35		at RT: 80	s ≤ 50

3) Smallest value of longitudinal or transverse test, q = tensile test, transverse, l = tensile test, longitudinal

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027 [1]	Short name to DIN EN 10 027	Trade name	Semi-finished product	Documentation	Upper temp. limit °C
Heat resistant steel	1.4828	X15CrNiSi20-12		Strip Sheet, Strip,	DIN EN 10095 (SEW470)	900
	1.4876	X10NiCrAlTi32-21	INCOLOY 800	Strip Sheet, Strip all	SEW470 VdTÜV-W412	600
		X10NiCrAlTi32-21 H	INCOLOY 800 H	Strip Sheet, Strip all	VdTÜV-W434 DIN EN 10095	950 900
Nickel-based alloys	2.4858	NICr21Mo	INCOLOY 825	all Strip Sheet, Strip	DIN 17750/02 VdTüV-W432 DIN 17744 [2]	450
	2.4816	NiCR15Fe	INCONEL 600 INCONEL 600 H	Strip Sheet, Strip	DIN EN 10095 DIN 17750/02 VdTÜV-W305 DIN 17742 [2]	1000 450
	2.4819	NiMo16Cr15W	HASTELLOY C-276	Strip Sheet, Strip	DIN 17750/02 VdTÜV-W400 DIN 17744 [2]	450
	2.4856	NiCr22Mo9Nb	INCONEL 625 INCONEL 625 H	Flat products Strip Sheet, Strip	DIN EN 10095 DIN 17750/02 (VdTÜV-W499) DIN 17744 [2]	900 450
	2.4610	NiMo16Cr16Ti	HASTELLOY-C4	Strip Sheet, Strip Strip Sheet, Strip	DIN 17750/02 VdTÜV-W424 DIN 17744 [2]	400
	2.4360	NiCu30Fe	MONEL	Strip, Strip Sheet Seamless tube Schmiedestück	DIN 17750/02 VdTÜV-W 263 DIN 17743 [2]	425

1) In the case of nickel-based alloys, DIN 17007 governs the material number
2) Chemical composition

Appendix A

Strength values at room temperature (RT)

(guaranteed values [3])

Material no. to DIN EN 10 027 [1]	Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. A_5 %	A_{80} %	Notched bar impact strength min. KV J	Remarks
1.4828	230	270	500 - 750				s ≤ 3 mm
							solution annealed
1.4876	170	210	450 - 680	22			Soft annealed
INCOLCOY 800	210	240	500 - 750	30		at RT: 150 [4]	
(1.4876 H)	170	200	450 -700	30			solution annealed (AT)
INCOLCOY 800H	170	210	450 - 680		28		
2.4858	240	270	≥ 550	30			Soft annealed
INCOLCOY 825	235	265	550 - 750			at RT: 80	s ≤ 30 mm
2.4816	240		500 - 850				Annealed (+A)
	180	210	≥ 550		28		solution annealed (F50)
INCONEL 600	200	230	550 - 750	30		at RT: 150 [4]	Soft annealed
INCONEL 600 H	180	210	500 - 700	35	30	at RT: 150 [4]	solution annealed
2.4819	310	330	≥ 690	30			s ≤ 5 mm, solution
HASTELLOY C-276	310	330	730 - 1000	30	30	at RT: 96	annealed (F69)
					30		
2.4856	415		820 - 1050				s ≤ 3 mm, Annealed (+A)
INCONEL 625 H	275	305	≥ 690			at RT: 100	solution annealed (F69)
INCONEL 625	400	440	830 - 1000	30			s ≤ 3 mm; Soft annealed
2.4610	305	340	≥ 690	40		at RT: 96	s ≤ 5, solution
HASTELLOY-C4	280	315	700 - 900	40	30	at RT: 96	annealed
					30		5 < s ≤ 30
2.4360	175	205	≥ 450	30			
MONEL	175		450 - 600	30		at RT: 120	s ≤ 50, Soft annealed
							Soft annealed

3) Smallest value of longitudinal or transverse test
4) Value a_k in J/cm²

Appendix A

Designations, available types, temperature limits

Material group	Material designation DIN EN 1652 (new) Number	Short name	DIN 17670 (old) Number	Short name	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Copper-based alloy	CW354H	CuNi30Mn1Fe	2.0882	CuNi30Mn1Fe CUNIFER 30 [1]	Strip, Strip Sheet	DIN-EN 1652 AD-W 6/2	DIN 17664 DIN 17670	350
Copper	CW024A	Cu-DHP	2.0090	SF-Cu	Strip, Strip Sheet	DIN-EN 1652 AD-W 6/2	DIN 1787 DIN 17670	250
Copper-tin alloy	CW452K	CuSn6	2.1020	CuSn6 Bronze	Strip, Strip Sheet	DIN-EN 1652	DIN 17662 DIN 17670	
Copper-zinc alloy	CW503L	CuZn20	2.0250	CuZn 20	Strip, Strip Sheet	DIN-EN 1652	DIN 17660 DIN 17670	
	CW508L	CuZn37	2.0321	CuZn 37 Brass	Strip, Strip Sheet	DIN-EN 1652	DIN 17660 DIN 17670	
			2.0402	CuZn40Pb2	Strip, Strip Sheet	DIN 17670 DIN 17660		
	DIN EN 485-2 (new) Number	Short Name	DIN 1745-1 (old) Number	Short Name	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Wrought aluminium alloy	EN AW-5754	EN AW-Al Mg3	3.3535	AlMg 3	Strip, Strip Sheet	DIN EN 485-2 DIN EN 575-3 AD-W 6/1	DIN 1745 DIN 1725	150 (AD-W)
	EN AW-6082	EN AW-AlSi1MgMn	3.2315	AlMgSi 1	Strip, Strip Sheet	DIN-EN 485-2 DIN-EN 573-3	DIN 1745 DIN 1725	
Pure nickel	2.4068	LC-Ni 99		LC-Ni 99	Strip, Strip Sheet	VdTÜV-W 345		600
Titanium	3.7025	Ti 1		Ti 1	Strip, Strip Sheet	DIN 17 850 DIN 17 860 VdTÜV-W 230		250
Tantalum		Ta		Ta	Strip, Strip Sheet	VdTÜV-W382		250

1) Trade name

Appendix A

Strength values at room temperature (RT)

(guaranteed values [2])

Material no.	Yield points min. $R_{p0,2}$ N/mm²	Yield points min. $R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. A_5 %	Notched bar impact strength min. KV J	Remarks
CW354H 2.0882	≥ 120		350 - 420	35 [6]		R350 (F35) [4] 0.3 ≤ s ≤ 15
CW024A 2.0090	≤ 100 ≤ 140		200 - 250 220 - 260	42 [6] 33 [7] / 42 [6]		R200 (F20) [4] s > 5 mm R220 (F22) [4] 0.2 ≤ s ≤ 5 mm
CW452K 2.1020	≤ 300		350 - 420	45 [7] 55 [6]		R350 (F35) [4] 0.1 ≤ s ≤ 5 mm
CW503L 2.0250	≤ 150		270 - 320	38 [7] 48 [6]		R270 (F27) [4] 0.2 ≤ s ≤ 5 mm
CW508L 2.0321	≤ 180		300 - 370	38 [7] 48 [6]		R300 (F30) [4] 0.2 ≤ s ≤ 5 mm
2.0402	≤ 300		≥ 380	35		- (F38) [5] 0.3 ≤ s ≤ 5 mm
Material no.	Yield points min. $R_{p0,2}$ N/mm²	Yield points min. $R_{p1,0}$ N/mm²	Tensile strength Rm N/mm²	Breaking elongation, min. A_5 %	Notched bar impact strength- min. KV J	Remarks
EN AW-5754 3.3535	≥ 80		190 - 240	14 (A50)		0.5 < s ≤ 1.5 mm State: 0 / H111 DIN EN-values
EN AW-6082 3.2315	≤ 85		≤ 150	14 (A50)		0.4 ≤ s ≤ 1.5 mm State: 0 ; DIN EN values
2.4068	≥ 80	≥ 105	340 - 540	40		
3.7025	≥ 180	≥ 200	290 - 410	30 / 24 [8]	62	0.4 < s ≤ 8 mm
TANTAL - ES TANTAL - GS	≥ 140 ≥ 200		≥ 225 ≥ 280	35 [3] 30 [3]		0.1 ≤s ≤ 5.0 Electron beam melted Sintered in vacuum

2) Smallest value of longitudinal or transverse test
3) Measured length lo = 25 mm
4) State designation to DIN EN 1652 or (--) to DIN
5) To DIN, material not contained in the DIN EN
6) Specification in DIN EN for s > 2.5 mm
7) Breaking elongation A50, specification in DIN EN for s ≤ 2.5 mm
8) A50 for thicknesses ≤ 5 mm

Appendix A

Chemical composition

(percentage by mass)

Material group	Material no.	Short name	C[1]	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Unalloyed 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			Al_{ges} ≥ 0.015
Common structural 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 resist. unalloyed steel	1.0460	C22G2	0.18 - 0.23	0.15 -0.35	0.40 -0.90	0.035	0.030	≤ 0.30			
Heat resistant 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 Al_{ges} ≥ 0.020 Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70
	1.0425	P265GH	≤ 0.20	0.4	0.50	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				

1) Carbon content dependent on thickness. Values are for a thickness of ≤ 16mm.

Appendix A

Chemical composition

(percentage by mass)

Material group	Material no.	Short name	C max.	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Fine-grained structural 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 - 18.0			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		8.00 -10.50	
	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	X2CrNiMuMo NbN2518-5-4	0.04	1.00	4.50 - 6.5	0.030	0.015	21.0 - 25.0	3.0 - 4.5	15.0 - 18.0	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, 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

Appendix A

Chemical composition

(percentage by mass)

Material group	Material no.	Short name Trade name	C	Si	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Austenitic steel of high heat resistance	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: max 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-based 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	Re-mainder	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	Re-mainder	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
Copper-based alloy	2.0882	CuNi 30 Mn1 Fe CUNIFER 30	≤ 0.05		0.5 -1.50		0.050			30.0 -32.0	Cu: Rest, Pb, Zn

Appendix A

Chemical composition

(percentage by mass)

Material group	Material no.	Short name	Cu	Al	Zn	Sn	Pb	Ni	Ti	Ta	Other elements
Copper	CW024A (2.0090)	Cu DHP (SF-Cu)	≥ 99.9								P: 0.015 - 0.04
Copper-tin alloy	CW452K (2.1020)	CuSn 6 Bronze	Rest		≤ 0,2	5.5 -7.0	≤ 0.2	≤ 0.2			P: 0.01 - 0.4 Fe: ≤ 0.1
Copper-zinc alloy	CW503L 2.0250	CuZn 20	79.0 -81.0	≤ 0.02	Re-mainder	≤ 0.1	≤ 0.05				
	CW508L (2.0321)	CuZn 37 Brass	62.0 -64.0	≤ 0.05	Re-mainder	≤ 0.1	≤ 0.1	≤ 0.3			
	2.0402	CuZn 40 Pb 2	57.0 -59.0	≤ 0.1	Re-mainder	≤ 0.3	1.5 -2.5	≤ 0.4			
Wrought aluminium alloy	EN AW-5754 (3.3535)	EN AW-Al Mg3	≤ 0.1	Re-mainder	≤ 0.1				≤ 0.15		Si, Mn, Mg
	EN AW-6082 (3.2315)	EN AW-Al Si1MgMn	≤ 0.1	Re-mainder	≤ 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							Re-mainder		N ≤ 0,05 H ≤ 0,013 C ≤ 0,06 Fe ≤ 0,15
Tantalum	-	Ta						≤ 0.01	≤ 0.01	Rem.	

Appendix A

Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm²													
		Temperatures in °C													
		RT[1)]	100	150	200	250	300	350	400	450	500	550	600	700	800
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 to AD W1)							
1.0570	$R_{p\,0,2}$	315	254		226	206	186								
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			215	200	170	160	150	145	140				
	$R_{p\,1/10000}$									216	132	(84)			
	$R_{p\,1/100000}$									167	73	(36)	() = values at		
	$R_{m\,10000}$									298	171	(102)	530 °C		
	$R_{m\,100000}$									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)	() = values at		
	$R_{m\,10000}$									370	239	(76)	570 °C		
	$R_{m\,100000}$									285	137	(33)			
	$R_{m\,200000}$									260	115	(26)			

1) Room temperature values valid up to 50°C

Appendix A

Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm²													
		Temperatures in °C													
		RT[1]	100	150	200	250	300	350	400	450	500	550	600	700	800
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)	() = values at 480 °C			
	$R_{m\,10000}$								191	113	(75)				
	$R_{m\,100000}$								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			
	$R_{m\,10000}$							(approx. values to DIN 17441)					122	48	(17)
	$R_{m\,100000}$												74	23	(5)
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			
	$R_{m\,10000}$							(approx. values to DIN 17441)					115	45	(17)
	$R_{m\,100000}$												65	22	(8)
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						

1) Room temperature values valid up to 50°C

Appendix A

Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm²														
		Temperatures in °C														
		RT[1]	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		
1.4828 DIN EN 10095	$R_{p\,0,2}$	230	332		318		300		279		253		218	(Manufacturer's figures)		
	R_m	550	653		632		600		550		489		421			
	$R_{p\,1/1000}$												120	50	20	8
	$R_{p\,1/10000}$												80	25	10	4
	$R_{m\,1000}$												190	75	35	15
	$R_{m\,10000}$												120	36	18	8.5
	$R_{m\,100000}$												65	16	7,5	3.0
1.4876 DIN EN 10095 Incoloy 800H	$R_{p\,0,2}$	170	185	170	160	150	145		130		125	120	115	(Manufacturer's figures)		
	$R_{p\,1}$	210	205	190	180	170	165		150		145	140	135			
	R_m	450	425		400		390		380		360		300			
	$R_{p\,1/1000}$												130	70	30	13
	$R_{p\,1/10000}$												90	40	15	5
	$R_{m\,1000}$												200	90	45	20
	$R_{m\,10000}$												152	68	30	10
	$R_{m\,100000}$												114	48	21	8
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						
2.4816 DIN EN 10095	$R_{p\,0,2}$	200	180		165		155		150	145			(Soft annealed)			
	R_m	550 -750	520		500		485		480	475						
	$R_{p\,0,2}$	180	170		160		150		150	145			(solution annealed)			
	R_m	500 -700	480		460		445		440	435						
	$R_{p\,1/10000}$										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

1) Room temperature values valid up to 50°C

Appendix A

Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm²														
		Temperatures in °C														
		RT	100	150	200	250	300	350	400	450	500	550	600	700	800	900
2.4819	$R_{p0,2}$	310	280		240		220		195							
VdTÜV-W 400	R_{p1}	330	305		275		215		200							
2.4856	$R_{p\,0,2}$	410	350		320		300		280		170					
DIN EN 10095	$R_{p\,1/100000}$					Manufacturer's figures							250	90	30	10
	$R_{m\,100000}$					for Inconel 625 H							290	135	45	18
	$R_{m\,1000}$													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)						
	R_m	450	420	400	390	385	380	375	370	(360)		() = values at 425 °C				
	$R_{p\,1/10000}$				107	99	92	84								
	$R_{p\,1/100000}$				102	94	86	78								
	K/S	93	87	84	82	80	78	75								
CW354H	$R_{p\,1}$	140	130	126	123	120	117	112								
2.0882	$R_{p\,1/10000}$				107	99	92	84								
	$R_{p\,1/100000}$				102	94	86	78		Permissible tension to AD-W 6/2 für 10^5 h						
	K/S		93	87	84	82	80	78	75							
CW024A	$R_{p\,1}$	65	58	58												
2.0090	R_m	220	220	195	170	145										
	$R_{p\,2/10000}$		58	53	46	37										
	$R_{p\,2/100000}$		56	49	40	30										
	K/S	57	57	50	43	36	Permissible tension to AD-W 6/2 für 10^5 h								(F 20)	
	K/S	67	63	56	49	41									(F 22)	
3.3535	$R_{p\,0,2}$	80	70			Permissible tension to AD-W6/1										
EN-AW 5754	$R_{m\,100000}$		(80)	45												
2.4068	$R_{p\,0,2}$	80	70		65		60		55		50		40			
Nickel	$R_{p\,1}$	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	$R_{p\,1}$	200	180	150	110	90										
Titan	$R_{m\,10000}$	220	160	150	130	110										
	$R_{m\,100000}$	200	145	130	120	90										
Tantal	$R_{p\,0,2}$	140	100	90	80	70							Electron beam melted			
	R_m	225	200	185	175	160	150									
	$A_{30[\%]}$	35														
	$R_{p\,0,2}$	200	160	150	140	130										
	R_m	280	270	260	240	230							Sintered in vacuum			
	$A_{30[\%]}$	25														

1) Room temperature values valid up to 50°C

Appendix A

Material designations according to foreign specifications

Material no. to DIN EN	USA			JAPAN		
	Standard	UNS designation	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.0254	ASTM A 53-01	K02504 A 53	Welded and seamless black-oxidized and galvanized steel tubes	JIS G 3445 (1988)	STKM 12 A	Tubes
	ASTM A 106-99	K02501 A 106	Seamless tubes of high-temperature unalloyed steel	JIS G 3454 (1988)	STPG 370	Pipes under pressure
				JIS G 3457 (1988)	STPY 400	Welded tubes
1.0255	ASTM A 135-01	K03013 A 135	Electric resistance welded tubes	JIS G 3455 (1988)	STS 370	Pipes subjected to high pressures
1.0038	ASTM A 500-01	K03000 A 500	Welded and seamless fittings of cold-formed unalloyed steel			
1.0050				JIS G 3101 (1995)	SS 490	General structural steels
1.0570	ASTM A 694-00	K03014 A 694	Forgings of unalloyed and alloyed steel for pipe flanges, fittings, valves and other parts for high-pressure drive systems	JIS G 3106 (1999)	SM 490 A	Steels for welded constructions
				JIS G 3106 (1999)	SM 520 B	Steels for welded constructions
1.0345	ASTM A 414-01	K02201 A 414	Sheet of unalloyed steel for pressure tanks	JIS G 3115 (2000)	SPV 450	Heavy plate for pressure vessels
1.0425	ASTM A 414-01	K02505 A 414		JIS G 3118 (2000)	SGV 480	Heavy plate for pressure vessels
1.0481	ASTM A 414-01	K02704 A 414		JIS G 3118 (2000)	SGV 410	Heavy plate for pressure vessels
1.5415	ASTM A 204-99	K12320 A 204	Sheet of molybdenum alloyed steel for pressure tanks	JIS G 3458 (1988)	STPA 12	Tubes
1.7335	ASTM A 387-99	K11789 A 387	Sheet of Cr-Mo alloyed steel for pressure tanks	JIS G 3462 (1988)	STBA 22	Boiler and heat exchanger pipes
1.7380	ASTM A 387-99	K21590 22 (22L)	Sheet of Cr-Mo alloyed steel for pressure tanks	JIS G 4109 (1987)	SCMV 4	Heavy plate for pressure vessels
1.0305	ASTM A 106-99	K02501 A 106	Seamless tubes of high-temperature unalloyed steel	JIS G 3461 (1988)	STB 340	Boiler and heat exchanger pipes

Appendix A

Material designations according to foreign specifications

Material no. to DIN EN	KOREA Standard	KOREA Designation	KOREA Semi-finished product applications	CHINA Standard	CHINA Designation	CHINA Semi-finished product applications
1.0254	KS D 3583 (1992)	SPW 400	Welded tubes of carbon steel			
1.0255						
1.0038				GB T 700 (1988)	Q 235 B; U12355	(unalloyed structural steels)
1.0050	KS D 3503 (1993)	SS 490	General structural steels	GB T 700 (1988)	Q 275; U12752	(unalloyed structural steels)
1.0570	KS D 3517 (1995)	STKM 16C	Unalloyed steel tubes for general mechanical engineering	GB T 713 (1997)	16Mng; L20162	Plate for steam boilers
				GB T 8164 (1993)	16Mn; L20166	Strip for welded tubes
1.0345	KS D 3521 (1991)	SPPV 450	Heavy plate for pressure vessels for medium application temp.			
1.0425	KS D 3521 (1991)	SPPV 315	Heavy plate for pressure vessels for medium application temp.			
1.0481						
1.5415	KS D 3572 (1990)	STHA 12	Tubes for boilers and heat exchangers	GB 5310 (1995)	15MoG; A65158	Seamless tubes for pressure vessels
1.7335	KS D 3572 (1990)	STHA 22	Tubes for boilers and heat exchangers	YB T 5132 (1993)	12CrMo; A30122	Plate of alloyed structural steels
1.7380	KS D 3543 (1991)	SCMV 4	Cr-Mo steel for pressure vessels	GB 5310 (1995)	12Cr2MoG; A30138	Seamless tubes for pressure vessels
1.0305						

Material no. to DIN EN	USA			JAPAN		
	Standard	UNS designation (AISI)	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.0562	ASTM A 299-01	K02803 A 299	Plate of C-Mn-Si steel for pressure tanks	JIS G 3106 (1999)	SM 490 A;B;C;	Steels for welded constructions
	ASTM A 714-99	K12609 A 714 (II)	Welded and seamless tubes of high-strength low-alloy steel	JIS G 3444 (1994)	STK 490	Steels for welded constructions
1.0565	ASTM A 633-01	K12037 A633(D)	Normalized high-strength low-alloy structural steel			
	ASTM A 724-99	K12037 A724(C)	Plate of tempered unal-loyed steel for welded pressure tanks of layered construction			
1.0566	ASTM A 573-00	K02701 A 573	Plate of unalloyed struc-tural steel with improved toughness	JIS G 3126 (2000)	SLA 365	Heavy plate for pressure vessels (low temperature)
1.1106	ASTM A 707-02	K12510 A 707 (L3)	Forged flanges of alloyed and unalloyed steel for use in low temperatures	JIS G 3444 (1994)	STK 490	Tubes for general use

Appendix A

Material designations according to foreign specifications

Material no. to DIN EN	KOREA			CHINA		
	Standard	Designation	Semi-finished product applications	Standard	Designation	Semi-finished product applications
1.0562						
1.0565						
1.0566	KS D 3541 (1991)	SLA1 360	Heavy plate for pressure vessels (low temperature)	GB T 714 (2000)	Q420q-D; L14204	Steels for bridge construction
1.1106				GB 6654 (1996)	16MnR; L20163	Heavy plate for pressure vessels

Material no. to DIN EN	USA			JAPAN		
	Standard	UNS designation (AISI)	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.4511				JIS G 4305 (1999)	SUS 430LX	Cold-rolled sheet, heavy plate and strip
1.4512	ASTM A 240-02	S40900; A 240 (409)	Sheet and strip of heatproof stainless Cr and Cr-Ni steel for pressure tanks			
1.4301	ASTM A 240-02	S30400; A 240 (304)		JIS G 4305 (1999)	SUS 304	Cold-rolled sheet, heavy plate and strip
1.4306	ASTM A 240-02	S30403; A 240 (340L)		JIS G 4305 (1999)	SUS 304L	Cold-rolled sheet, heavy plate and strip
1.4541	ASTM A 240-02	S32100 A 240 (321)		JIS G 4305 (1999)	SUS 321	Cold-rolled sheet, heavy plate and strip
1.4571	ASTM A 240-02	S31635 A240 (316Ti)		JIS G 4305 (1999)	SUS 316Ti	Cold-rolled sheet, heavy plate and strip
1.4404	ASTM A 240-02	S31603 A240 (316L)		JIS G 4305 (1999)	SUS 316L	Cold-rolled sheet, heavy plate and strip
1.4435	ASTM A 240-02	S31603 A240 (316L)		JIS G 4305 (1999)	SUS 316L	Cold-rolled sheet, heavy plate and strip
1.4565	ASTM A 240-02	S34565 A240				
1.4539	ASTM A 240-02	N08904 A240 (904L)				
1.4529	ASTM B 625-99	N08925 B 625	Sheet and strip of low-carbon Ni-Fe-Cr-Mo-Cu alloys			

Material designations according to foreign specifications

Material no. to DIN EN	KOREA Standard	KOREA Designation	KOREA Semi-finished product applications	CHINA Standard	CHINA Designation	CHINA Semi-finished product applications
1.4511	KS D 3698 (1992)	STS 430LX	Cold-rolled sheet, heavy plate and strip			Cold-rolled sheet, heavy plate and strip
1.4512				GB T 4238 (1992)	0Cr11Ti; S11168	Hot-rolled sheet of heat-proof steel, ferritic
1.4301	KS D 3698 (1992)	STS 304	Cold-rolled sheet, heavy plate and strip	GB T 3280 (1992)	0Cr18Ni9; S30408	Cold-rolled sheet, heavy plate and strip
1.4306	KS D 3698 (1992)	STS 304L	Cold-rolled sheet, heavy plate and strip	GB T 3280 (1992)	00Cr19Ni10; S30403	Cold-rolled sheet, heavy plate and strip
1.4541	KS D 3698 (1992)	STS 321	Cold-rolled sheet, heavy plate and strip	GB T 3280 (1992)	0Cr18Ni10Ti; S32168	Cold-rolled sheet, heavy plate and strip
1.4571	KS D 3698 (1992)	STS 316Ti	Cold-rolled sheet, heavy plate and strip	GB T 3280 (1992)	0Cr18Ni12Mo2Cu2 S31688	Cold-rolled sheet, heavy plate and strip
1.4404	KS D 3698 (1992)	STS 316L	Cold-rolled sheet, heavy plate and strip	GB T 4239 (1991)	00Cr17Ni14Mo2; S31603	Cold-rolled sheet, heavy plate and strip
1.4435	KS D 3698 (1992)	STS 316L	Cold-rolled sheet, heavy plate and strip	GB T 3280 (1992)	00Cr17Ni14Mo2; S31603	Cold-rolled sheet, heavy plate and strip
1.4565						
1.4539						
1.4529	KS D 3698 (1992)	STS 317J5L	Cold-rolled sheet, heavy plate and strip			

Appendix A

Material designations according to foreign specifications

Material no. to DIN EN	USA			JAPAN		
	Standard	UNS designation (AISI)	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.4948	ASTM A 240-02	S30409 A240 (304H)	Sheet and strip of heatproof stainless Cr and Cr-Ni steel for pressure tanks			
1.4919	ASTM A 240-02	S31609 A240 (316H)				
1.4958	ASTM A 240-02	N 08810 A 240				
1.4828	ASTM A 167-99	S30900 A 167 (309)	Sheet and strip of stainless heatproof Cr-Ni steel	JIS G 4312 (1991)	SUH 309	Heatproof sheet and heavy plate
1.4876	ASTM A 240-02	N 08800 A 240	Sheet and strip of stainless heatproof Cr and Cr-Ni steel for pressure tanks	JIS G 4902 (1991)	NCF 800	Special alloy in sheet form
2.4858	ASTM B 424-98	N 08825 B 424	Sheet and strip of low-carbon Ni-Fe-Cr-Mo-Cu alloys (UNS N08825 and N08221)	JIS G 4902 (1991)	NCF 825	Special alloy in sheet form
2.4816	ASTM B 168-98	N 06600 B 168	Sheet and strip of low-carbon Ni-Cr-Fe and Ni-Cr-Co-Mo alloys (UNS N06600 and N06690)			
2.4819	ASTM B 575-99	N 10276 B 575	Sheet and strip of low-carbon Ni-Mo-Cr alloys			
2.4856	ASTM B 443-99	N 06625 B 443	Sheet and strip of Ni-Cr-Mo-Nb alloy (UNS N06625)	JIS G 4902 (1991)	NCF 625	Special alloy in sheet form
2.4610	ASTM B 575-99	N 06455 B 575	Sheet and strip of low-carbon Ni-Mo-Cr alloys			
2.4360	ASTM B 127-98	N 04400 B 127	Sheet and strip of Ni-Cu alloy (UNS N04400)			

Material no. to DIN EN	KOREA Standard	KOREA Designation	KOREA Semi-finished product applications	CHINA Standard	CHINA Designation	CHINA Semi-finished product applications
1.4948						
1.4919						
1.4958						
1.4828	KS D 3732 (1993)	STR 309	Heatproof sheet and heavy plate	GB T 1221 (1992)	1Cr20Ni14Si2; S38210	Heatproof steels, austenitic
1.4876	KS D 3532 (1992)	NCF 800	Special alloys in sheet and heavy plate form	GB T 15007 (1994)	NS 111; H01110	Stainless alloys
2.4858	KS D 3532 (1992)	NCF 825	Special alloys in sheet and heavy plate form	GB T 15007 (1994)	NS 142; H01420	Stainless alloys
2.4816				GB T 15007 (1994)	NS 312; H03120	Stainless alloys
2.4819				GB T 15007 (1994)	NS 333; H03330	Stainless alloys
2.4856	KS D 3532 (1992)	NCF 625	Special alloys in sheet and heavy plate form	GB T 15007 (1994)	NS 336; H03360	Stainless alloys
2.4610				GB T 15007 (1994)	NS 335; H03350	Stainless alloys
2.4360						

Appendix A

Permissible operating pressures and temperatures for threaded fittings in malleable cast iron

Threaded fasteners of malleable cast iron are applicable up to the operating pressures indicated in the table below, depending on type of fluid and operating temperature.

permissible operating pressure for the fluids					
DN	d inch	water and gas up to max. 120° C	gases and steam up to max. 150° C	gases and steam up to 300° C	oils up to 200° C
nipples, flat sealing threaded fasteners					
6 - 50	¼ - 2	65 bar	50 bar	40 bar	35 bar
conically sealing threaded fasteners					
6 – 32	¼ - 1 ¼	65 bar	50 bar	40 bar	35 bar
40	1 ½	65 bar	50 bar	40 bar	30 bar
50	2	55 bar	40 bar	32 bar	24 bar

Sealing is to be carried out with special care. The sealing materials are to be selected according to the operating conditions. Only approved sealing materials must be applied for sealing of threaded fasteners in drinking water and gas insulations.

Only high-quality threads are appropriate for high operating requirements.

Resistance tables

The tables below provide an overview of the resistance of the metal materials most commonly used for our products to different media.

The tables have been drawn up on the basis of relevant sources in accordance with the state of the art; they make no claims to completeness. The data constitutes recommendations only, for which no liability can be accepted.

The main function of the tables 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. Any uncertainties with regard to the exact composition of the working medium, differences in the operating states and other boundary operating conditions must be taken into consideration.

APPENDIX B

Resistance tables

Meanings of abbreviations:

dr:	dry condition	cs:	cold-saturated (at room temperature)
mo:	moist condition	sa:	saturated (at boiling point)
hy:	hydrous solution	bp:	boiling point
me:	melted	adp:	acid dewpoint

Assessment	Corrosion behaviour	Suitability
0	Resistant	Suitable
1	Eroding corrosion with reduction in thickness of up to one 1 mm/year	Of restricted suitability
P	Risk of pitting corrosion	
S	Risk of stress corrosion cracking	
2	Hardly resistant, equal surface corrosion with reduction in thickness of over 1 mm up to 10 mm/year	Not recommended
3	Not resistant (different forms of corrosion)	Unsuitable

Pitting corrosions

Locally restricted corrosion can occur under certain conditions; it is referred to as pitting corrosion (Figs B.1 and B.2) on account of its appearance. It is caused by the effects of chlorine, bromine and iodine ions, especially when they are present in hydrous solutions.

This selective type of corrosion cannot be calculated, unlike surface corrosion, and can therefore only be kept under control by choosing the best possible material.

The resistance of stainless steels to pitting corrosion increases in line with the molybdenum content in the chemical composition of the material. As a rough guide, the resistance of materials to pitting corrosion can be compared with the so-called cumulated reaction values (WS = Cr + 3.3 : Mo); the higher the cumulated reaction values, the greater the resistance.

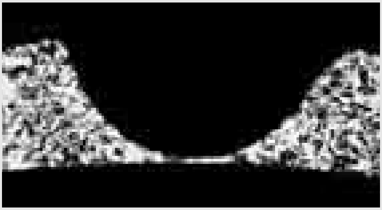


Fig. B.1: Pitting corrosion on a cold strip made of austenitic steel. Sectional view enlarged 50x

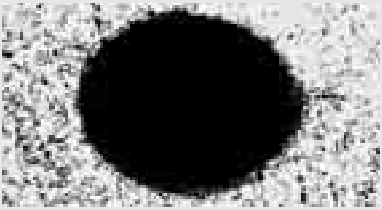


Fig. B.2: Plan view of the pitting corrosion shown in Fig. B.1

Intercrystalline corrosion

Intercrystalline corrosion is a local, selective type of corrosion which primarily affects the grain boundaries. It is caused by deposits in the material structure, which lead to a reduction in the corrosion resistance in the regions close to the grain boundaries. In stainless steels this type of corrosion can advance up to the point where the grain composition is dissolved (grain disintegration; Fig. B.3).

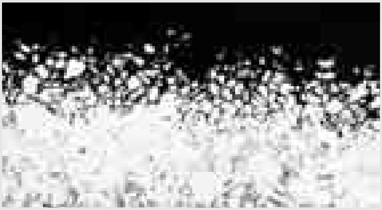


Fig. B.3: Intercrystalline corrosion (grain disintegration) in material 1.4828. Sectional view enlarged 100x

These deposit processes are dependent on temperature and time in CrNi steels, whereby the critical temperature range is between 550 and 650 °C and the period up to the onset of the deposit 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 heat treatment (1000–1050 °C).

This type of corrosion can be avoided by using stainless steels with a low carbon content (≤ 0.03 % C) or containing stabilizing elements, such as titanium or niobium. Our stainless-steel products are made using stabilized or low-carbon material qualities (e.g. 1.4541, 1.4571, 1.4306).

The susceptibility of materials to intercrystalline corrosion can be demonstrated by the standardized test (DIN EN ISO 3651-2). Our order specifications and inspection regulations demand that evidence be provided of the resistance of the materials to intercrystalline corrosion, in accordance with the above standard, by the material supplier.

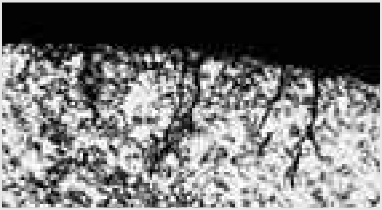


Fig. B.4: Transcrystalline stress corrosion cracking in a cold strip made of austenitic steel. Sectional view enlarged 50x

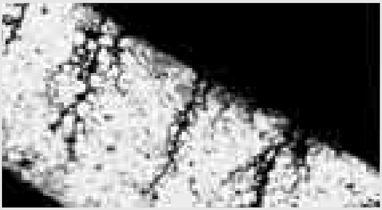


Fig. B.5: Transcrystalline stress corrosion cracking in a cold strip made of austenitic steel. Sectional view enlarged 50x

Stress corrosion cracking

This type of corrosion is observed most frequently in austenitic materials, which are subjected to internal or external tensile stresses and exposed to a corrosive agent. The most important agents which cause corrosion are alkaline solutions and those containing chloride. The form of the crack may be either transcrystalline (Fig. B.4) or intercrystalline (Fig. B.5). Whereas the transcrystalline form only occurs at temperatures higher than 50 °C (especially in solutions containing chloride), the intercrystalline form can be established at temperatures as low as room temperature in austenitic materials in neutral solutions containing chloride.

At higher temperatures stress corrosion cracking can be caused by very small concentrations of chloride or lye, whereby the latter always leads to the transcrystalline form. Stress corrosion cracking takes the same forms in non-ferrous metals as in austenitic materials. Damage caused by intercrystalline stress corrosion cracking can occur in nickel and nickel alloys in highly concentrated lyes at temperatures above 400° C, and in solutions or water vapour containing hydrogen sulfide at temperatures above 250° C.

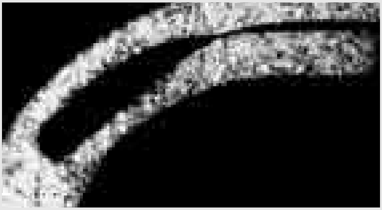


Fig. B.6: Crevice corrosion in a cold strip made of austenitic steel. Sectional view enlarged 50x

Comprehensive, detailed information on the operating conditions, forming the basis of a careful choice of materials, are essential in order to prevent this type of corrosion damage.

Crevice corrosion

Crevice corrosion is a localized, seldom encountered form of corrosion found in crevices which are the result of the design or of deposits (Fig. B.6). This corrosion type is caused by the lack of oxygen in the crevices, oxygen being essential in passive materials to preserve the passive layer.

Because of the risk of crevice corrosion design and applications which represent crevice or encourage deposits should be avoided, because under deposits there are the risks of crevice corrosion.
The resistance of high-alloy steels and Ni-based alloys to this type of corrosion increases in the line with the molybdenum content of the materials; as with pitting corrosion, the cumulated reaction values can be taken as a criteria for assessing the resistance to crevice corrosion

Contact corrosion

Contact corrosion is the term used to describe the corrosion which can result from a combination of different materials.

So-called “practical galvanic potentials” are used in practice to assess the risk of contact corrosion, e.g. in seawater (Fig. B.7). Metals which are close together on this graph are mutually compatible; the anodic metal corrodes increasingly in line with the distance between two metals.

Contact corrosion

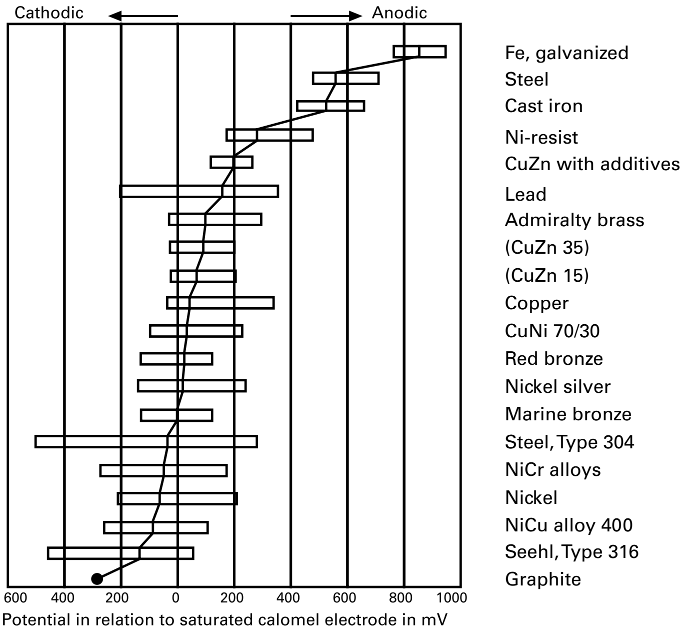


Fig. B.7:Galvanic potentials in seawater

Source: DECHEMA material tables

The materials which can be encountered in both the active and passive states must also be taken into account. A CrNi steel, 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.

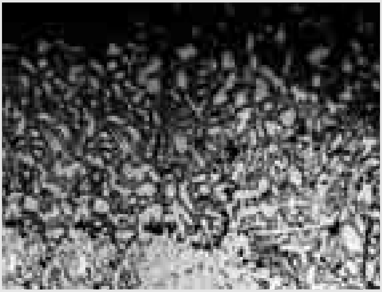


Fig. B.8: Dezincing in a copper-zinc alloy (CuZn 37). Sectional view enlarged 100 x

Dezincing

Dezincing is a type of corrosion which occurs primarily in copper-zinc alloys with more than 20% zinc (Fig. B.8).
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 dezincing can be either of the surface type or locally restricted, and can also occur deeper inside.

Conditions which encourage this type of corrosion include thick coatings made of corrosion products, lime deposits from the water or other deposits of foreign bodies on the surface of the metal, as well as water at high temperatures, with a high chloride content and in conjunction with low flow velocities.

APPENDIX B

Resistance tables

Corrosion types
According to DIN 50900 (s.a. DIN EN ISO 8044), corrosion is the reaction of a metal material to its environment, which causes a measurable change in the material and which may result in corrosion damage. In most cases the corrosion takes the form of an electrochemical process, whereby different types of corrosion can occur, depending on the material and on the corrosion conditions. The most important types of corrosion of ferrous and non-ferrous metals are described in brief below.

Equal surface corrosion
The entire surface of the material is affected by this type of corrosion. The loss in weight which occurs is generally specified either in g/m^{2}h or as the reduction in the wall thickness in mm/year. This corrosion type includes the rust which commonly forms on normal steel. It can only affect stainless steels under extremely unfavourable conditions (e.g. spatter rust or foreign rust). Other types of eroding corrosion can be caused by liquids, such as acids, bases and salt solutions.

The wall-thickness allowance which is usually made when designing components which are subject to corrosion is not applied when designing the flexible, metal pipe elements, which usually have thin walls. This must be taken into account in the choice of materials. The resistance of a material to equal surface corrosion increases in line with its surface quality.

Appendix B

Resistance tables

Medium: Designation / Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
1.3-butadiene $CH_2{=}CHCH{=}CH_2$							0	0	0		0				0	0			0	
Acetic acid $CH_3{-}COOH$	5	20	3	0	0	0	0	1	0	0	1				0	3	0	0	0	
	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 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 aldehyde $CH_3{-}CHO$	100	bp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acetic anhydride $(CH_3{-}CO)_2O$	all	20	1	0	0	0	0	1	0	0	1	1	3	0	0	1	0	0	0	0
	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
Acetic anilide = Antifebrine		<114	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Acetone CH_3COCH_3	100	bp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acetyl chloride CH_3COCl		20	1	1	1	1	1	1	0	0	1	1		1	1	1		0	1	0
Acetylen tetrachloride $CHCl_2{-}CHCl_2$ see tetrachloroethane																				
Acetylene dr $HC{=}CH$		20	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	3
dr		200	1	0	0	0	0	0	0	0	0	3	3	3	3	3	0	0	1	3
Acetylene dichloride hy $C_2H{=}CCl_2$	5	20																	1	
dr	100	20	0	P	P	P	0	0	0		0					0			0	
Adipic acid $HOOC(CH_2)_4COOH$	all	200	0	0	0	0	0	0	0	0	0					0	0	0	0	0
Alcohol see ethyl/methyl alcohol																				
Allyl alcohol CH_2CHCH_2OH	100	bp			0	0	0	0	0	1	0					0				

Appendix B

Resistance tables

Medium			Materials																	
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Allyl chloride CH_2=$CHCH_2Cl$	100	25				0	0	0	0		0					0				
Alum $KAl(SO_4)_2$ hy hy	100 10 10 sa	20 20 <80	1 1 1	1 0 1 3	0 0 0 3	0 0 0 1	0	1	0	0 1 1 3		1 1 1 3	1	1	1 1		0 0	0 0 0	1 1	
Aluminium me Al		750	3	3	3	3					3					3	3			
Aluminium acetate hy $(CH_3{-}COO)_2Al(OH)$ hy	3 sa	20	3 3	0 0	0 0	0 0				0 1						0	0 0	1		
Aluminium chloride hy $AlCl_3$	5	20	3	3	3	P	1	1	0	0	1	3	3	1	3	1	0	0	3	1
Aluminium fluoride hy AlF_3	10	25	3	3	3	3				1	1				1	1	0	3	1	1
Aluminium formate $Al(HCOO)_3$			1	0	0	0	0	0	0	0				0	1	0	0	0	0	
Aluminium hydroxide hy $Al(OH)_3$	10	20	1	3	0	0	0		0	0	1	0			0		0	0	1	
Aluminium nitrate $Al(NO_3)_3$			0	0	0	0	0	0	0	0	0						0	0	1	
Aluminium oxide Al_2O_3		20	1	1	0	0	0		0	0	3	0	0	0	0			0	3	
Aluminium potassium sulphate see alum																				
Aluminium sulphate hy $Al_2(SO_4)_3$ hy	10 15	<bp 50	3 3	3 3	3 3	0 1	0	1 1	0 1	1 1	3 1	3 1	3 1	3 1	3 1	1 1	0 0	0 0	3 3	
Ammonia dr NH_3 hy hy hy	10 2 20 sa	20 20 40 bp	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0	0 0 1 3	0 0 1 1	0 0 1 1	1 0 3 3	0 3	S S	S S	0 3 3	3 3 3	0 0 0 0	0 0 0 0	0 1	0 0
Ammonia bromine NH_4Br see ammonium bromide																				

Medium			Materials																			
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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 acetate $CH_3–COONH_4$			1	0	0	0												0	0	
Ammonium alum hy $NH_4Al(SO_4)_2$	cs	20			0	0											3	0		
Ammonium bicarbonate hy $(NH_4)HCO_3$			0	0	0	0	1	3			3	3			3			0	0	
Ammonium bifluoride hy NH_4HF_2	10	25	3	3	3	3				0							3	0		
hy	100	20	3	3	0	0				0							3	0		
Ammonium bromide hy NH_4Br	10	25	3	P	P	P	0		0	1								0	1	
Ammonium carbonate hy $(NH_4)_2CO_3$	1	20	0	0	0	0	0	0	0	1	0	1			1			0	0	0
hy	50	bp	0	0	0	0	0	0	0	1	0	1			1	1		0	0	0
Ammonium chloride hy NH_4Cl	1	20	1	P	P	P	0	0	0	0	0	1	S	S	1	1	0	0	1	1
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 NH_4F	10	25	1	1	0	0				0							1	0		
hy	hg	70	3																	
hy	20	80	3		3	3				0			3	3	3			0		
Ammonium fluosilicate hy $(NH_4)_2SiF_6$	20	40	3		1	0	0	0	0	0	0					0				
Ammonium formate hy $HCOONH_4$	10	20	1	0	0	0	0	0	0	0	0						0	0	0	
hy	10	70																0	0	
Ammonium hydroxide NH_4OH	100	20		0	0	0	0	0	0	0	3	3			3	0	0	0	1	
Ammonium nitrate hy NH_4NO_3	5	20	3	0	0	0	0	1	0	0	3	3			3			0	0	
hy	100	bp	3	0	0	0	0			0	3		3	3	3			0	0	
Ammonium oxalate hy $(COONH_4)_2$	10	20	1	1	0	0		1	0	0	1	1			1		0	0		
hy	10	bp	3	3	1	0		1	0		1	1			1		1	0		
Ammonium perchlorate hy NH_4ClO_4	10	20		P	P	P				1							0			
Ammonium persul-phate $(NH_4)S_2O_8$ hy	5	20		0	0	0	0	1	0	0	3	3			3	3	0	0	3	
hy	10	25	3	1	1	1				0	3	3	3	3	3	3	0			3

Medium				Materials																		
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals						
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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 phosphate $NH_4H_2PO_4$	hy	5	25	0	1	1	0	0	1	0	0	1	1			3	1	0	0	1	
Ammonium rhodanide NH_4CNS			70		0	0	0											0		0	
Ammonium sulphate $(NH_4)_2SO_4$	hy hy hy	1 10 sa	20 20 bp	0 0 1	0 1	0 1 0	0 0	0 0	1 3	0	0 1 3	1 1 2	3 3 3	 3	 1	3 3	1 1	0 3 0	0 0 0	P P	 1
Ammonium sulphite $(NH_4)_2SO_3$		cs sa	20 bp		1 3	0 1	0 1	3 3	3 3			3 3	3 3			3 3	3 3	0 0	0 0		
Ammonium sulphocyanate see ammonium rhodanide																					
Amyl acetate $CH_3–COOC_5H_{11}$		all 100	20 bp	 1		 1	 1	1	1 0	1 1	1 1	1 0	1 0			1	1 0		1	1 0	
Amyl alcohol $C_5H_{11}OH$		100 100	20 bp	0 1	0 0	0 0	0 0		0	0	0	0	0	0	0	0	0	 0	0	 1	
Amyl chloride $CH_3(CH_2)_3CH_2Cl$		100	bp	1		P	P	0	1	0	0	1	0			0	1	0	0	3	
Amyl thiol		100	160			0	0				0										
Aniline $C_6H_5NH_2$		100 100	20 180			0 1	0 1	0	1	0	0	3 1	3	3	3	3	3	0		0 3	0 0
Aniline chloride see aniline hydrochloride																					
Aniline hydrochloride $C_6H_5NH_2HCl$	hy hy	5 5	20 100		P P	P P	P P				0 0		3			3	3	0 0	0	3	
Aniline sulphate			20				0				0									1	
Aniline sulphite	hy hy	10 cs	20 20				0 0		1		0 0										
Antifreeze Glysantine			20		0	0	0	0	0	0	0	0					0	0	0	0	
Antimony Sb	me	100	650	3						0	0							3		3	
Antimony trichloride $SbCl_3$	dr hy		20 100	0 1	3 3	3 3	3 3										0 0			3 3	

Medium			Materials																				
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Aqua regia $3HCl+HNO_3$		20	3	3	3	3		3		3		3	3	3	3		0	0		1
Arsenic As		65 110			0 1	0 1														
Arsenic acid hy H_3AsO_4 hy	 90	20 110	3 	 3	0 3	0 3		 3				 3			 3				 3	
Asphalt		20	0	0	0	0						0	0	0	0	0			0	
Azobenzene $C_6H_5{-}N{=}N{-}C_6H_5$		20		0	0	0	0	0	0	0	0						0	0	0	
Baking powder mo			1	0	0	0	0	0	0	0	0				1				0	
Barium carbonate $BaCO_3$		20	3	0	0	0	0		0	0	0	0	0	0	0		0	0	1	
Barium chloride hy $BaCl_2$ hy	5 25	20 bp		P P	P P	P P	1 1	1 1	0 0	0 0	1 1	3			3	1 1	0 0	0 0	3 P	
Barium hydroxide $Ba(OH)_2$ see sodium hydroxide																				
Barium nitrate hy $Ba(NO_3)_2$	all	bp		0	0	0	0	1	0			3			3		0	0	0	
Barium sulphate $BaSO_4$		25	0	0	0	0	0		0		0	0	0	0	0	1	0	0	0	
Barium sulphide BaS		25		0	0	0						3	1	3	3					
Basic aluminium acetate see aluminium acetate																				
Beer	100 100	20 bp	3 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	0 0	1 1	0 0	0 0	0 0	0 0	
Benzaldehyde dr $C_6H_5{-}CHO$		bp		0	0	0					1						1	0	0	0
Benzene	100 100	20 bp		0 0	0 0	0 0	0	0 1	0 1	1 1	0 1	0 1	0	0		0 1	0 1	0 0	0 1	1
Benzenesulfonic acid hy $C_6H_5{-}SO_3H$ hy	5 5	40 60	3 3	0 3	0 1	0 1														

Appendix B

Resistance tables

Medium				Materials																	
Designation Chemical formula		Concentration	Temperature		Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
		%	°C	Non/low alloy steels	Ferritic	Austenitic	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
Benzine		100	25		0	0	0	0	0	0	0	0	0	0	0	1		0		1	
Benzoic acid C_6H_5COOH	hy hy	all all	20 bp	1 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	 3	0 0	0 0	0 0	0 0	0 0	0 3	
Benzyl alcohol $C_6H_5–CH_2OH$		all	20	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
Biphenyl $C_6H_5–C_6H_5$		100 100	20 400	0 0	0 0	S S	S S	0 0	0 0	0 0	0 0	0 0	0	0	0	0 0	0 0	0 0	0 0	0 0	
Blood			20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Boiled acid			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Borax $Na_2B_4O_7$	hy hy	cs sa		1 3	0 0	0 0	0 0						0	0	0	0		0 0	0 0	0 1	
Boric acid H_3BO_3	hy hy hy	50 50 70	100 150 150	3 3 3	0 1 1	0 0 1	0 0 1	0 0 0	1 1 1	0 0 0	0 0 0	1 1 1	 0	1 1 1	 1	1 1 1	1 1 1	0 0 0	0 0 0	1 1 1	1 0 0
Boron B			20 900	0 0	0	0	0														
Bromine Br	dr mo	100 100	20 20	P P	P P	P P	P P	1	0 3	0	0 3	0 0	 1	0 3	0 1	0 3	0 0	3 0		3 3	0 0
Bromine water		0.03 1	20 20		P P	P P	P P														
Bromoform $CHBr_3$	dr mo		20	0 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0			0 0	0 0				3 3	
Butane C_4H_{10}		100 100	20 120	0	0 1	0 0	0 0	0	0	0	0 1	0	0	0	0	1	0			1	
Butanol $CH_3–CH_2–CH_2–$ CH_2OH		100 100	20 bp	0 0	0 0	0 0	0 0	0	0 0	0	0 0	0 0	0	0	0	0	0	0 0	0 0	0 0	0
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	
Butylacetate $CH_3COOC_4H_9$			20 bp	1 1	0 0	0 0	0 0	0 0		0 0	0 0	1 0	0 0	0	0	0 0		0 0	0 0	0 0	0

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Butyric acid $CH_3–CH_2–CH_2–COOH$	hy hy	cs sa	20 bp	3 3	0 3	0 3	0 0	1 1	3 3	0 0	0 0	1 1					3 3			0 1	
Cadmium Cd	me					3	3														
Calcium Ca	me		850	3		3	3														
Calcium bisulphite $CaSO_3$		cs sa	20 bp	3 3	3 3	0 3	0 0						1	3	1	0		0 0			
Calcium carbonate $CaCO_3$			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Calcium chlorate $Ca(ClO_3)_2$	hy hy	10 10	20 100		P 3	P 3	P P	1 1	1 1	1 1	1 1	1 1	3 3			1 1	1 1		0 0		
Calcium chloride $CaCl_2$	hy hy	5 10 cs sa	100 20	3 3 3 3	P P P 3	P P P P	P P P P	 0 0 0	 0 0 0	 0 0 0	0 0 0 0	 0 1 3	 0 0 0	 3 3 3	 1	 1 0	 0 1	0 0 0 P	0 0 0 0	3 3 3 3	
Calcium hydroxide $Ca(OH)_2$				0	0	0	0	1	1	0	0	1	0	0	0	1	1	0	0	3	
Calcium hypochlorite $Ca(OCl)_2$	hy hy	2 cs	20	3 3	3 3	3 3	P P	0	3	0	0 1	3	3			3	3	0	0 0	3 3	
Calcium nitrate $Ca(NO_3)_2$		 all	20 100	3 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0						0 0		0 0	
Calcium oxalate $(COO)_2Ca$	mo		20	1	0	0	0	0	0	0	0	0	0	0	0			0	0	3	
Calcium oxide CaO			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	
Calcium sulphate $CaSO_4$	mo mo		20 bp	1 1	0 0	0 0	0 0	0 0		0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	
Calcium sulphite $CaSO_3$	hy hy	cs sa		0 0	0 0	0 0	0 0									1 1		0 0	0 0	1 1	
Carbolic acid $C_6H_5(OH)$	 hy	 90	20 bp bp	0 3 3	0 3 3	0 3 3	0 0 0	0	1	0	0 1 1	1 0 0	0			0	1 0 0	0 0 0	0 0 0	0 3 3	

Appendix B

Resistance tables

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
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	dr		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
tetrachloride	dr		bp	1	0	0	0				0	0		0	0	0	0	0		3	
CCl_4	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 see carbon dioxide																					
Caustic-soda solution see sodium hydroxide																					
Chilean nitrate see sodium nitrate																					
Chloral CCl_3–CHO			20								0								0	3	
Chloramine				3	3	1	0	0		0	0	0									
Chloric acid $HClO_3$	hy		20	3	3	3	3	0			0							0	0	3	3
Chlorinated lime see 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 ClO_2	hy	0.5	20	3	3	3	3				1				3			0	0		
Chloroacetic acid		all	20	3	3	3	L	3		1	1	3	3			3		0	0	3	
CH_2Cl–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 C_2H_5Cl see ethyl chloride																					

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
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	
Chloronaphthaline $C_{10}H_7Cl$				0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	
Chlorophenol $C_6H_4(OH)Cl$				1	0	0	0				0										
Chlorosulphon acid	hy	100	20	0	0	0	0	0	0	0	0	0				0	0	0	0	0	3
$HOSO_2Cl$	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	hy	5	90	3	3	3	3				1	3	3	3	3	3	3	0	0		
(H_2CrO_4)	hy	10	20	3	3	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	
Chromic-acid anhydride Cr_2O_3 see chromium oxide																					
Chromium oxide CrO_3				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
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	<80	3	3	0	0		0		0										
CH_2COOH (COH)	hy	all	bp	3	3	3	0		0		0										
Combustion gases free from S or H_2SO_4 and Cl			≤400	0	0	0	0				0										
with S or H_2SO_4 and Cl			>adp 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	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Copper(II)nitrate $Cu(NO_3)_2$	hy hy hy	1 50 cs	20 bp		0 0 0	0 0 0	0 0 0	0 0	3 3 3		0 1 1	3 3 3	3 3			3 3	3 0 3	0 0 0	0 3 0	3 3	
Copper(II)sulphate $CuSO_4$	hy hy	cs sa		3 3	0 1	0 0	0 0	0 0	3 3		0 0	3 3	3			3 3	3 3	0 0	0 0	3 3	 0
Copper acetate $(CH_3–COO)_2$	hy hy		20 bp	3 3	0 0	0 0	0 0	0	1	0	0	1	3		3 3	3	1	0 0	0	3 3	1
Cresol $C_6H_4(CH_3)OH$		all all	20 bp	3 3	1 1	0 1	0 0		0 0	0 0	 1	0 0					0 0	0 0		0 3	0 0
Crotonaldehyde $CH_3–CH{=}CH–CHO$			20 bp	3		0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0				0 0	
Cyclohexane $(CH_2)_6$				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Diammonium phosphate s. ammonium phosphate																					
Dibromethane see ethylene dibromide																					
Dichlorodifluor- methane CF_2Cl_2	dr dr mo		bp 20 20			0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0							0 0 0	0 0 0	
Dichloroethane $CH_2Cl–CH_2Cl$ see ethylene dichloride																					
Dichloroethylene $C_2H_2Cl_2$ see acethylene dichloride																					
Diethyl ether $(C_2H_5)_2O$				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ethane $CH_3–CH_3$			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ether $(C_2H_5)_2O$ see diethyl ether																					
Ethereal oils			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Medium			Materials																		
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
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
Ethylbenzene $C_6H_5–C_2H_5$			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl chloride C_2H_5Cl			0	S	S	S	0	0	0	1	0	0	1	1	1	0		0	1	0
Ethylene $CH_2=CH_2$		20	0	0	0	0													0	
Ethylene dibromide $CH_2Br–CH_2Br$			1		0	0									0			3		
Ethylene dichloride 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 $CH_2OH–CH_2OH$	100	20	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	
Exhaust gases see combustion gas																				
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
Fixing salt see sodium thiosulphate																				
Flue gases see combustion gases																				
Fluorine 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	
Fluorosilicic acid	100	20	3	3	P	P				1		1	3	1	1				3	
$H_2(SiF_6)$	25	20	3	3	3	3	1	1	1	1	3		3	1	1	1	3		3	
	70	20	3	3	3	3				1									3	
vapour			3	3	3	3				1							2		3	

Appendix B

Resistance tables

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
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	
Fuels																					
Benzine			20		0	0	0	0	0	0	0	0		0	0	0	0			0	
			bp		0	0	0	0	0	0	0	0		0	0	0	0			0	
Benzene			20		0	0	0	0	0	0	0	0		0	0	0	0			0	
			bp		0	0	0	0	0	0	0	0		0	0	0	0			0	
Benzine-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 see acetic acid																					
Glass	me		1200	1		1	1														
Glauber salt see sodium sulphate																					
Gluconic acid $CH_2OH(CHOH)_4–COOH$		100	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Glucose $C_6H_{12}O_6$	hy		20		0	0	0						0	1	0	0		0		0	
Glutamic acid			20	1	P	P	0	0	1	0	0	1					1				
$HOOC–CH_2–CH_2–CHNH_2–COOH$			80	3	P	P	0		1		1										
Glycerine		100	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
$CH_2OH–CHOH–CH_2OH$		100	bp	1	1	0	0		0	0	0	0		1		0	0		0	0	

Medium			Materials																	
Designation Chemical formula	Concentration	Temperature		Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
	%	°C	Non/low alloy steels	Ferritic	Austenitic	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
Glycol $CH_2OH{-}CH_2OH$ see ethylene glycol																				
Glycolic acid $CH_2OH{-}COOH$		20	3	1	1	1				0							0		1	
		bp	3	3	3	3				0							0		1	
Glysantine see antifreeze																				
Hexachloroethane $CCl_3{-}CCl_3$ see perchloroethane																				
Hexamethylene-tetramine hy $(CH_2)_6N_4$	20	60	1		0	0				0										1
hy	80	60	3		0	0				0										
Household ammonia see ammonium hydroxide																				
Hydrazene $H_2N{-}NH_2$		20	0		0		3	3			3					3			1	
Hydrazene sulphate hy $(N_2H_6)SO_4$	10	bp	3		3	3														
Hydrobromic acid HBr		20	3	3	3	3	3	3	3	3	3	3	3	3	3	3		0	3	3
Hydrochloric acid HCL	0.2	20	3	3	P	P				0						P	0	0		
	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 see hydrogen chloride																				
Hydrofluoric acid HF	10	20	3	3	3	3	1	1	0	0	1		3	3	3	1	3	3	3	
	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	

Medium: Designation, Chemical formula		Concentration %	Temperature °C	Materials	Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
				Non/low alloy steels	Ferritic	Austenitic	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			<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 cyanate	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 peroxide H_2O_2		all	20	3	3	0	0	0	1	0	0	1	3	3	3		3	1	3	0	0
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
Hydroiodic acid	dr		20	0	0	0	0														
	mo		20	3	3	3	3														
Hypochlorous acid HOCl			20	3	3	3	3											0		3	
Indol			20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Ink see 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														
Iron(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	
Iron(II) sulphate $FeSO_4$	hy	all	bp	0	0	0	0				0	0					3	0		3	

Medium: Designation / Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Iron(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		
Iron(III) nitrate	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				
Iron(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	
Isatine			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
$C_8H_5NO_2$																					
Kalinite																					
see alum																					
Ketene			20		0	0	0	0	0	0	0						0	0	0	0	
$(C_nH_{2n}+1)_2C{=}C{=}O$			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	
$(CH_3{-}COO)_2Pb$																					
Lead acide		<20	<30					0	0	0		1					1				
$Pb(N_3)_2$																					
Lead nitrate	hy		100	1	0	0	0	0	0	0	0	0						0	0	0	
$Pb(NO_3)_2$																					
Lime																					
CaO																					
see calcium oxide																					
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	P	0	0	0	0	1					0	0			
LiCl																					

Appendix B

Resistance tables

Medium			Materials																		
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals						
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Lithium hydroxide hy LiOH	all	20	1	0	0	0	0	0	0		0					0	0			
Magnesium me Mg		650		1	3	3	3	3		3	3	3	3	3	3	3	0	0	3	
Magnesium hy **carbonate** $MgCO_3$ hy		20 bp	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0			0 0	0 0	0 0	0 0	1 1	
Magnesium chloride hy $MgCl_2$ hy hy	5 5 50	20 bp bp	3 3 3	3 3 3	P 3 3	P 3 3	0 0	0 0	0 0	0 0 0	0 0	3 3			3 3	0 0	0 0 0	0 0 0	3 3 3	
Magnesium hydroxide hy $Mg(OH)_2$ hy	cs sa		0 0		0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	3 3	
Magnesium nitrate $Mg(NO_3)_2$	cs		0	0	0	0	3	3		3	0	3	0	0	3	3	0	0	1	
Magnesium oxide MgO s. magnesium hydroxide																				
Magnesium sulphate hy $MgSO_4$ hy hy	0.1 5 50	20 20 bp	0 3 3	1 1 1	0 0 0	0 0 0	0	1	0	0 0 1	1	0	3	0	0	1	0 0 0	0 0 0	3 0 0	
Maleic acid hy HOOC–HC=CH–COOH hy	5 50	20 100	3 3	0 0	0 0	0 0	0	1 1	0	0 0	1	0				1			0 0	
Maleic anhydride	100	285								0										
Mallic acid hy hy	 50	20 100	3 3	3 3	0 0	0 0	0 0	1 1	0 0	0 0	1 1	3 3	 3	 3	3 3	3 3	0 0	0 0	0 0	
Malonic acid $CH_2(COOH)_2$		20 50 100			1	1	1 1 3	1 1 3	1 1	1 1 3	1 1 3					1 1 3	1 1 3		1	
Manganese(II) hy **chloride** $MnCl_2$ hy	5 50	100 20	3 1	P 3	P P	P P	1 1	1 1	1 1		1 1	3 3			3 3	1 1	0 0	0 0		
Manganese(II) **sulphate** $MnSO_4$	cs			0	0	0	0	0	0	0	0				0	0	0			
Maritime climate see atmosphere																				
Methanol see methyl alcohol																				

Medium			Materials																	
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Menthol $C_{10}H_{19}OH$				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mercury dr Hg	100 all	20 <500	0 1	P 1	P 1	P 0		0 0	0 0	0 0	3 3	3 3	3 3	3 3	3 3	0	0 0	 0	1 3	3
Methane CH_4		200 600	0	0	0	0	0	0	0 0	0	0	0	0	0	0 0	0			0	
Methyl acetate CH_3COOCH_3	60 60	20 bp	0 0		0 0	0 0				0 0							0 0	0 0		
Methyl alcohol CH_3OH	<100 100	20 bp	 1	0 3	0 1	0 1	0	0 0	0 0	0 0	0 0		 0	 0	0 0	0 0	0 0	1 0	 1	 0
Methyl chloride dr CH_3Cl mo mo	100	20 20 100	0 3	0 P P	0 P P	0 P P		0 0 0	0 0 0	0	0		0	0	0 1	0	0 0 0		0 3 3	
Methylamine hy $CH_3–NH_2$	25	20	1	0	0	0	0		0	0	3	3	3	3	3		0		0	
Methyldehyde see formaldehyde																				
Methylene dichloride dr CH_2Cl_2 mo mo		20 20 bp	0	P P P	P P P	P P P	 0 1		 1 1	 1 1	 1 1	0 0 1			 0 0	 1 1	0 0 0		0 3 3	
Milk of lime $Ca(OH)_2$		20 bp	0 0	1 1	0 0	0 0													0 0	
Milk sugar see lactose																				
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	1	1														
5 15 80		134		3	1	1														

Medium: Designation, Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Molasses				0	0	0	0	0	0	0	0					0	0	0	0	
Monochloroacetic acid see chloroacetic acid																				
Naphthaline $C_{10}H_8$	100	20	0	0	0	0											0		1	
	100	390	0	0	0	0														
Naphthaline chloride	100	45								0										
	100	200								0										
Naphthalinesulphonic acid $C_{10}H_7SO_3H$	100	20	0		0	0				0										
	100	bp		3	3	3				0										
Naphthenic acid hy	100	20		P	P	P	0	0	0		0					1			0	
Nickel(II) chloride hy $NiCl_2$	10	20	3	P	P	P	0	1	0	0	1	1	3	1	3	1	0			0
hy	10	bp	3	3	P	P				0							0			
	tot	70				0				1										
Nickel(II) nitrate hy $Ni(NO_3)_2$	10	25	3	0	0	0	0	0	0	0	3	3			3	3	0	0	3	
hy	<100	25	3	0	0	0	0	3		1	3				3	3	0	0	3	
Nickel(II) sulphate hy $NiSO_4$		20	3	0	0	0	0	1	1	1	1					3	0			
hy		bp	3	0	0	0		0		1	1					3	0			
Nitric acid HNO_3	1	20	3	0	0	0				0	0	1	3	3	3	0	0	0		
	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 hy $C_6H_x(NO_2)_y$			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	
Nitrobenzoic acid hy $C_6H_4(NO_2)COOH$		20	1	0	0	0	0	0	0	0	0	0	0	0		0			0	

Medium			Materials																			
				Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Nitroglycerine hy $C_3H_5(ONO_2)_3$		20	0	0	0	0													0	
Nitrogen N	100 100	20 900	0 1		0	0		0	0	0	0	0	0	0	0	0 3	0		0	0
Nitrous acid HNO_2 cf. nitric acid																				
Oleic acid see fatty acid																				
Oleum see sulphur trioxide																				
Oxalic acid hy $C_2H_2O_4$ hy hy	all 10 sa	20 bp	3 3 3	3 3 3	0 3 3	0 3 3	1 0 1	1 1 1	0 0 1	0 0 1	1 1 1	 1			 1	3 3	0 3	0 0	0 3	
Oxygen O		500	1	0	0	0					0			3	3				0	3
Ozone				0	0	0	0	0	0	0	0				1		0		0	
Paraffin C_nH_{2n+2} me		20 120	0 0	0 0	0 0	0 0						 0	 0	 0	 0		0 0		0 0	
Perchlorethylene C_2Cl_4 mo		20 bp	0 0 3	0 1 P	0 1 P	0 1 P							0 1	0 1	0 0	0 0			0 3	
Perhydrol see hydrogen superoxide																				
Petroleum		20 bp	0 0	0 0	0 0	0 0		0 0	0 0	0 0	0 0	0	1 1	0 0	0 0	0 3	0 0		0 0	
Plaster see calcium sulphate																				
Phenol see carbolic acid																				
Phloroglucinol $C_6H_3(OH)_3$		20		0	0	0	0	0	0	0	0						0	0	0	

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Phosgene $COCl_2$	dr		20		0	0	0	0	0	0	0	0						0	0	0	
Phosphoric acid H_3PO_4	hy	1	20	3	0	0	0	0	0	0	0	1	3			3	0	0	0	3	
	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 P	dr		20	0	0	0	0														
Phosphorous penta-chlorite PCl_5	dr	100	20	0	0	0					0					0	1				
Phtalic acid and phtalic anhydride $C_6H_4(COOH)_2$			20	0		0	0				0	0		0	0	0	0			0	0
			200		0	3	0				0	0				0	0			0	0
	dr		bp			0	0	0								0			0	0	
Picric acid $C_6H_2(OH)(NO_2)_3$	hy	3	20	3	0	0	0											0		1	0
	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	
Potash lye see potassium hydroxide																					
Potassium K	me		604	0		0	0				1							0		0	
			800			0	0				1							0	1	0	
Potassium acetate $CH_3–COOK$	me	100	292	1		0	0									1		0			
	hy		20	1	0	0	0		0	0	0	0			1	1	0	0			
Potassium bisulphate $KHSO_4$	hy	5	20	3	3	2	0											0			
	hy	5	90	3	3	3	3											3			
Potassium bitartrate $KC_4H_5O_6$	hy	cs		3	3	0	0										0	0		0	
	hy	sa		3	3	3	1										1	0		0	
Potassium bromide KBr	hy	5	30	3	P	P	P	0	1	0	0	1	0	0		0	0	0	0	3	
Potassium bromine KBr see potassium bromide																					
Potassium carbonate K_2CO_3	hy	50	20	1	0	0	0	0	0	0	0	0	1	3	1	1	0	0	0	3	0
	hy	50	bp	3	3	0	0	0	0	0	0	0		3			0	0	0	3	0

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Potassium chlorate	hy	5	20	3	0	0	0	0	1	0		1	3	1	1	1	1	0		0	
$KClO_3$	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	
Potassium dichromate	hy	10	40	3	0	0	0	1	1	1	1	1	0			3	1	0	0	0	
	hy	25	40	3	3	0	0	1	1	1	1	1	3	3	3	3	1	0	0	0	0
$K_2Cr_2O_7$	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	0		
	hy	cs			0	0	0		0		0	0			0		0	0	0	0	3
$K_3(Fe(CN)_6)$	hy	sa		3	0	P	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	
	hy	25	20		0	0	0	0	0	0	0	0	0		0		0	0	0	0	3
$K_4(Fe(CN)_6)$	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	3	3	3	3		3		3						0	3	3	3	
Potassium hypochloride $KClO$	hy	all	20		P	P	P	3	3		0	3	3				3	0		3	
	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				

Appendix B

Resistance tables

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Potassium permanganate $KMnO_4$	hy hy	10 all	20 bp	0 3	0 1	0 1	0 1	 0	 1	 1	0 1	1 1	0 0			 0	0 0	0 0	0 0	0 0	3
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	
Potassium sulphate K_2SO_4	hy hy	10 all	25 bp	3 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	1 0	0 0	0 0	0 1	
Propionic acid see acetic acid																					
Protein solutions			20	1	0	0	0	0	0	0	0	0	0					0	0	0	
Pyridine C_5H_5N	dr	all all	20 bp		0 0	0 0	0 0		 0	 0	 0	 0					 0	0 0		0 0	
Pyrogallol $C_6H_3(OH)_3$		all all	20 bp	3 3	0 0	0 0	0 0				0 1				0 0			0 0		0 0	
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		
Quinol $HO–C_6H_4–OH$				3		0	0	0	0	0		1					1			0	
Salicylic acid HOC_6H_4COOH	dr mo hy	100 100 cs	20 20 	1 3 3	0 	0 0 0	0 0 0	0 0	1 1	0 0	0 1 0	1 0 0	0 0			0 	1 0	0 0 0	0 	0 1	
Salmiac see ammonium chloride																					
Salpetre see potassium nitrate																					
Seawater at flow velocity (v): $v < 1.5$ m/s $1.5 < v < 4.5$ m/s			20 20	1 1	P 0	P 0	P 0	P P	P 0	0 0	0 0	P 0	1 0	 0		1 3	P 1				
Siliceous flux acid see fluorsilicic acid																					

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
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			
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	
$NaBo_3$ 4 H_2O	me			3	3	3	3				3										
(Borax)																					
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				

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Stainless steels: Ferritic	Stainless steels: Austenitic	Stainless steels: Austenitic + Mo	Nickel-based alloys: Incoloy 825 2.4858	Nickel-based alloys: Inconel 600 2.4816	Nickel-based alloys: Inconel 625 2.4856	Nickel-based alloys: Hastelloy-C 2.4610 2.4819	Nickel-based alloys: Monel 2.4360	Copper-based-alloys: Cunifer 30 2.0882	Copper-based-alloys: Tombac	Copper-based-alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
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 Na_2CrO_4	hy	all	bp	0	0	0	0	0	0	0	0	0	0	0	0	0				0	
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 hydrogensulphate see sodium bisulphate																					
Sodium hydrogensulphite see 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				
	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		

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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 iodide NaJ					P	P	P	0	0	0	0						0			1	
Sodium nitrate $NaNO_3$	hy	5	20	3	0	0	0	0	0	0	0	1	0			0	1	0	0	0	
	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
Sodium nitrite $NaNO_2$	hy		20			0	0	1	0	0	0	0	0			1	3	0	0	1	
Sodium perborate $NaBO_2$	hy	10	20	3	0	0	0				1							1			
	hy	10	bp	3	0	0	0				1							1			
Sodium perchlorate $NaClO_4$	hy	10	20	3	3	0	0	1			1							0			
	hy	10	bp	3		0	0	1			1							0			
Sodium peroxide Na_2O_2	hy	10	20	3	1	0	0	1	1	1	1	0	3			3	0	3	3	3	3
	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 Na_2HPO_4	hy	10	20		0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	
	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 salicylate $C_6H_4(OH)COONa$	hy	all	20		0	0	0	0			0					0	0	0		0	
Sodium silicofluoride $Na_2(SiF_6)$	hy	cs		3	3	3	3	0	0	1	1	0				0				1	
Sodium sulphate Na_2SO_4	hy	10	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	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 Na_2S	hy	1	20	3	0	0	0	0	0			1					1	0			
	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 sulphide Na_2SO_3	hy	10	20	3	1	0	0					0	1	3	1	1		0		0	
	hy	50	bp	3	3	0	0											0		3	
Sodium superoxide see sodium peroxide																					
Sodium tetraborate see borax																					

Appendix B

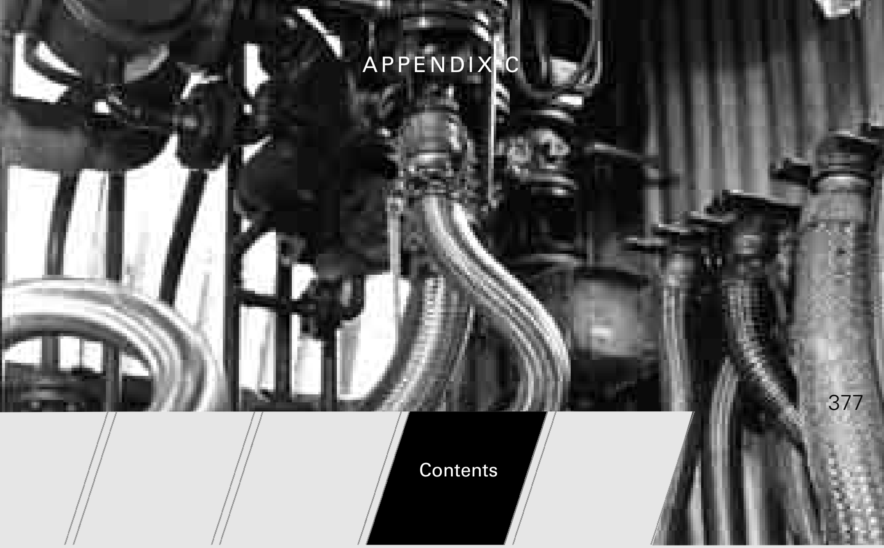
Resistance tables

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature ˚C	Non/low alloy steels	Ferritic	Austenitic	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 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	
Spirit of terpentine		100	20	3	0	0	0						0	1	0	0		0		0	
		100	bp	3	0	0	0						0	1	0	0		0		0	
Spirits			20	1	0	0	0	0	0	0	0	0									
			bp	3	0	0	0	0	0	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	
Succinic acid			bp	1	0	0	0	0	0	0	0	0	0	0	0						
$CH_2–COOH$ I $CH_2–COOH$																					
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	
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

Medium				Materials																	
					Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non/low alloy steels	Ferritic	Austenitic	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
Sulphuric acid H_2SO_4		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
Sulphurous acid H_2SO_3	hy	1	20	3	3	0	0		1		0	3					3		0	1	
	hy	cs		3	3	0	0				0	3						1	0	3	
	hy	sa		3	3	1	0				1								0	3	
Tannic acid $C_{76}H_{52}O_{46}$	hy	5	20	3	0	0	0		0			0	0	1	0	0	0	0		0	
	hy	25	100	3	3	0	0											0			
	hy	50	bp	3	3	0	0						0					0			
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	
Tetrachloroethylene see carbon tetrachloride																					
Tin chloride $SnCl_2$; $SnCl_4$		5	20	3	3	3	3	3	3		0	1	3				1	0	0	3	
		sa		3	3	3	3														
Toluene C_6H_5-CH_3		100	20	0	0	0	0					0	0	0	0	0		0		0	
		100	bp	0	0	0	0					0	0	0	0	0		0		0	
Town gas				0	0	0	0	0	0	0	0	1	1	0	0	1	1				
Trichloroacetaldehyde see chloral																					
Trichloroethylene $CHCl{=}CCl_2$	pure	100	20	0	0	0	0				0		0	0	0	0	0	0		0	
	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 see chloroform																					
Tricresylphosphate				0	0	0	0	0	0	0	0					0					0

Medium			Materials																		
	Concentration	Temperature		Stainless steels			Nickel-based alloys					Copper-based-alloys			Pure metals						
Designation Chemical formula	%	°C	Non/low alloy steels	Ferritic	Austenitic	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
Trinitrophenol see picric acid																				
Trichloroacetic acid see chloroacetic 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	
Vinyl chloride dr		20	0	0	0	0				0				0					0	
$CH_2{=}CHCl$		<400	0	0	0	0				0						0	0			
Water vapour																				
$O_2<1$ ppm; $Cl<10$ ppm		<560	1	1	1	0				0							0			
$O_2>1$ ppm; $Cl<10$ ppm		<315	S	S	S	S				0						0	0			
$O_2>15$ ppm; $Cl<3$ ppm		>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
Yellow potassium prussiate see potassium ferricyanide																				
Zinc chloride hy	5	20	3	P	P	P	0	1	0	0	1	3				1	0	0	3	
$ZnCl_2$ hy	5	bp	3	3	3	3	0	3		1	3	3				1	0	0	3	
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		
Zinc sulphate hy	2	20	3	0	0	0				0		0					0	0	0	
$ZnSO_4$ hy	20	bp	3	0	0	0				1							0	0	3	
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	

APPENDIX C



Contents

Appendix C – Pipes/Flanges/Pipe bends/Threads

Appendix C

Seamless and welded steel pipes

DIN EN 10220, March 2003 edition (extract), dimensions and weights

Nom. dia.	O.D.	Std. wall thickness	Mass (weight) in relation to length [kg/m] Wall thickness [mm]											
DN	mm	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	1.6	**0.339**	0.373	0.404	0.448	0.487							
8	13.5	1.8	**0.470**	0.519	**0.567**	0.635	0.699	0.758	0.813	0.879				
10	17.2	1.8	0.616	0.684	**0.750**	0.845	0.936	1.02	1.10	1.21	1.30	1.41		
15	21.3	2	**0.777**	0.866	**0.952**	1.08	1.20	1.32	**1.43**	1.57	**1.71**	1.86	2.01	
20	26.9	2	**0.998**	**1.11**	**1.23**	1.40	1.56	1.72	**1.87**	2.07	**2.26**	2.49	2.70	2.94
25	33.7	2	**1.270**	1.42	**1.56**	**1.78**	1.99	2.20	**2.41**	2.67	2.93	**3.24**	3.54	3.88
32	42.4	2.3	**1.610**	1.80	**1.99**	**2.27**	**2.55**	2.82	3.09	**3.44**	3.79	4.21	**4.61**	5.08
40	48.3	2.3	**1.840**	2.06	**2.28**	**2.61**	**2.93**	3.25	3.56	**3.97**	4.37	4.86	**5.34**	5.90
50	60.3	2.3	**2.320**	2.60	**2.88**	**3.29**	3.70	**4.11**	4.51	5.03	**5.55**	6.19	6.82	**7.55**
65	76.1	2.6	**2.940**	3.30	3.65	**4.19**	**4.71**	**5.24**	5.75	6.44	7.11	7.95	**8.77**	9.74
80	88.9	2.9	3.440	3.87	**4.29**	**4.91**	5.53	**6.15**	**6.76**	7.57	8.38	9.37	10.3	**11.5**
100	114.3	3.2	4.450	4.99	**5.54**	6.35	**7.16**	**7.97**	**8.77**	**9.83**	10.9	12.2	13.5	15.0
125	139.7	3.6	5.450	6.12	**6.79**	7.79	**8.79**	9.78	**10.8**	**12.1**	**13.4**	15.0	16.6	18.5
150	168.3	4	6.580	7.39	8.20	9.42	10.6	11.8	**13.0**	14.6	**16.2**	**18.2**	20.1	22.5
200	219.1	4.5		9.65	10.7	12.3	13.9	15.5	17.0	**19.1**	21.2	**23.8**	26.4	29.5
250	273.0	5			13.4	15.4	17.3	19.3	21.3	**23.9**	26.5	29.8	**33.0**	36.9
300	323.9	5.6					20.6	23.0	25.3	28.4	**31.6**	**35.4**	39.3	**44.0**

Appendix C

Seamless and welded steel pipes

DIN EN 10220, March 2003 edition (extract), dimensions and weights

Nom. dia.	O.D.	Std. wall thick-ness	Mass (weight) in relation to length [kg/m] Wall thickness [mm]											
DN	mm	mm	6.3	7.1	8	8.8	10	11	12.5	14.2	16	17.5	20	22.2
6	10.2	1.6												
8	13.5	1.8												
10	17.2	1.8												
15	21.3	2												
20	26.9	2	3.20	3.47	3.73									
25	33.7	2	4.26	4.66	5.07	5.40								
32	42.4	2.3	5.61	6.18	6.79	7.29	7.99							
40	48.3	2.3	6.53	7.21	7.95	8.57	9.45	10.1	11.0					
50	60.3	2.3	8.39	9.32	10.3	11.2	12.4	13.4	14.7	16.1	17.5			
65	76.1	2.6	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	2.9	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	3.2	**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	3.6	**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	4	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	4.5	**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	5	**41.4**	46.6	52.3	57.3	**64.9**	71.1	80.3	90.6	101	110	125	137
300	323.9	5.6	49.3	**55.5**	62.3	68.4	**77.4**	84.9	96.0	108	121	132	150	165

Appendix C

Austenitic stainless steel pipes

DIN EN ISO 1127, March 1997 edition (extract), dimensions and weights

Nom. dia.	O.D.	Mass (weight) in relation to length [kg/m]										
		Wall thickness [mm]										
DN	mm	1.0	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.6	4.0	4.5
6	10.2	0.230	0.270	0.344	0.410	-	-	-	-	-	-	-
8	13.5	0.313	0.369	0.477	0.576	0.645	-	0.789	-	-	-	-
10	17.2	0.406	-	0.625	0.761	0.858	-	-	1.12	-	-	-
15	21.3	0.509	-	0.789	0.966	-	1.22	-	1.45	-	1.74	-
20	26.9	0.649	-	1.01	1.25	-	1.58	1.75	1.9	-	2.29	-
25	33.7	0.818	0.976	1.29	1.58	1.81	2.02	-	2.45	-	-	3.29
32	42.4	-	-	1.63	2.02	-	2.59	-	3.14	3.49	-	-
40	48.3	-	-	1.87	2.31	-	2.97	-	3.61	4.03	-	-
50	60.3	-	-	2.35	2.92	3.34	3.76	4.17	4.58	5.11	5.83	-
65	76.1	-	-	2.98	3.7	4.25	4.78	5.32	-	6.54	7.22	-
80	88.9	-	-	3.49	4.35	4.98	5.61	6.24	6.86	7.68	8.51	-
100	114.3	-	-	4.52	5.62	-	7.27	8.09	-	9.98	-	12.4
125	139.7	-	-	5.53	6.89	-	8.92	-	11	-	13.6	-
150	168.3	-	-	6.68	8.32	-	10.8	-	13.2	-	16.4	18.5
200	219.1	-	-	-	10.9	-	14.1	-	17.3	19.4	21.5	-
250	273.0	-	-	-	13.6	-	17.6	-	21.6	24.3	26.9	-
300	323.9	-	-	-	-	-	20.9	-	25.7	-	32.1	35.9

Appendix C

Austenitic stainless steel pipes

DIN EN ISO 1127, March 1997 edition (extract), dimensions and weights

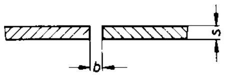
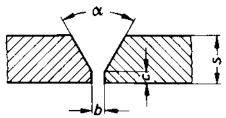
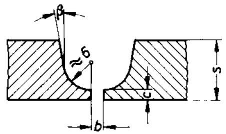
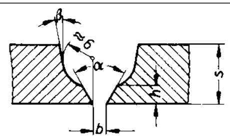
Nom. dia.	O.D.	Mass (weight) in relation to length [kg/m]									
		Wall thickness [mm]									
DN	mm	5.0	5.6	6.3	7.1	8.0	8.8	10.0	11.0	12.5	14.2
6	10.2	-	-	-	-	-	-	-	-	-	-
8	13.5	-	-	-	-	-	-	-	-	-	-
10	17.2	-	-	-	-	-	-	-	-	-	-
15	21.3	-	-	-	-	-	-	-	-	-	-
20	26.9	-	-	-	-	-	-	-	-	-	-
25	33.7	-	-	-	-	-	-	-	-	-	-
32	42.4	4.68	-	-	-	-	-	-	-	-	-
40	48.3	5.42	-	-	-	-	-	-	-	-	-
50	60.3	-	7.66	-	-	-	-	-	-	-	-
65	76.1	8.9	-	-	12.3	-	-	-	-	-	-
80	88.9	-	11.7	-	-	16.2	-	-	-	-	-
100	114.3	-	-	17.1	-	-	23.2	-	-	-	-
125	139.7	16.8	-	21	23.5	-	-	32.5	-	-	-
150	168.3	20.4	-	-	28.6	-	-	-	43.3	-	-
200	219.1	-	-	33.6	-	42.2	-	-	-	64.7	-
250	273.0	-	-	42	-	-	-	65.9	-	81.5	92
300	323.9	39.9	-	-	56.3	-	-	78.6	-	97.4	-

Tolerance class	Limit deviations for O.D.	
D_1	± 1.5 %	with min. ± 0.75 mm
D_2	± 1 %	with min. ± 0.50 mm
D_3	± 0.75 %	with min. ± 0.30 mm
D_4	± 0.5 %	with min. ± 0.10 mm

Tolerance class	Limit deviations for wall thickness	
T_1	± 15 %	with min. ± 0.60 mm
T_2	± 12.5 %	with min. ± 0.40 mm
T_3	± 10 %	with min. ± 0.20 mm
T_4	± 7.5 %	with min. ± 0.15 mm
T_5	± 5 %	with min. ± 0.10 mm

Appendix C

Joint forms for steel pipes, guidelines for fusion welding of butt joints, edge preparation to DIN EN ISO 9692-1, May 2004 edition

ID No.	Wall thickness	Designa-tion	Picto-gram [1])	Joint form (section)	Dimensions bevel angle (approx.)		gap [2])	root face	root depth
–	s	–	–	–	α	β	b	c	h
–	mm	–	–	–	degree	degree	mm	mm	mm
1	≤ 3	square butt			–	–	0 - 3	–	–
2	≤ 16	single V			40 - 60 for SG 60 for E and G	–	0 - 4	≤ 2	–
3	> 12	single U			–	8	0 - 3	≤ 2	–
4	> 12	single U on V-root			60	8	0 - 3	–	~ 4

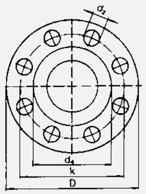
[1]) *See DIN 1912 for additional symbols.*

[2]) *The dimensions given here applied to the tacked condition.*

Standard flanges

DIN 2501, Feb 1972 edition, DIN EN 1092, June 2002 edition (extract)

Connection dimensions for PN 1 / PN 2,5 / PN 6



	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ritch diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

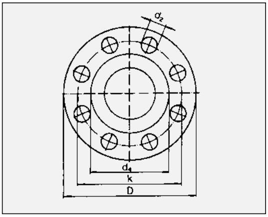
Nom. dia.	PN 1 and 2,5						PN 6					
DN	D	d_4	k	Bolts		d_2	D	d_4	k	Bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10	See PN 6						75	35	50	4	M 10	11
15							80	40	55	4	M 10	11
20							90	50	65	4	M 10	11
25							100	60	75	4	M 10	11
32							120	70	90	4	M 12	14
40							130	80	100	4	M 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							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

Appendix C

Standard flanges

DIN 2501, Feb 1972 edition, DIN EN 1092, June 2002 edition (extract)

Connection dimensions for PN 10 / PN 16



	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ritch diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

Nom. dia.	PN 10						PN 16					
DN	D	d_4	k	Bolts		d_2	D	d_4	k	Bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10	See PN 40						See PN 40					
15												
20												
25												
32												
40												
50												
65	See PN 16						185	122	145	4/8*	M 16	18
80	See PN 40						See PN 40					
100							220	158	180	8	M 16	18
125	See PN 16						250	188	210	8	M 16	18
150							285	212	240	8	M 20	22
(175)**							315	242	270	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

* *DIN 2501: 4*

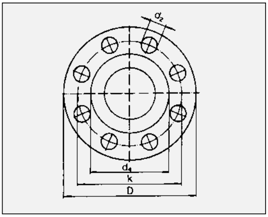
DIN EN 1092: 8, but 4 are permitted if agreed

** *DIN 2501 only*

Standard flanges

DIN 2501, Feb 1972 edition, DIN EN 1092, June 2002 edition (extract)

Connection dimensions for PN 25 / PN 40



	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ritch diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

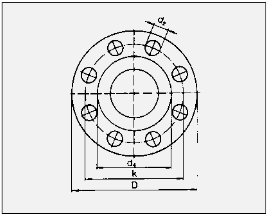
Nom. dia.	PN 25						PN 40					
DN	D	d_4	k	Bolts		d_2	D	d_4	k	Bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10							90	40	60	4	M 12	14
15							95	45	65	4	M 12	14
20							105	58	75	4	M 12	14
25							115	68	85	4	M 12	14
32							140	78	100	4	M 16	18
40	See PN 40						150	88	110	4	M 16	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
(175)**	330	248	280	12	M 24	26	350	260	295	12	M 27	30
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

*** DIN 2501 only*

Standard flanges

DIN 2501, Feb 1972 edition, DIN EN 1092, June 2002 edition (extract)

Connection dimensions for PN 63 / PN 100



	DIN 2501	DIN EN 1092
Exterior diameter	*D*	*D*
Sealing ritch diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

Nom. dia.	PN 63						PN 100					
DN	D	d_4	k	Bolts		d_2	D	d_4	k	Bolts d_2		
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
10							100	40	70	4	M 12	14
15	See PN 100						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
(175)**	375	260	310	12	M 30	33	385	260	320	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

* *DIN EN 1092 only*

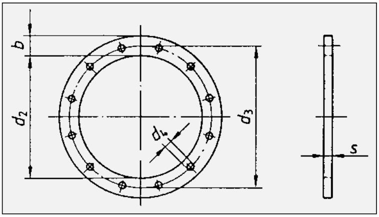
** *DIN 2501 only*

Appendix C

Plain flanges

DIN 24154 part 2, July 1990 edition (extract)

Connection dimensions



Nom. dia.	Interior diameter		Width x thick-ness	Hole circle diameter ± 0,5	Bolt hole diameter ± 0,5	Number of holes	Bolts	Weight (approx.)
		limit deviation						
DN	d_2	–	b x s [1])	d_3	d_4	–	–	–
–	mm	–	mm	mm	mm	–	–	kg
71	73			110				0.44
80	82			118				0.48
90	92	+ 1	30 x 6	128	9,5	4	M 8	0.53
100	102	0		139				0.55
112	114			151				0.63
125	127			165				0.68
140	142			182				0.87
160	162			200				0.98
180	182	+ 1,5	35 x 6	219	11,5	8	M 10	1.08
200	203	0		241				1.19
224	227			265				1.32
250	253			292				1.45
280	283			332				2.51
315	318			366		8		2.98
355	358	+ 1,5	40 x 8	405	11,5		M10	3.10
400	404	0		448				3.44
450	454			497		12		3.84
500	504			551				4.13

[1]) *Limit deviations for width b and thickness s to DIN 1016, nominal diameters* ***printed in bold*** *are to be preferred*

Appendix C

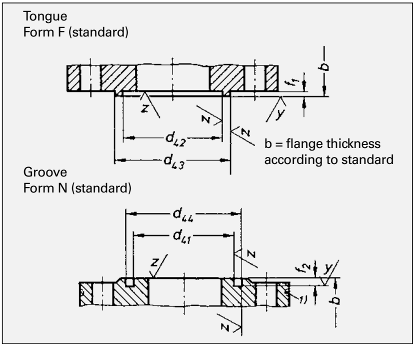
Comparison of sealing face designations according to previous DIN standards and DIN EN 1092-1

Old DIN designation	New designation to DIN EN 1092-1
Form A	Form A
Form B	
Form C	Form B 1
Form D	
Form E	Form B 2
Form F	Form C
Form N	Form D
Form V 13	Form E
Form R 13	Form F
Form R 14	Form G
Form V 14	Form H

Flanges with tongue or groove

DIN 2512, March 1975 edition (extract), DIN EN 1092, June 2002 edition (extract)

Dimensions (tongue, groove), PN 10 bis PN 160 / 100



DIN 2512	*DIN EN 1092*
d_{42}	w
d_{43}	x
d_{41}	z
d_{44}	y
f_1	f_2
f_2	f_3
$z = \sqrt{R_z = 160}$ turned $y = \sqrt{R_z = 40}$	*Sealing face turned:* R_z = 3.2 - 12.5

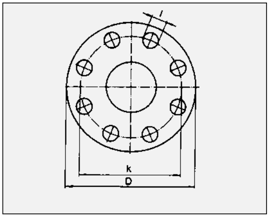
Nom. dia.	Tongue			Groove		
DN	d_{42}	d_{43}	f_1	d_{41}	d_{44}	f_2
	w	x	f_2	z	y	f_3
	+0.5 0	0 -0.5	+0.5 0	0 -0.5	+0.5 0	+0.5 0
10	24	34	4.0 (f_1) 4.5 (f_2)	23	35	2.5 (f_1) 4.0 (f_2)
15	29	39		28	40	
20	36	50		35	51	
25	43	57		42	58	
32	51	65		50	66	
40	61	75		60	76	
50	73	87		72	88	
65	95	109		94	110	
80	106	120		105	121	
100	129	149	4.5 (f_1) 5.0 (f_2)	128	150	3.0 (f_1) 4.5 (f_2)
125	155	175		154	176	
150	183	203		182	204	
200	239	259		238	260	
250	292	312		291	313	
300	343	363		342	364	

Appendix C

Flanges to US standard

ANSI B 16.5

Connection dimensions for Class 150



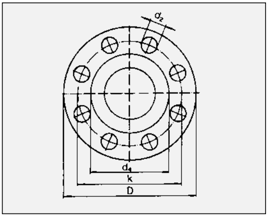
D Exterior diameter

k Hole circle diameter

l Bolt hole diameter

Nominal diameter		Flange				Bolts				
		Exterior diameter		Hole circle diameter		Number	bolt hole dia.		Thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	88.9	3 1/2	60.3	2 3/8	4	15.9	5/8	12.7	1/2
20	**3/4**	98.4	3 7/8	69.8	2 3/4	4	15.9	5/8	12.7	1/2
25	**1**	107.9	4 1/4	79.4	3 1/8	4	15.9	5/8	12.7	1/2
32	**1 1/4**	117.5	4 5/8	88.9	3 1/2	4	15.9	5/8	12.7	1/2
40	**1 1/2**	127.0	5	98.4	3 7/8	4	15.9	5/8	12.7	1/2
50	**2**	152.4	6	120.6	4 3/4	4	19.0	3/4	15.9	5/8
65	**2 1/2**	177.8	7	139.7	5 1/2	4	19.0	3/4	15.9	5/8
80	**3**	190.5	7 1/2	152.4	6	4	19.0	3/4	15.9	5/8
100	**4**	228.6	9	190.5	7 1/2	8	19.0	3/4	15.9	5/8
125	**5**	254.0	10	215.9	8 1/2	8	22.2	7/8	19.0	3/4
150	**6**	279.4	11	241.3	9 1/2	8	22.2	7/8	19.0	3/4
200	**8**	342.9	13 1/2	298.4	11 3/4	8	22.2	7/8	19.0	3/4
250	**10**	406.4	16	361.9	14 1/4	12	25.4	1	22.2	7/8
300	**12**	482.6	19	431.8	17	12	25.4	1	22.2	7/8

Connection dimensions for Class 300



D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

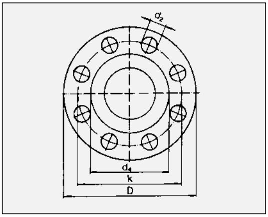
Nominal diameter		Flange				Bolts					
		Exterior diameter		Hole circle diameter		Number	bolt hole dia.		Thread		
DN		D		k		–	l		–		
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch	
15	**$^1/_2$**	95.2	3 $^3/_4$	66.7	2 $^5/_8$	4	15.9	$^5/_8$	12.7	$^1/_2$	
20	**$^3/_4$**	117.5	4 $^5/_8$	82.5	3 $^1/_4$	4	19.0	$^3/_4$	15.9	$^5/_8$	
25	**1**	123.8	4 $^7/_8$	88.9	3 $^1/_2$	4	19.0	$^3/_4$	15.9	$^5/_8$	
32	**1 $^1/_4$**	133.3	5 $^1/_4$	98.4	3 $^7/_8$	4	19.0	$^3/_4$	15.9	$^5/_8$	
40	**1 $^1/_2$**	155.6	6 $^1/_8$	114.3	4 $^1/_2$	4	22.2	$^7/_8$	19.0	$^3/_4$	
50	**2**	165.1	6 $^1/_2$	127.0	5	8	19.0	$^3/_4$	15.9	$^5/_8$	
65	**2 $^1/_2$**	190.5	7 $^1/_2$	149.2	5 $^7/_8$	8	22.2	$^7/_8$	19.0	$^3/_4$	
80	**3**	209.5	8 $^1/_4$	168.3	6 $^5/_8$	8	22.2	$^7/_8$	19.0	$^3/_4$	
100	**4**	254.0	10	200.0	7 $^7/_8$	8	22.2	$^7/_8$	19.0	$^3/_4$	
125	**5**	279.4	11	234.9	9 $^1/_4$	8	22.2	$^7/_8$	19.0	$^3/_4$	
150	**6**	317.5	12 $^1/_2$	269.9	10 $^5/_8$	12	22.2	$^7/_8$	19.0	$^3/_4$	
200	**8**	381.0	15	330.2	13	12	25.4	1	22.2	$^7/_8$	
250	**10**	444.5	17 $^1/_2$	387.3	15 $^1/_4$	16	28.6	1 $^1/_8$	25.4	1	
300	**12**	520.7	20 $^1/_2$	450.8	17 $^3/_4$	16	31.7	1 $^1/_4$	28.6	1 $^1/_8$	

Appendix C

Flanges to US standard

ANSI B 16.5

Connection dimensions for Class 400



D Exterior diameter

k Hole circle diameter

l Bolt hole diameter

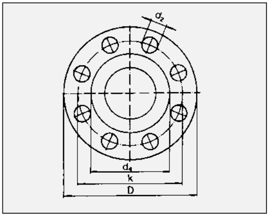
Nominal diameter		Flange				Bolts				
		Exterior diameter		Hole circle diameter		Number	bolt hole dia.		Thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**$^1/_2$**	95.2	3 $^3/_4$	66.7	2 $^5/_8$	4	15.9	$^5/_8$	12.7	$^1/_2$
20	**$^3/_4$**	117.5	4 $^5/_8$	82.5	3 $^1/_4$	4	19.0	$^3/_4$	15.9	$^5/_8$
25	**1**	123.8	4 $^7/_8$	88.9	3 $^1/_2$	4	19.0	$^3/_4$	15.9	$^5/_8$
32	**1 $^1/_4$**	133.3	5 $^1/_4$	98.4	3 $^7/_8$	4	19.0	$^3/_4$	15.9	$^5/_8$
40	**1 $^1/_2$**	155.6	6 $^1/_8$	114.3	4 $^1/_2$	4	22.2	$^7/_8$	19.0	$^3/_4$
50	**2**	165.1	6 $^1/_2$	127.0	5	8	19.0	$^3/_4$	15.9	$^5/_8$
65	**2 $^1/_2$**	190.5	7 $^1/_2$	149.2	5 $^7/_8$	8	22.2	$^7/_8$	19.0	$^3/_4$
80	**3**	209.5	8 $^1/_4$	168.3	6 $^5/_8$	8	22.2	$^7/_8$	19.0	$^3/_4$
100	**4**	254.0	10	200.0	7 $^7/_8$	8	25.4	1	22.2	$^7/_8$
125	**5**	279.4	11	234.9	9 $^1/_4$	8	25.4	1	22.2	$^7/_8$
150	**6**	317.5	12 $^1/_2$	269.9	10 $^5/_8$	12	25.4	1	22.2	$^7/_8$
200	**8**	381.0	15	330.2	13	12	28.6	1 $^1/_8$	25.4	1
250	**10**	444.5	17 $^1/_2$	387.3	15 $^1/_4$	16	31.7	1 $^1/_4$	28.6	1 $^1/_8$
300	**12**	520.7	20 $^1/_2$	450.8	17 $^3/_4$	16	34.9	1 $^3/_8$	31.7	1 $^1/_4$

Appendix C

Flanges to US standard

ANSI B 16.5

Connection dimensions for Class 600



D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

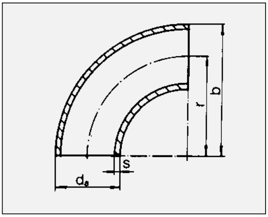
Nominal diameter		Flange				Bolts				
		Exterior diameter		Hole circle diameter		Number	bolt hole dia.		Thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	95.2	3 3/4	66.7	2 5/8	4	15.9	5/8	12.7	1/2
20	**3/4**	117.5	4 5/8	82.5	3 1/4	4	19.0	3/4	15.9	5/8
25	**1**	123.8	4 7/8	88.9	3 1/2	4	19.0	3/4	15.9	5/8
32	**1 1/4**	133.3	5 1/4	98.4	3 7/8	4	19.0	3/4	15.9	5/8
40	**1 1/2**	155.6	6 1/8	114.3	4 1/2	4	22.2	7/8	19.0	3/4
50	**2**	165.1	6 1/2	127.0	5	8	19.0	3/4	15.9	5/8
65	**2 1/2**	190.5	7 1/2	149.2	5 7/8	8	22.2	7/8	19.0	3/4
80	**3**	209.5	8 1/4	168.3	6 5/8	8	22.2	7/8	19.0	3/4
100	**4**	273.0	10 3/4	215.9	8 1/2	8	25.4	1	22.2	7/8
125	**5**	330.2	13	266.7	10 1/2	8	28.6	1 1/8	25.4	1
150	**6**	355.6	14	292.1	11 1/2	12	28.6	1 1/8	25.4	1
200	**8**	419.1	16 1/2	349.2	13 3/4	12	31.7	1 1/4	28.6	1 1/8
250	**10**	508.0	20	431.8	17	16	34.9	1 3/8	31.7	1 1/4
300	**12**	558.8	22	488.9	19 1/4	20	34.9	1 3/8	31.7	1 1/4

Appendix C

90° pipe bend

DIN 2605 part 1, Feb 1991 edition (extract)

Dimensions



Nom. dia.	O.D.	Wall thickness	**Form 2:** r ~ 1,0 x d_a		**Form 3:** r ~ 1,5 x d_a	
DN	d_a	s	r	b	r	b
–	mm	mm	mm	mm	mm	mm
15	21.3	2	17.5	28	28	38
20	26.9	2.3	25	39	29	43
25	33.7	2.6	25	42	38	56
32	42.4	2.6	32	53	48	69
40	48.3	2.6	38	62	57	82
50	60.3	2.9	51	81	76	106
65	76.1	2.9	63	102	95	133
80	88.9	3.2	76	121	114	159
100	114.3	3.6	102	159	152	210
125	139.7	4.0	127	197	190	260
150	168.3	4.5	152	237	229	313
200	219.1	6.3	203	313	305	414
250	273	6.3	254	391	381	518
300	323.9	7.1	305	467	457	619

The wall thickness s for nominal diameters up to and including DN 300 corresponds to the standard wall thickness (series 1) to DIN EN 10220 or DIN EN ISO 1127.

Appendix C

Pipe threads for joints not sealing in the thread

DIN EN ISO 228-1, May 2003 edition (extract)

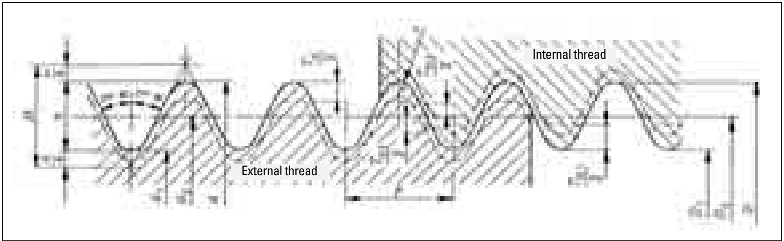
Application

This international standard specifies the designations, dimensions and tolerances of pipe threads for joints not sealing in the thread.

Examples of the complete thread designation for a thread of nominal diameter: $1^1/_2$

Internal thread	(one tolerance class only)	pipe thread DIN EN ISO 228-G 1 $^1/_2$
External thread	tolerance class A	pipe thread DIN EN ISO 228-G 1 $^1/_2$ A
	tolerance class B	pipe thread DIN EN ISO 228/1-G 1 $^1/_2$ B

Thread profile and tolerances



Appendix C

Pipe threads for joints not sealing in the thread

DIN EN ISO 228-1

Thread dimensions

Thread nominal diameter	Threads per inch (25.4 mm)	Pitch	Depth of thread	Diameter: Exterior diameter	Diameter: Flank diameter	Diameter: Thread core diameter
–	–	P	h	d = D	$d_2 = D_2$	$d_1 = D_1$
–	mm	mm	mm	mm	mm	mm
$^1/_{16}$	28	0.907	0.581	7.723	7.142	6.561
$^1/_8$	28	0.907	0.581	9.728	9.147	8.566
$^1/_4$	19	1.337	0.856	13.157	12.301	11.445
$^3/_8$	19	1.337	0.856	16.662	15.806	14.950
$^1/_2$	14	1.814	1.162	20.955	19.793	18.631
$^5/_8$	14	1.814	1.162	22.911	21.749	20.587
$^3/_4$	14	1.814	1.162	26.441	25.279	24.117
$^7/_8$	14	1.814	1.162	30.201	29.039	27.877
1	11	2.309	1.479	33.249	31.770	30.291
1 $^1/_8$	11	2.309	1.479	37.897	36.418	34.939
1 $^1/_4$	11	2.309	1.479	41.910	40.431	38.952
1 $^1/_2$	11	2.309	1.479	47.803	46.324	44.845
1 $^3/_4$	11	2.309	1.479	53.746	52.267	50.788
2	11	2.309	1.479	59.614	58.135	56.656
2 $^1/_4$	11	2.309	1.479	65.710	64.231	62.752
2 $^1/_2$	11	2.309	1.479	75.184	73.705	72.226
2 $^3/_4$	11	2.309	1.479	81.534	80.055	78.576
3	11	2.309	1.479	87.884	86.405	84.926
3 $^1/_2$	11	2.309	1.479	100.330	98.851	97.372
4	11	2.309	1.479	113.030	111.551	110.072
4 $^1/_2$	11	2.309	1.479	125.730	124.251	122.772
5	11	2.309	1.479	138.430	136.951	135.472
5 $^1/_2$	11	2.309	1.479	151.130	149.651	148.172
6	11	2.309	1.479	163.830	162.351	160.872

Appendix C

Pipe threads for joints not sealing in the thread

DIN EN ISO 228-1

Tolerances

Thread nominal diameter	Tolerances for pitch diameter 1)					Tolerances for thread core diameter		Tolerances for exterior diameter	
	Internal thread T_{D2}		External thread T_{d2}			Internal thread T_{D1}		External thread T_d	
	lower limit	upper limit	lower limit Class A	lower limit Class B	upper limit	lower limit	upper limit	lower limit	upper limit
–	mm	mm	mm	mm	mm	mm	mm	mm	mm
1/16	0	+ 0.107	- 0.107	- 0.214	0	0	+ 0.282	- 0.214	0
1/8	0	+ 0.107	- 0.107	- 0.214	0	0	+ 0.282	- 0.214	0
1/4	0	+ 0.125	- 0.125	- 0.250	0	0	+ 0.445	- 0.250	0
3/8	0	+ 0.125	- 0.125	- 0.250	0	0	+ 0.445	- 0.250	0
1/2	0	+ 0.142	- 0.142	- 0.284	0	0	+ 0.541	- 0.284	0
5/8	0	+ 0.142	- 0.142	- 0.284	0	0	+ 0.541	- 0.284	0
3/4	0	+ 0.142	- 0.142	- 0.284	0	0	+ 0.541	- 0.284	0
7/8	0	+ 0.142	- 0.142	- 0.284	0	0	+ 0.541	- 0.284	0
1	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
1 1/8	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
1 1/4	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
1 1/2	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
1 3/4	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
2	0	+ 0.180	- 0.180	- 0.360	0	0	+ 0.640	- 0.360	0
2 1/4	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
2 1/2	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
2 3/4	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
3	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
3 1/2	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
4	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
4 1/2	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
5	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
5 1/2	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0
6	0	+ 0.217	- 0.217	- 0.434	0	0	+ 0.640	- 0.434	0

1) When assessing the dimensional stability of thin-walled parts, use the pitch diameter equal to the arithmetic mean of two diamater measurements at 90° to each other.

Appendix C

Pipe threads for joints sealing in the thread

DIN EN 10226-1, Oct 2004 edition (extract), ISO 7-1, 1994 edition (extract)

Thread profile and tolerances

Application

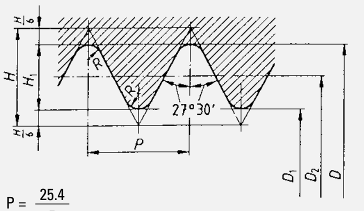
This standard applies to joints in cylindrical internal threads for pipe fittings, threaded flanges, etc. with tapering external threads.
If necessary, a suitable sealing material may be incorporated in the thread to guarantee a sealed joint.

Designation of a

- **conical right-hand thread with external pipe thread** of nominal diameter $^1/_2$
  pipe thread DIN EN 10226 R $^1/_2$

- **cylindrical internal pipe thread**
  of nominal diameter $^1/_2$
  pipe thread DIN EN 10226 R $^1/_2$

Cylindrical internal thread (Rp thread)

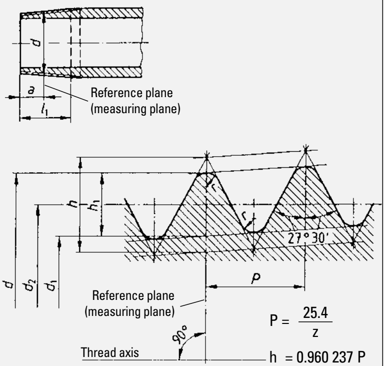


$$P = \frac{25.4}{z}$$

$H = 0.960\,491\ P$
$H_1 = 0.640\,327\ P$
$R = 0.137\,329\ P$

The profile of the cylindrical internal thread matches that to DIN EN ISO 228-1.

Conical external thread (R thread)



$$P = \frac{25.4}{z}$$

$h = 0.960\,237\ P$
$h_1 = 0.640\,327\ P$
$r = 0.137\,278\ P$

Appendix C

Pipe threads for joints sealing in the thread

DIN EN 10226-1

Nominal dimensions

Designation external thread	Designation internal thread	Nom. dia. of pipe	Position of reference plane	Exterior diameter	Flank diameter	Thread core diameter	Pitch	No. of threads per inch (25.4 mm)	Depth of thread	Rounding (approx.)	Effective thread length
–	–	–	a	d = D	$d_2 = D_2$	$d_1 = D_1$	P	Z	$h_1 = H_1$	r = R	l_1
–	–	mm	mm	mm	mm	mm	deg.	–	–	–	mm
R 1/16	**Rp 1/16**	3	4.0	7.723	7.142	6.561	0.907	28	0.581	0.125	6.5
R 1/8	**Rp 1/8**	6	4.0	9.728	9.147	8.566	0.907	28	0.581	0.125	6.5
R 1/4	**Rp 1/4**	8	6.0	13.157	12.301	11.445	1.337	19	0.856	0.184	9.7
R 3/8	**Rp 3/8**	10	6.4	16.662	15.806	14.950	1.337	19	0.856	0.184	10.1
R 1/2	**Rp 1/2**	15	8.2	20.955	19.793	18.631	1.814	14	1.162	0.249	13.2
R 3/4	**Rp 3/4**	20	9.5	26.441	25.279	24.117	1.814	14	1.162	0.249	14.5
R 1	**Rp 1**	25	10.4	33.249	31.770	30.291	2.309	11	1.479	0.317	16.8
R 1 1/4	**Rp 1 1/4**	32	12.7	41.910	40.431	38.952	2.309	11	1.479	0.317	19.1
R 1 1/2	**Rp 1 1/2**	40	12.7	47.803	46.324	44.845	2.309	11	1.479	0.317	19.1
R 2	**Rp 2**	50	15.9	59.614	58.135	56.656	2.309	11	1.479	0.317	23.4
R 2 1/2	**Rp 2 1/2**	65	17.5	75.184	73.705	72.226	2.309	11	1.479	0.317	26.7
R 3	**Rp 3**	80	20.6	87.884	86.405	84.926	2.309	11	1.479	0.317	29.8
R 4	**Rp 4**	100	25.4	113.030	111.551	110.072	2.309	11	1.479	0.317	35.8
R 5	**Rp 5**	125	28.6	138.430	136.951	135.472	2.309	11	1.479	0.317	40.1
R 6	**Rp 6**	150	28.6	163.830	162.351	160.872	2.309	11	1.479	0.317	40.1

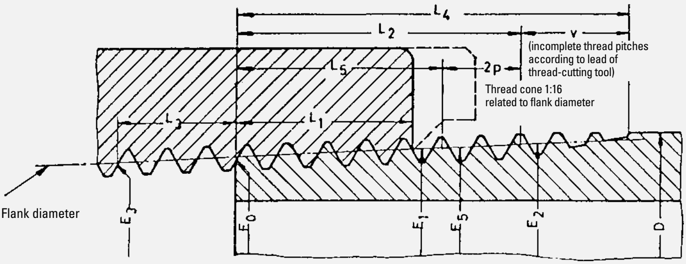
US standard, conical pipe thread NPT

ANSI B1. 20.1, 1983 edition (extract)

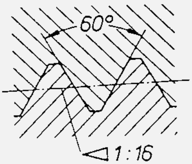
Example of designation:

3/8 - 18 NPT

Nominal dimensions – number of threads, thread series



Thread profile



Appendix C

US standard, conical pipe thread NPT

ANSI B1.20.1

Nominal dimensions

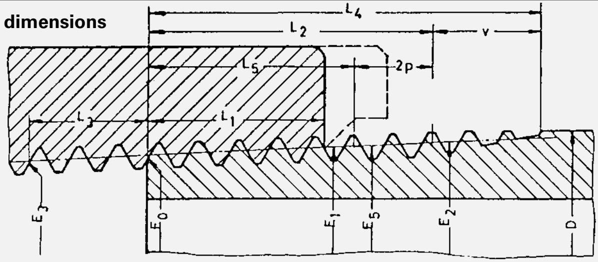
Nominal diameter of pipe	O.D. of pipe	No. of threads per inch (25.4 mm)	Pitch	Flank diameter at start of external thread	Effective external thread		
					length		diameter
						threads	
–	D	n	P	E_0	L_2	–	E_2
inch	mm	–	deg.	mm	mm	–	mm
1/16	7.938	27	0.941	6.8880	6.632	7.05	7.3025
1/8	10.287	27	0.941	9.2332	6.703	7.12	9.6520
1/4	13.716	18	1.411	12.1257	10.206	7.23	12.7635
3/8	17.145	18	1.411	15.5451	10.358	7.34	16.1925
1/2	21.336	14	1.814	19.2641	13.556	7.47	20.1115
3/4	26.670	14	1.814	24.5791	13.861	7.64	25.4455
1	33.401	11 1/2	2.209	30.8262	17.343	7.85	31.9100
1 1/4	42.164	11 1/2	2.209	39.5511	17.953	8.13	40.6730
1 1/2	48.260	11 1/2	2.209	45.6207	18.377	8.32	46.7690
2	60.325	11 1/2	2.209	57.6331	19.215	8.70	58.8340
2 1/2	73.025	8	3.175	69.0761	28.892	9.10	70.8817
3	88.900	8	3.175	84.8517	30.480	9.60	86.7567
3 1/2	101.600	8	3.175	97.4725	31.750	10.00	99.4567
4	114.300	8	3.175	110.0933	33.020	10.40	112.1567
5	141.300	8	3.175	136.9245	35.720	11.25	139.1569
6	168.275	8	3.175	163.7307	38.418	12.10	166.1317
8	219.075	8	3.175	214.2132	43.498	13.70	216.9317
10	273.050	8	3.175	267.8509	48.895	15.40	270.9067
12	323.850	8	3.175	318.3334	53.975	17.00	321.7067

Appendix C

US standard, conical pipe thread NPT

ANSI B1.20.1

Nominal dimensions



Nominal diameter of pipe	Engagement length for manual fastening		Engagement length for power-tool fastening of internal thread			Thread runout	
	length	diameter	length	threads	diameter		threads
–	L_1	E_1	L_3	–	E_3	v	–
inch	mm	mm	mm	–	mm	mm	–
$^1/_{16}$	4.064	7.1420	2.822	3	6.7117	3.264	3.47
$^1/_8$	4.102	9.4894	2.822	3	9.0566	3.264	3.47
$^1/_4$	5.786	12.4867	4.234	3	11.8610	4.897	3.47
$^3/_8$	6.096	15.9261	4.234	3	15.2806	4.897	3.47
$^1/_2$	8.128	19.7721	5.443	3	18.9240	6.294	3.47
$^3/_4$	8.611	25.1173	5.443	3	24.2390	6.294	3.47
1	10.160	31.4612	6.627	3	30.4122	7.663	3.47
1 $^1/_4$	10.668	40.2179	6.627	3	39.1371	7.663	3.47
1 $^1/_2$	10.668	46.2874	6.627	3	45.2064	7.663	3.47
2	11.074	58.3253	6.627	3	57.2191	7.663	3.47
2 $^1/_2$	17.323	70.1589	6.350	2	68.6793	11.016	3.47
3	19.456	86.0679	6.350	2	84.4550	11.016	3.47
3 $^1/_2$	20.853	98.7758	6.350	2	97.0758	11.016	3.47
4	21.438	111.4328	6.350	2	109.6962	11.016	3.47
5	23.800	138.4120	6.350	2	136.5278	11.016	3.47
6	24.333	165.2516	6.350	2	163.3339	11.016	3.47
8	27.000	215.9008	6.350	2	213.8164	11.016	3.47
10	30.734	269.7719	6.350	2	267.4541	11.016	3.47
12	34.544	320.4924	6.350	2	317.9366	11.016	3.47

Appendix C

US standard, conical pipe thread NPT

ANSI B1. 20.1

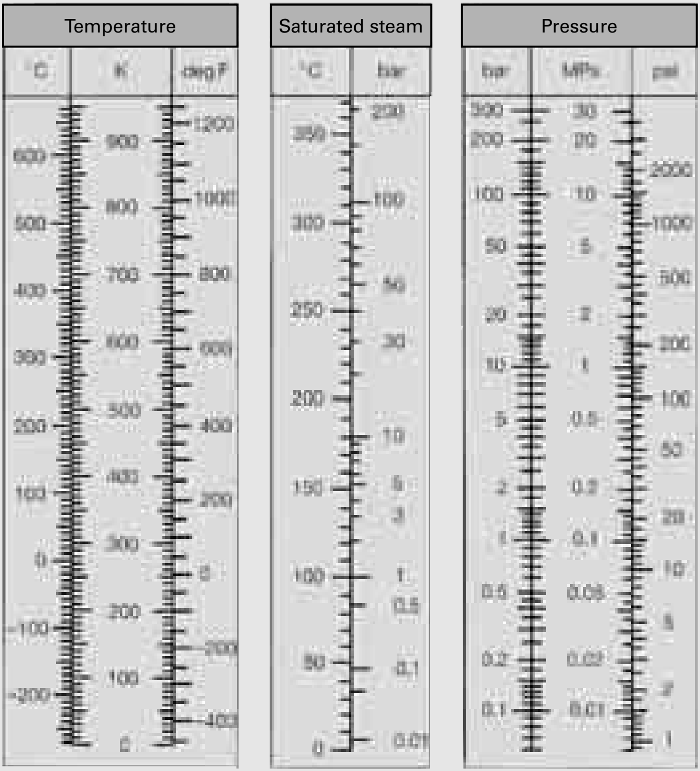
Nominal diameter of pipe	Total length of external thread	Nominal length of fully cut thread		Depth of thread	Increase in diameter per thread	Minor dia. Nom. dim. at end of pipe
		length	flank diameter			
–	L_4	L_5	E_5	h	$\frac{0,0625}{n}$	K_0
inch	deg.	mm	mm	mm		mm
1/16	9.896	4.750	7.1849	0.753	0.059	6.137
1/8	9.967	4.821	9.5344	0.753	0.059	8.481
1/4	15.103	7.384	12.5872	1.129	0.088	10.996
3/8	15.255	7.536	16.0162	1.129	0.088	14.417
1/2	19.850	9.929	19.8846	1.451	0.113	17.813
3/4	20.155	10.234	25.2186	1.451	0.113	23.127
1	25.006	12.924	31.6339	1.767	0.138	29.060
1 1/4	25.616	13.536	40.3969	1.767	0.138	37.785
1 1/2	26.040	13.960	46.4929	1.767	0.138	43.853
2	26.878	14.798	58.5579	1.767	0.138	55.867
2 1/2	39.908	22.524	70.4850	2.540	0.198	66.535
3	41.496	24.130	86.3600	2.540	0.198	82.311
3 1/2	42.766	25.400	99.0600	2.540	0.198	94.932
4	44.036	26.670	111.7600	2.540	0.198	107.554
5	46.736	29.370	138.7602	2.540	0.198	134.384
6	49.433	32.068	165.7350	2.540	0.198	161.191
8	54.513	37.148	216.5350	2.540	0.198	211.673
10	59.911	42.545	270.5100	2.540	0.198	265.311
12	64.991	47.625	321.3100	2.540	0.198	315.793

Contents

Appendix D – Conversion tables

APPENDIX D

Temperature, saturated steam, pressure



Appendix D
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''
0.020	17.513	650.240	0.01492
0.040	28.983	345.295	0.02873
0.060	36.183	240.676	0.04212
0.080	41.534	186.720	0.05523
0.10	45.833	153.456	0.06814
0.14	52.574	114.244	0.09351
0.20	60.086	83.612	0.1307
0.25	64.992	68.802	0.1612
0.30	69.124	58.690	0.1912
0.40	75.886	45.699	0.2504
0.45	78.743	41.262	0.2796
0.50	81.345	37.665	0.3086
0.60	85.954	32.177	0.3661
0.70	89.959	28.178	0.4229
0.80	93.512	25.126	0.4792
0.90	96.713	22.716	0.5350
1.0	99.632	20.760	0.5904
1.5	111.37	14.683	0.8628
2.0	120.23	11.483	1.129
2.5	127.43	9.494	1.392
3.0	133.54	8.130	1.651
3.5	138.87	7.132	1.908
4.0	143.62	6.367	2.163
4.5	147.92	5.760	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''
5.0	151.84	5.268	2.669
6.0	158.84	4.511	3.170
7.0	164.96	3.956	3.667
8.0	170.41	3.531	4.162
9.0	175.36	3.193	4.655
10.0	179.88	2.918	5.147
11.0	184.07	2.689	5.637
12.0	187.96	2.496	6.127
13.0	191.61	2.330	6.617
14.0	195.04	2.187	7.106
15.0	198.29	2.061	7.596
20.0	212.37	1.609	10.03
25.0	223.94	1.323	12.51
30.0	233.84	1.126	15.01
34.0	240.88	1.008	17.03
38.0	247.31	0.913	19.07
40.0	250.33	0.872	20.10
45.0	257.41	0.784	22.68
50.0	263.91	0.712	25.33
55.0	269.93	0.652	28.03
60.0	275.55	0.601	30.79
65.0	280.82	0.558	33.62
70.0	285.79	0.519	36.51
75.0	290.50	0.486	39.48

Appendix D

Physical units (D, UK, US)

DIN 1301, Part 1, December 1985 Edition

SI base units

Quantity	SI base unit	
	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electrical current intensity	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Light intensity	candela	cd

Prefix symbols

Prefix	Prefix symbol	Multiplication factor
Pico	p	10^{-12}
Nano	n	10^{-9}
Micro	μ	10^{-6}
Milli	m	10^{-3}
Centi	c	10^{-2}
Deci	d	10^{-1}
Deca	de	10^{1}
Hecto	h	10^{2}
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}

Appendix D
Conversion tables

Length – SI unit Metre, m

Symbol	Name	in mm
mm	millimetre	0.0010
km	kilometre	1000.0000
in, 9	inch	0.0254
ft, 8	foot (=12 in)	0.3048
yd	yard (=3 ft / =36 in)	0.9144

Mass – SI unit Kilogram, kg

Symbol	Name	in kg
g	gram	0.00100
t	ton	1000.00000
oz	ounce	0.02835
lb	pound	0.45360
sh tn	short ton (US)	907.20000
tn	ton (UK)	1016.00000

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)

Appendix D

Conversion tables

Temperature – SI unit Kelvin, K (see also earlier alignment chart)

Symbol	Name	in K	in °C
°C	degree celsius	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 Radian, rad = m/m

Symbol	Name	in rad
	round angle or perigon	2π
gon	Gon (or grade)	$\pi/200$
°	degree	$\pi/180$
8	minute	$\pi/1{,}08 \cdot 10^{-4}$
9	second	$\pi/6{,}48 \cdot 10^{-5}$

Pressure – SI unit Pascal, Pa = N/m^2 = kg/ms^2

Symbol	Name	in Pa	in bar
Pa = N/m^2	pascal	1	0.00001
hPa = mbar	hectopascal	100	0.001
kPA	kilopascall	1000	0.01
bar	bar	100000	1
MPa = N/mm^2	megapascal	1000000	10
mm WS	millimetres water head	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

Appendix D
Conversion tables

Energy (also work, amount of heat) – SI unit Joule, J = Nm = Ws

Symbol	Name	in J
kWs	kilowatt-second	1000
kWh	kilowatt-hour	$3.6 \cdot 10^6$
kcal	kilocalorie	4186
lbf x ft	pound-force foot	1.356
Btu	British thermal unit	1055

Power – SI unit Watt, W = m^2 kg/s^3 = J/s

Symbol	Name	in W
kW	kilowatt	1000
PS	continental horsepower	735.5
hp	horsepower	745.7

Volume – SI unit, m^3

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

Appendix D
Greek alphabet

α	Alpha	A	Alpha
β	Beta	B	Beta
γ	Gamma	Γ	Gamma
δ	Delta	Δ	Delta
ε	Epsilon	E	Epsilon
ζ	Zeta	Z	Zeta
η	Eta	H	Eta
ϑ θ	Theta	Θ	Theta
ι	Jota	I	Jota
$\varkappa$	Kappa	K	Kappa
λ	Lambda	Λ	Lambda
μ	My	M	My
ν	Ny	N	Ny
ξ	Xi	Ξ	Xi
o	Omikron	O	Omikron
π	Pi	Π	Pi
ϱ	Rho	P	Rho
σ ς	Sigma	Σ	Sigma
τ	Tau	T	Tau
υ	Ypsilon	Υ	Ypsilon
φ	Phi	Φ	Phi
χ	Chi	X	Chi
ψ	Psi	Ψ	Psi
ω	Omega	Ω	Omega

Appendix D

Technical terms and information

Abrasion protection
Layer of flexible material between corrugated hose and braiding. This reduces the friction between the corrugation rim of the hose and the braiding when subjected to dynamic forces. The result is a longer service life.

Acceptance inspections
–> Section 3.5 "Test certification / documentation", page 37

Amplitude
Greatest deflection of a vibration from the centre axis.

Angular
–> Movement

Annularly corrugated hose
Corrugated hose with annular parallel corrugations.
-> corrugated hose

Axial
–> Movement

Bending moment
Moment of a metal hose, bellow or expansion joint that acts on adjacent pipework or equipment through angular movement.

Bending radius
The radius of the hose bend in relation to the hose axis. With corrugated hose assemblies, there is an important difference between the smallest permissible (minimum) bending radius caused by one-off movements and the nominal bending radius caused by frequent movements. The respective data sheet for the metal hose gives these values.

The minimum bending radius for stripwound hoses is the smallest radius to which the hose can be bent without suffering plastic deformation.

The minimum bending radius stated in the tables for corrugated hoses should only occur during static stress, e.g. compensation during assembly. The hose should be bent to this minimum radius no more than 4 or 5 times (hose types tested to DIN EN ISO 10380 up to a maximum of 10 bending actions).

Braiding
Single or multiple round-wire braided covering on the outside of the metal hose. To prevent expansion of the hose through the internal pressure, this is attached to hose fittings at both ends of the hose.
–> Hose braiding page 118

Buckling protection
Mostly a stripwound hose with an interlocking profile fitted over the ends of corrugated hoses to prevent below minimum bending radius.

Bursting pressure
Test pressure at which the hose assembly fails through a visible leak or rupture of

a component. The bursting pressure for HYDRA metal pressure hoses is at least 3 times the permissible pressure. In the case of hose types for which a nominal pressure level to DIN EN ISO 10380 is given in the technical tables, a 4-to-1 bursting pressure safety factor exists.

Corrugation
Smallest functional element of a corrugated hose, bellow or pipe, whose corrugated profile provides flexibility and pressure resistance and helps to prevent leaks.

Corrugation flank
Connection of outer and inner corrugation rim. The two flanks of a corrugation can be arranged parallel or skewed.

Connection fitting (hose fitting)
Component that makes a functional joint between a metal hose and adjacent pipe or equipment. Hose fittings are characterised by the types of joint at the hose and connection ends. In most cases, HYDRA metal hoses are supplied as ready-to-fit units (hose assemblies) complete with connection fittings (flange or threaded connections, welding ends, etc.). Apart from the connection fittings listed in the tables, hoses can be supplied with special fittings on request. Since extensive experience is required to attach the fittings correctly, we generally advise our customers to let us carry out this work instead of attempting it themselves.

Corrugated hose
Pressure-proof metal hose with corrugated wall profile. The flexibility of the flank of the corrugation lends a high degree of flexibility to the hose as a whole. The two basic types are annularly corrugated hose and helically corrugated hose.

Corrugated length
–> Selection of length; Real hose length

Corrugation length
Distance between two adjacent corrugations (e.g. between one outer crest and the next) in the axial direction of the hose.

Corrugation rim
Toroidal half-shell that marks the limits of the corrugation at the outside diameter (outer rim) or inside diameter (inner rim).

Cross-sectional shape
Generally round, but also rectangular or polygonal in the case of stripwound hoses.

Displacement, mechanical movement
Parallel movement of the two ends of a metal hose assembly arranged in a 180° bend in the plane of the hose.

DN
–> Nominal diameter

Documentation
–> Test certificates

Appendix D

Technical terms and information

Double-tube pipe
–> Jacketed pipe

Double-hose assembly
One hose inside another with a lesser or greater difference in diameter between them. One of the hoses, typically the inner one, carries the medium, while the outer carries a heating or cooling medium. In other cases, the outer hose – the jacket – is only a safety measure (e.g. in nuclear reactor construction), which, depending on circumstances, is evacuated and accordingly checked or, filled with gas or liquid, acts as a safety cushion. For such applications, we supply the double-hose assembly Conectoflex, page 198.

Effective cross-sectional area
The cross-sectional area that determines the size of the axial force arising from the internal or external pressure; approximately the area calculated from the average corrugation diameter.

Expansion joint
–> Metal bellows

Fixed point
Support that accepts all pipework forces and moments that occur through heat expansion, internal pressure, stiffness, mass flow while allowing no movement or twisting.

Flexible hose length:
Length between the connection fittings including the end sleeves of a hose assembly.

Flexible length of hose
–> Selection of length

Frequency
–> Load cycles

Hose with helical corrugations
Corrugated hose with corrugations in a spiral arrangement.

Interlocked profile (Agraff profile)
–> Stripwound hose with folded seam.

Internal pressure load
–> Maximum permissible pressure

Inside diameter
Describes the inside diameter d of metal hoses (= diameter of the largest ball that can pass through the hose).

Insulation
HYDRA metal hoses can be supplied ex works with various insulation types suitable for different applications. Typically, the customer himself installs suitable bindings, insulating jackets or other special insulation as required. The insulation must not contain any corrosion-triggering materials.

Lateral
–> Movement

Load cycles
A load cycle is the single movement of a hose and its return to the starting position.

Appendix D

Technical terms and information

Leak rate
The quantity of test medium that flows through a leak in a given time due to the pressure difference. The SI unit of leak rate is N • m/s, the normal unit is mbar l/s. A leak with a rate of 10-8 mbar l/s exists when a pressure rise of 1 mbar in an evacuated component of 1 litre volume takes 108 seconds (i.e. around 3 years). This leak corresponds to a pore size of less than 10-4 mm.

Material certificates
-> Test certificates

Maximum permissible pressure (PS)
As defined in the Pressure Equipment Directive, the maximum permissible continuous operating pressure (or design pressure) for the pressure vessel (in this case hose) in bar at the min./max. operating temperature TS.
–> Section 7 "Design, calculation, installation", page 246

Maximum permissible temperature (TS)
As defined in the Pressure Equipment Directive, the min./max. permissible continuous operating temperature (or design temperature) in °C at the maximum permissible pressure PS.
–> Section 7 "Design, calculation, installation", page 246

Metal bellows
A short flexible conducting and construction element of metal whose high expansion and flexibility is due to the profiling of its wall. The four basic types are: corrugated bellows, diaphragm bellow, lenticular bellow and torus bellow. Expansion joints are metal bellows with connection fittings at both ends, in some cases also with an anchor, to absorb pressure reaction forces or to achieve a defined restriction of movement.

Metal hose
Flexible conducting element of a metal hose assembly whose high flexibility is due to the profiling of its wall. The two basic types are stripwound and corrugated hose.

Metal hose assembly
Pipe with high elastic flexibility. It consists of metal hose, connection fittings at both ends and, in the case of corrugated hoses, frequently with exterior braiding.

Minimum bending radius
–> Bending radius

Movement
The movement of the two ends of the hose assembly in relation to each other.

axial: in axial direction
Change of length with uniform stretching or compression in the axial direction.

lateral: perpendicular to the axis, in the transverse direction.
Parallel movement of the axis.

–> Section 7 " "Design, calculation, installation", page 246

angular: angular bending of the axis.

polydirectional movement:
movements caused by forces acting on the hose from all directions (x, y, z planes)

Corrugated hoses should naturally only perform bending movements, i.e. movements in a lateral direction (angular, lateral). The direction of movement then lies in the same plane as the axis of the hose. Where the amplitude of the movement is very small, as often occurs with vibrations, the hose is able to absorb polydirectional movements, e.g. when installed with a 90° bend to absorb vibrations. Twisting, i.e. rotational movement around the hose axis, causes damage to corrugated hoses whatever type they are, and must be avoided. Axial movements, i.e. compression or stretching of the hose in the axial direction should also be avoided. Annularly corrugated hoses without braiding can absorb a small amount of axial movement, but such applications are rare in practice. The only installation arrangement for hose assemblies that is optimal for absorption of axial movements of the pipework is a 180° bend.
–> Section 7 "Design, calculation, installation", page 246

In most cases, however, the axial expansion joint is the more economic and technically better solution for compensation of axial movements.

Whatever movements a metal hose assembly is required to absorb, proper installation and handling is essential.
–> Section 7 "Design, calculation, installation", page 246
Section 3 "Basic facts about metal hoses", page 18

Neutral hose length
Additional flexible length of hose to prevent movement in the vicinity of the connections.
When calculating the overall hose length, the neutral hose length is added to the minimum length needed to absorb movement. The calculation formulae of this manual take account of a neutral length where necessary.

Nominal bending radius
–> Bending radius

Nominal pressure (PN)
A commonly used dimensionless characteristic value referring to pressure. The numeric value of nominal pressure for a standardized component states the maximum permissible pressure in bar at 20 °C.

Nominal length (NL)
–> Selection of length

Appendix D

Technical terms and information

Nominal diameter (DN)
Characteristic quantity for piping systems. Its numeric value roughly corresponds to the inside diameter in mm.

Operating pressure
–> Maximum permissible pressure (PS)

Operating temperature
–> Maximum permissible temperature (TS)

Outside diameter
Describes the external diameter D of metal hoses, measured at the vertex of the hose profile or braiding D1.

Overall length
–> Selection of length

Parallel movement
–> Movement, lateral

Parallel corrugation
–> Corrugated hose; Annularly corrugated hose

Permissible length deviations:
–> Section 7 “Design, calculation, installation”, page 246

Pitch
–> Length of a corrugation

PN (nominal pressure)
–> Nominal pressure

Pressure
–> Maximum permissible pressure

Pressure hose
–> Pressure-proof hose –> Corrugated hose

Pressure fluctuations / pulsations
These have a significant effect on the life of a metal hose.
–> Section 3 “Test certification / documentation”, page 18

Production length
The production lengths given in the tables are the single lengths of continuous hose the factory produces (without combining two or more).

Profile height
Distance between outer and inner crest of the corrugations in the radial direction of the hose.

Protecting spiral
Metal hoses can be provided with an external surrounding round-wire spiral as additional protection against abrasion or in rough operating conditions.

PS
–> Maximum permissible pressure

Quick-release coupling
Connection fitting consisting of two coupling halves (male and female) for

a metal hose assembly. The two halves of the coupling are plugged together then locked by moving a cam lever, for example.

Real hose length:
Overall length of the corrugated hose assembly (cut length).

Reduction factor for higher operating temperatures
To take account of the fall in strength of materials at operating temperatures above 20 °C, this factor is applied for calculation of acceptable pressure. It describes the ratio of the 1% expansion limit of the component at working or operating temperature to the 1% expansion limit at 20 °C. In the case of components consisting of several materials, the smallest value of all individual components applies.
–> Section 7 "Design, calculation, installation", page 246

Seal
Separable connection fittings for corrugated hoses are essentially classified into joints that are metallically sealing, flat sealing and those that seal in the thread. The type of connection or method of sealing should be appropriate for the application, especially in respect of resistance to medium/temperature and re-usability.

Selection of length
Nominal length (NL):
Supply length within tolerances of a hose assembly, i.e. overall length including fittings.

Service life
This depends on the operating conditions and movement stresses. In terms of purely dynamic stress, the service life refers to the number of –> Load cycles executed until the first case of leakage.
–> Section 7 "Design, calculation, installation", page 246

Stripwound hose
Hose made of profiled and spirally wound metal strip. The two basic types are stripwound hose with interlocked sections and stripwound hose with engaged sections.

Stripwound hose with interlocked sections
Stripwound hose whose profiled coils are loosely interlocked through a hooked profile at the edge of the strip. Where better sealing is required, a packing thread can be wound into the profile.

Stripwound hose with engaged sections
Stripwound hose whose profiled coils engage loosely through folds at the edge of the strip. These profiles are mostly made with a metallic seal and with no additional packing thread.

Metal hose assemblies only require light support points. Their function is to fix the hose assembly in its installed position and to prevent the transmission of residual vibrations and movements to other components. Typically, these are fixed to the section of pipe directly after the hose.

Temperature factors
–> Maximum permissible pressure

Test certificates
Documentation of varying content or scope that certifies conformity with the scope of supply/testing.
–> Section 3 "Basic facts about metal hoses", page 18

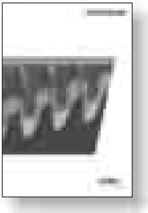
Testing pressure
Before delivery, HYDRA corrugated hose assemblies are factory-tested for leakage and pressure resistance.
–> Section 3 "Basic facts about metal hoses", page 18

Torsion
Twisting of a metal hose about its longitudinal axis. During assembly, it is important to ensure that the hose assembly is installed without torsion and is not subjected to a twisted action as a result of movements during use. In the interests of a long service life it is essential to observe this ground rule.
–> Section 3 "Basic facts about metal hoses", page 18

TS
–> Maximum permissible temperature

Twisting
–> Torsion

Folders to our further products



Expantion Joints Manual

Metal Bellows Manual

Business field- Industry
- Flexperte CDR
- Product Overview Industry
- Flexible Heat Trance System
- Stripwound Hoses
- Pipe Hangers and Supports including accessories
- Clamped Base Support for Pipelines

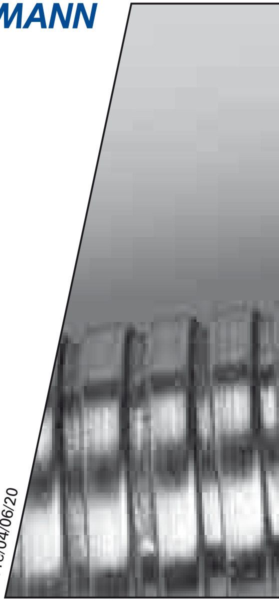
Business field – Heating Ventilation and Sanitary Equipment
- Product Overview Heating Ventilation and Sanitary Equipment
- Heating Ventilation and Sanitary Equipment Metal Hoses and Expasion Joints
- Heat Exchangers for Heating and Ventilation
- Stainlees steel drinking water feed hose
- Fire protection
- Connection pipes for flexible tubing of units
- Flexibel stainlees steel units for heat exchangers/
  Connecting pipes for solar collectors

Business field – Commercial vehicles and engines
- Flexible solutions for commercial verhicles and engines

Business field – Automotive Engineering
- Flexibel solutions for automotive engineering

WITZENMANN

managing flexibility



0301e/04/06/20

Witzenmann GmbH

Östliche Karl-Friedrich-Str. 134
75175 Pforzheim
Phone +49 - (0)-72 31 - 5 81 - 0
Fax +49 - (0)-72 31 - 5 81 - 8 20
wi@witzenmann.com
www.witzenmann.com