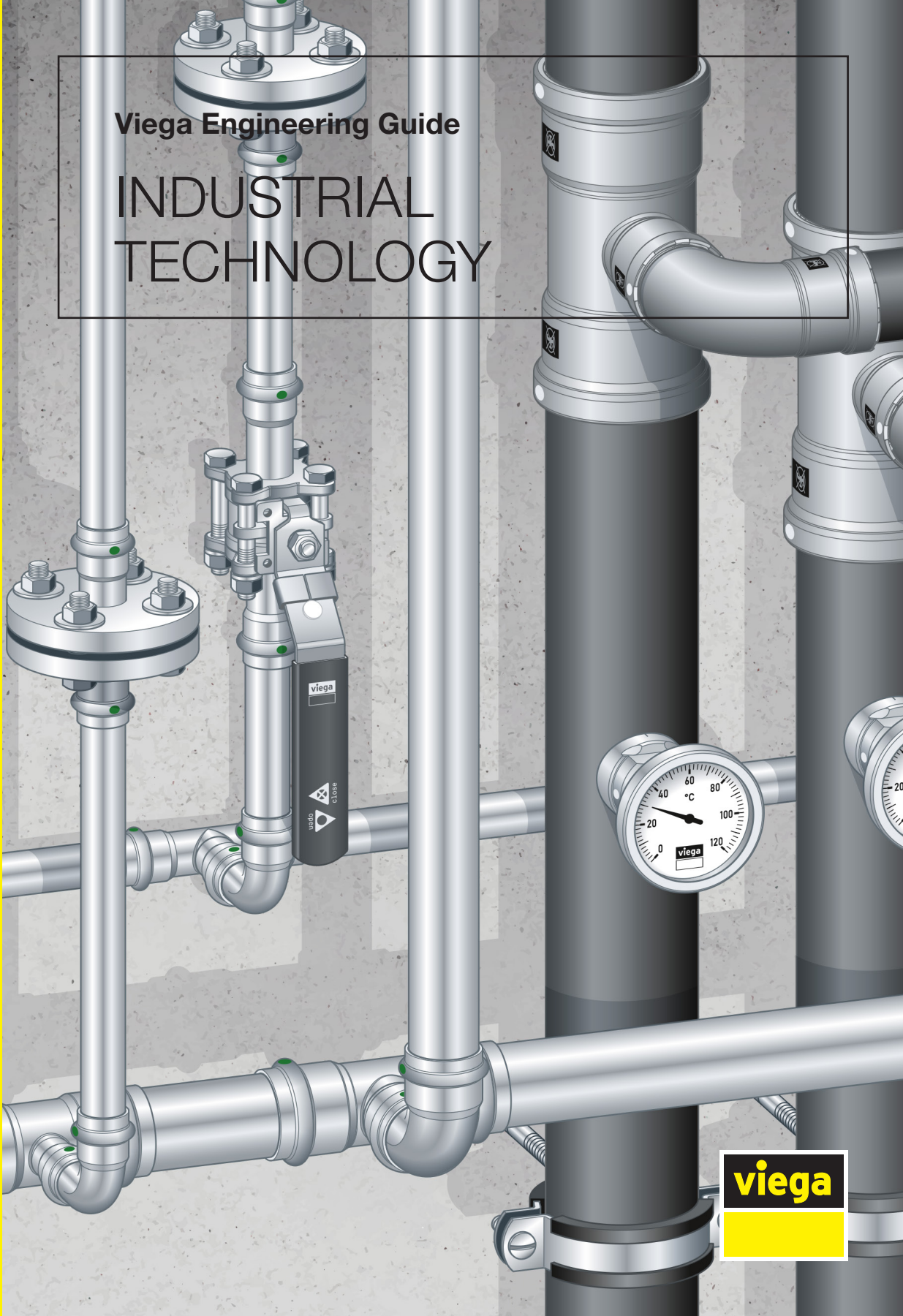
Viega Engineering Guide

INDUSTRIAL TECHNOLOGY



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INDUSTRIAL TECHNOLOGY

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FOREWORD

Dear expert,

When planning, maintaining or operating an industrial system, your demands on the availability, safety and economic efficiency of your production facility are high. This is where piping technology plays a key and indeed connecting role, because it guarantees the smooth interaction of all system components.

When it comes to the media being conveyed, you expect a constant quality under specified operating parameters, as well as compliance with legal requirements and due consideration for technical regulations. This is not just about potable-water quality. The purity of compressed air and industrial gases, as well as process water specifications, are also often crucial to production quality. Once the quality standards have been met, you strive to achieve economic production coupled with high system availability.

This is where cold press connection technology comes in, because it is a perfect match for these objectives. As a leading system provider, Viega had revolutionised installation technology by the mid-1990s. Press connection technology is now the recognised standard in building services engineering. And numerous other industrial processes are already benefiting from the use of this technology too.

In piping installation, a fast, safe and durable execution without extensive use of highly skilled labour is ideal. This is true both for installing new systems and maintaining existing ones, which requires keeping downtime short. This manual will show you how you can use the advantages of cold press connection technology for these very tasks and which applications can be realised with the wide variety of materials available for press connectors.

Join us in installing the lifelines for the buildings of tomorrow. Everything industrial units and buildings need flows through our piping systems: process water, compressed air, industrial gases and oil – and not forgetting potable water.

We would like to take this opportunity to wish you every success, both at your desk and on the construction site!

Attendorn, July 2024
The Viega team

PLANNING PRINCIPLES

General principles

bar	mbar	Pa	kPa	hPa	MPa
0,001	1	100	0,1	1	0,0001
0,01	10	1 000	1	10	0,001
0,1	100	10 000	10	100	0,01
1	1 000	100 000	100	1 000	0,1

Tab. 1: Conversion Bar / Pascal

Press connector systems

Viega press connection technology

Viega press connection technology is a clean, efficient and reliable method of connecting piping to one another. With a large choice of materials and sealing elements, the Viega product range offers win-win solutions for a host of applications in the industrial sector.

Fig. 1: Viega press connectors

No matter if it is about compressed air, process water, industrial gases, extinguishing water or various types of oil – there are numerous benefits to Viega press connection technology.

Advantages of Viega press connection technology	
Time savings	Press connecting technology in a matter of seconds, no welding needed
Manpower requirements	Easy assembly without the need for qualified welders
Safety	No fire risk, no fire watch, no danger to personnel or to the environment
Costs	Short assembly times, minimum system downtimes, no X-ray costs
Mounting material	Handy press tools, no welding equipment required
Diversity	Broad range of systems and materials for the most diverse processes
Reliability	Tried and proven, certified technology

Tab. 2: Advantages of Viega press connection technology

SC-Contur and double pressing

All Viega press connectors are fitted with the SC-Contur. This allows any inadvertently unpressed connections to be detected and pressed in good time. Using dry leakage tests with air or inert gas, Viega enables detection of unpressed connections at a pressure range of 22 hPa to 0.3 MPa or, in case of wet leakage tests using water, 0.1 to 0.65 MPa.

Fig. 2: SC-Contur of a Profipress press connector

The quality tests for Viega press connectors are geared to meeting the requirements of DVGW-W 534, and easily surpass these requirements in some cases. Tab. 3 shows the test values for the Profipress, Sanpress and Sanpress Inox systems as examples.

Testing criteria	Requirements as per DVGW-W 534	Viega test values
Compression strength	At least 2.5 MPa	5.0–20 MPa
Pressure surge	10 000 loads between 0.1 and 1.5 MPa at room temperature	100 000 loads between 0.1 and 1.5 MPa at room temperature and 95 °C
Resistance to temperature fluctuations	10 000 loads with a duration of 15 min alternating between 20 °C and 95 °C, at a pressure of 1.0 MPa and with the piping prestressed at 2 N/mm²	
Vacuum	-0,08 MPa; P_{abs} = 200 hPa	
Sealing elements	Special tests	

Tab. 3: Viega quality tests for Profipress / Sanpress / Sanpress Inox

Materials for piping systems

NOTE!
Be sure to refer to the information on the intended use of the selected piping system. Always agree any use of the system going beyond the applications specified in 'Intended Use' with the Viega Service Center.

The various Viega piping systems differ in terms of press connector material, suitable pipes and factory-fitted sealing elements. The most suitable piping system for a particular application case depends largely on the medium being conveyed and the operating and ambient conditions. The flow rule explained below and the information on material compatibility should be observed at all times.

Flow rule

An interconnected potable-water installation in which different materials are used is referred to as a mixed installation. Although considered cutting edge technology, such a system can lead to contact corrosion if installed incorrectly. The less noble of two metals can disintegrate and even become completely destroyed. Base metals for potable-water installations are galvanised ferrous materials.

If, for instance, oxygen-rich potable water flows through components of higher-grade material and then comes into contact with lower-grade materials on its way through the system, deposits of copper ions, for example, will form on iron or zinc surfaces, causing these lower-grade materials to dissolve. This is referred to as copper-induced pitting. If the opposite situation occurs, such corrosion is far less likely to occur.

This is the basis for a flow rule:

Flow rule
In potable-water installations with two or more metals, the base metal must be used upstream from the higher-grade material.

Mixed installation
In most cases, installing a non-ferrous metal fitting or a component made of gunmetal or silicon bronze along the length of the pipe cross-section is sufficient to prevent contact corrosion. In mixed installations of metal Viega press connector systems with galvanised iron materials, Viega recommends the arrangement according to Tab. 4.

	Installation in the flow direction	
System	**Upstream of galvanised ferrous materials**	**Downstream of galvanised ferrous materials**
Sanpress Inox	✓	✓
Sanpress	✓	✓
Profipress	✗	✓

Tab. 4: Viega press connector systems in combination with galvanised ferrous materials

Copper
Components made of copper must not be installed upstream of galvanised ferrous materials. Observe the flow rule at all times.

Stainless steel
Stainless steel system components must be protected against high concentrations of chloride produced by both the medium and by external factors.

Mixed installations of stainless steel system components and other materials are permitted, irrespective of the flow direction.

Steel (non-alloyed/galvanised)
Steel system components are designed for use in industrial and heating installations. Steel system components are not suitable for use in potable-water installations or other open systems because their constant oxygenation would cause the system to corrode. Pipes and press connectors are therefore labelled with a red or black “Not for potable-water installations” symbol.

Components made of galvanised ferrous materials must not be installed downstream of copper components. Observe the flow rule at all times.

Steel components may be used only with those components belonging to the system.

Brass
Brass system components must be protected against high concentrations of chloride produced by both the medium and by external factors (risk of dezincification).

Gunmetal/silicon bronze
Gunmetal and silicon bronze can be used as insulation between different metals to prevent contact corrosion. Observe the flow rule at all times.

Technical data for installation materials

Material	Density	Breaking strength	E-modulus	Heat expansion	Heat conductivity
	ρ	δ_z	E	α	λ
	[kg/dm³]	[N/mm²]	[N/mm²]	[mm/(m·K)]	[W/(m·K)]
Stainless steel 1.4401	8.0	520	210 000	0.0165	15
Stainless steel 1.4521	7.7	420	220 000	0.0108	26
Stainless steel 1.4520	7.7	380	220 000	0.0108	26
Copper	8.89	250–340	120 000	0.0166	372
Steel (non-alloy, galvanised)	7.85	420	210 000	0.0120	50
Brass	8.44	360	97 000	0.0200	123
Gunmetal	8.74	220	84 000	0.0180	72
Plastic	0.91–1.55	–	350–3 500	0.08–0.20	0.15–0.40
Composite material	–	–	70 000	0.025–0.030	0.45

Tab. 5: Technical data – Installation materials

Sealing elements

Seals play a key role in all technical systems or equipment in which media are kept enclosed. They are designed to prevent the enclosed medium from escaping unchecked into the environment at the connection points of the individual system components. This requires the seals to fulfil a number of crucial requirements:

- They are in perfect mechanical condition and clean when installed.
- They are chemically resistant to the enclosed medium.
- They withstand the operating conditions of the installation (pressure, temperature, etc.).

Seals can be made from numerous dissimilar materials. The most suitable material for the special application case concerned must be selected. Its composition influences the mechanical and chemical properties and hence its compatibility with certain media. As a rule, the seal material to be selected for a particular application is already specified in the regulations pertaining to this application. A range of sealing materials, along with their general characteristics, is shown in the next section „Sealing materials“.
Viega uses different sealing elements to meet the various media and system requirements, paired with the ideal pipe and connecting material in each case. Consequently, the selected system (pipe connector sealing element) provides the optimum solution for the intended purpose, including special applications such as systems for the automotive industry or paint shops that need to be PWIS-free. The properties of the sealing elements used at Viega are described in section „Viega solutions“ on page 21.

Sealing materials

Of the multitude of sealing materials available, the following are described here:

- EPDM
- FKM
- HNBR
- NBR
- PTFE
- AFM 34/2

Each of these designations is a generic term for a number of subtypes. Each individual type can have various forms of a particular property. For example, there are different types of EPDM that may produce different results in material testing due to their composition (see Fig. 11 on page 20).
Therefore, before any sealing material is used, it is necessary to verify with the manufacturer whether the chemical composition of the seal it offers is actually suitable for the application case concerned.

EPDM

EPDM is the standard international abbreviation for ethylene-propylene-diene rubber of the M group according to DIN ISO 1629. This is a rubbery-elastic synthetic rubber based on ethylene and propylene, as well as a diene with no further specification.
The expression "ethylene-propylene-diene-monomer-rubber" has also spuriously become common currency for EPDM. However, this is misleading because it is a polymer rather than a monomer.

The backbone and side groups of EPDM consist mainly of saturated compounds and a relatively small number of double carbon-carbon ones (Fig. 3). These unsaturated double bonds make EPDM a highly efficient reactant for certain substances. This limits the possible use of EPDM in systems and may need to be considered if selected as a sealing material.

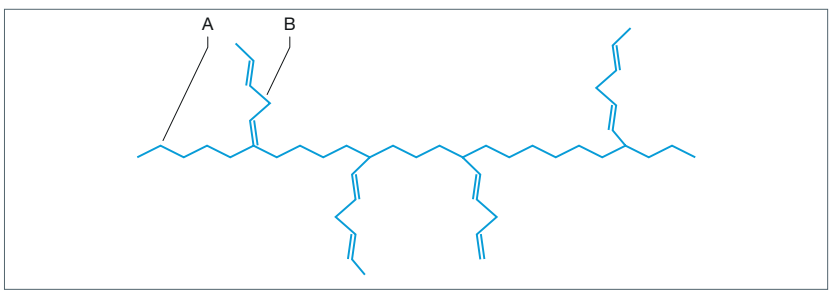


Fig. 3: Schematic representation of EPDM

A Backbone

B Unsaturated side groups

Consequently, EPDM is an ideal sealing material for polar media such as water (Fig. 4) or alcohols, especially for potable water according to DIN EN 806 in combination with the “Evaluation basis for plastics and other organic materials in contact with potable water”[1] (KTW evaluation basis) of the German Environmental Agency (UBA). It can also be used effectively for cooling liquids and acids or bases within certain limits.
However, it is not suitable for non-polar substances such as hydrocarbon solvents, chlorinated hydrocarbons, turpentine or petrol. EPDM is also resistant to oils to a very limited extent.

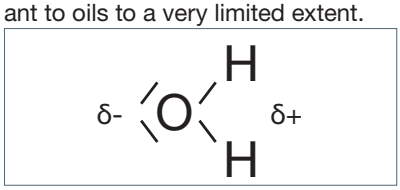


Fig. 4: Schematic representation of polar water

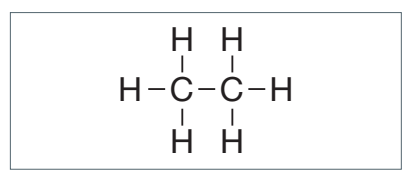


Fig. 5: Schematic representation of non-polar ethane

The lines in the diagram represent the electron pairs that connect the atoms

[1] On 21 March 2021, this evaluation basis replaced the established KTW guideline (“Leitlinie zur hygienischen Beurteilung von organischen Materialien im Kontakt mit Trinkwasser” (KTW) of the German Environmental Agency)

carbon (C), hydrogen (H) and oxygen (O) with one another. Since there are more electrons on the left side of the water, this side has a slightly more negative charge (δ-) than the right side (δ+). This polarisation does not occur with symmetrical ethane.

FKM

FKM is the abbreviation for fluorocarbon rubber of the M group according to DIN ISO 1629 as well as ASTM D1418 and refers to a whole group of elastic rubbers that have vinylidene (di)fluoride (VDF) as a common characterising monomer.
The "K" is derived from the German for carbon (Karbon). The previously used term fluoropolymer rubber, abbreviated FPM, has been replaced. Depending on its composition, FKM can be used at a temperature range from -40 °C to +200 °C and is characterised by increased resistance to many chemicals as well as a good compression set (DVR) („Compression set“ on page 17).
This chemical resistance is due, among other things, to the saturated side groups, which lack the chemically highly reactive double bonds (Fig. 6). This makes FKM particularly suitable for:

- Oxygen and ozone
- Greases and oils
- Non-polar media
- Non-polar solvents

The typical properties of a special FKM of a group are determined by the other monomers used and the fluorine content. Consequently, the resistance to certain chemicals, to the effects of heat and to mechanical deformation, for example, can be adjusted over a wide range.

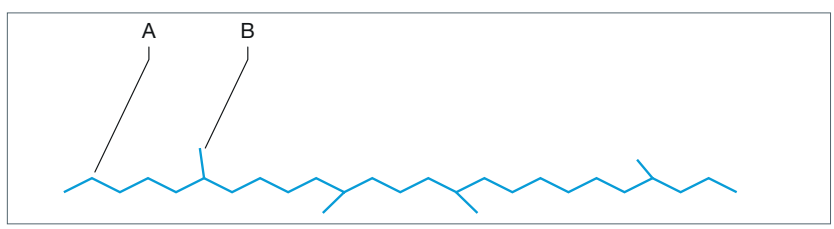


Fig. 6: Schematic representation of FKM

A Backbone B Short saturated side groups

HNBR

The abbreviation HNBR stands for hydrogenated acrylonitrile butadiene rubber. The **R** is derived from “rubber”. The essential components of this plastic are the eponymous monomers acrylonitrile and 1,3-butadiene, the proportions of which determine its material properties:

- Elasticity
- Compression set (page 17)
- Flexibility when cold
- Resistance to swelling
- Gas permeability

Generally speaking, products made of HNBR have a high resistance to oils, greases and hydrocarbons. They also exhibit low abrasion and favourable ageing behaviour.
Their temperature resistance allows them to be used in the range between -55°C and +150°C, depending on the proportion of the monomers used and with any necessary addition of plasticisers. Low temperature resistance and resistance to fuel are in competition here:
The lower the acrylonitrile content, the lower the minimum usage temperature, though the poorer the fuel resistance.

Since HNBR contains hardly any unsaturated double bonds, products made from it are also resistant to oxidation, ozone and UV light. Their resistance to swelling depends largely on the medium with which they come into contact:

- Good resistance to swelling in
  - aliphatic hydrocarbons (e.g. propane, butane, certain mineral oils),
  - animal and vegetable oils and fats and
  - light heating oil and diesel fuel.
- Limited resistance to swelling in
  - media with a high content of aromatic hydrocarbons (e.g. premium fuel).
- Little to no resistance to swelling in
  - aromatic hydrocarbons (e.g. petrol),
  - chlorinated hydrocarbons (e.g. methylene chloride, trichloroethylene),
  - esters, as well as
  - polar solvents.

NBR

NBR stands for nitrile butadiene rubber. The **R** is derived from “rubber”. Its chemical properties are comparable to those of the HNBR derived from it. However, due to the double bonds still present in NBR, its resistance to oxygen, ozone and UV light, as well as its temperature resistance of only approx. 100°C are significantly lower.

PTFE

PTFE is an abbreviation for **polytetrafluoroethylene**. It is a long-chain, unbranched polymer consisting of the elements carbon and fluorine.
It is known colloquially under various proprietary trade names, such as Teflon®, Dyneon® or Gore-Tex® for membranes.

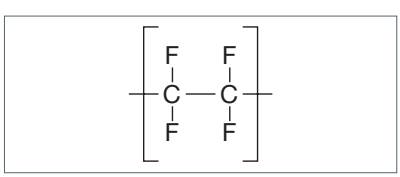


Fig. 7: Schematic of the structure of PTFE

Due to its chemical structure, PTFE is extremely inert and therefore biologically and physiologically harmless. It is resistant to most acids and to bases, alcohols, ketones, petrols, oils, etc. Its application range extends from -270 °C to +260 °C. Hot bases (e.g. caustic soda, potassium hydroxide solution) above approx. 70 °C will destroy PTFE.

A special feature of PTFE is its extremely low surface tension. This means that only a few materials will adhere to its surface, making it extremely difficult to wet. PTFE is both water-repellent (hydrophobic) and grease-repellent (lipophobic). In combination with its extreme inertness, PTFE is therefore suitable as a sealant for almost any common media transported in pipelines.

Fluorinated refrigerants based on fluorinated gases (F-gases) are a notable exception. Their chemical structure is similar to that of PTFE, and the fluorine atoms in both substances will interact. F-gases cause PTFE to swell and should therefore not be brought into contact with it.

AFM 34/2

AFM 34/2 is a high-quality asbestos-free sealing material. It contains substances resistant to high temperatures, inorganic fillers and fibres made from aromatic polyamides (PA). The latter are referred to as aramid fibres, a portmanteau of aromatic polyamides. In the production of AFM 34/2, the individual components are bonded with high-quality elastomers at elevated temperatures and pressures to create a high-strength and particularly gas-tight connection.

AFM 34/2 is mainly manufactured as a sheet material, so it is predominantly used as a flat gasket, e.g. for flange connections.

The material has high tensile, compressive and shear strength and is very suitable for use with both liquids and gases. Its high temperature and pressure resistance in combination with its high inertness allow it to be used in a wide range of operating conditions for a variety of different media, e.g.

- Water (including potable water)
- Aqueous solutions
- Salt solutions
- Solvents
- Oils
- Fuels
- Antifreeze mixtures
- Liquid gases
- Frigenes

AFM 34/2 does not contain any physiologically harmful substances or colour additives. This means it is also suitable and certified for use in potable-water installations.

Material testing

Sealing materials are subjected to various material tests for the purpose of comparability and to ensure their suitability for a particular application (cf. e.g. DIN ISO 1817: Elastomers or thermoplastic elastomers - Determination of behaviour towards liquids).
Two tests are cited here as examples. The first test examines a material property and the second the suitability for a specific application.

Compression set

When used with press connectors, these are usually sealing elements which, when pressing connectors are gently pressed with the pipe and hence deformed by approx. 25% in order to seal the connection. In order to maintain this function for a prolonged period, the material of the sealing element has to remain elastic for a long time without permanently deforming. This behaviour is described with the compression set, which is determined using the test procedure according to DIN EN 681-1, Annex B.
The sealing elements to be tested are clamped in a fixture according to ISO 815 and compressed for a defined time at a specific elevated (ISO 815-1) or low (ISO 815-2) temperature (Fig. 8).

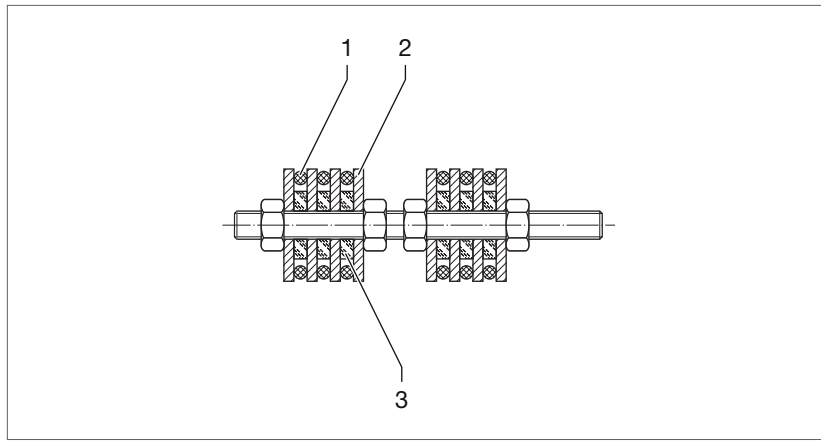


Fig. 8: Setup of the fixture for determining the compression set according to ISO 815

1 Sealing element
2 Stainless steel pressure plate
3 Compression limiter

At the end of the test time, the tested sealing element is measured after being relieved (Fig. 9) and the value of the compression set is calculated.

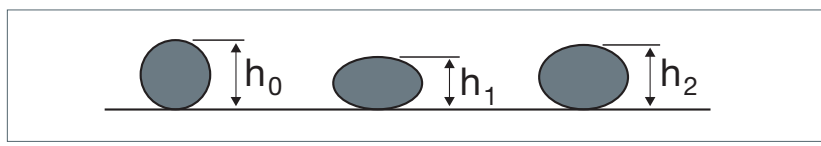


Fig. 9: Measurement of the sealing element before, during and after the test

h_0 original height of the sealing element
h_1 height of the spacer between the test plates = compressed height
h_2 height of the sealing element after relieving

The following formula according to ISO 815 is used to calculate the compression set in percent:

$$DVR = \frac{h_0 - h_2}{h_0 - h_1} \cdot 100$$

The formula shows that a perfectly elastic material would have a compression set of 0%, i.e. return to its original shape completely. This represents the ideal case for a sealing material.
The reverse of this is a plastic material with a compression set of 100%, which does not return to its original shape after being relieved and remains deformed.

For illustration purposes, Fig. 10 shows the profile of the compression set plotted over time at different temperatures.

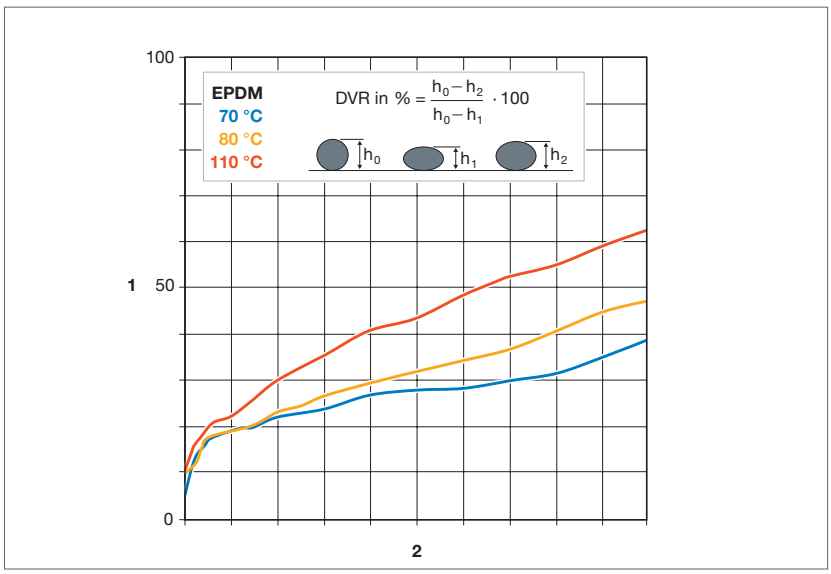


Fig. 10: Compression set for a selected EPDM at different temperatures

1 Compression set [%] 2 Time

Due to the different compositions of various EPDM types, the same test may produce different results (Fig. 11). In simple terms: the smaller the compression set, the better the long-term behaviour of a pipe connection.

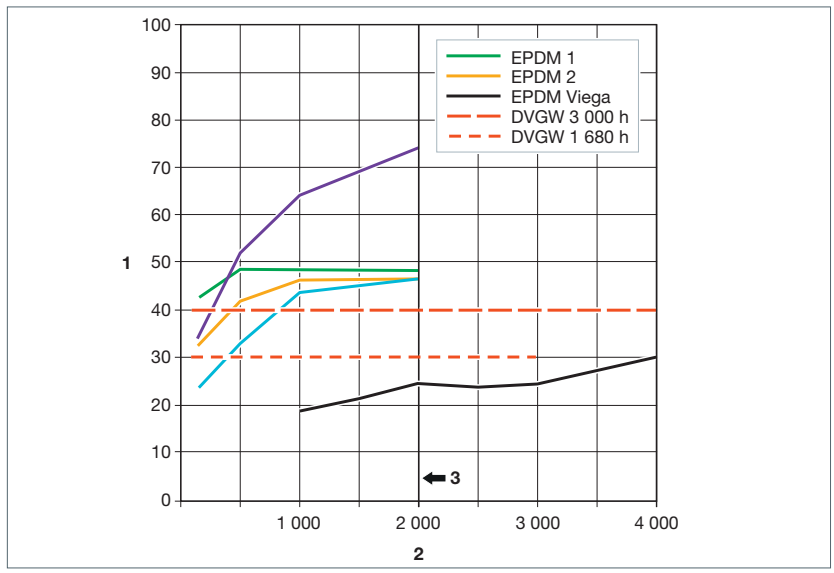


Fig. 11: Compression set for various EPDM types at the same temperature during the test procedure according to DIN EN 681-1

1 Compression set [%]
2 Time [h]
3 End of DIN testing time (2 000 h)

Higher thermal resistance (HTR)

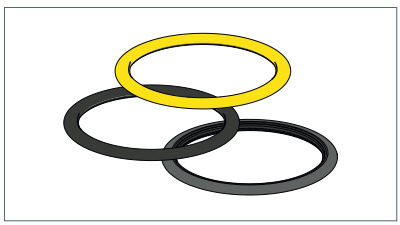
The criterion for higher thermal resistance (HTR) is based on the ignition temperature of natural gas in air (approx. 640°C). To prevent the formation of an explosive mixture, in case of fire, no dangerous quantity of gas must escape at any point in the building that is below the ignition temperature.

For gas installations in the domestic sector, only components labelled “higher thermal resistance (HTR)” may be used. Non-HTR components must be secured separately by means of a thermal shut-off system (TSS). Gas fittings meet HTR criteria in accordance with DIN EN 331 if the product will resist fire for at least 30 minutes at an operating pressure of 0.1 MPa (1 bar) and an ambient temperature of 650 °C and remain functional. Leak tightness even at extreme ambient temperatures prevents the spread of fire due to gas escaping unchecked and buys time for closing the shut-off systems.

Products that meet the criteria in accordance with DIN 3537-1 at a required max. operating pressure of 0.1 MPa (1.0 bar) are provided with the "GT 1" marking.
Products that achieve the increased thermal capacity even at a higher maximum operating pressure are marked accordingly, e.g. with "GT 5" for the maximum operating pressure of 0.5 MPa (5.0 bar).

Viega solutions

Viega uses the following sealing materials for press connectors, the properties and special features of which are described in detail:



- EPDM
- FKM
- HNBR
- NBR
- PTFE
- AFM 34/2

Fig. 12: Sealing elements for Viega press connector

Viega sealing elements

Viega uses sealing elements made of the materials itemised in Tab. 6 with the properties indicated. They are inserted in the factory into the connectors of the listed Viega press connector systems. Some typical applications of the various sealing materials are shown in Tab. 7.

Acronyms	EPDM[1)]	HNBR	FKM
Material	Ethylene propylene diene rubber	Acrylonitrile butadiene rubber	Fluorine carbon rubber
Colour	Black, polished	Yellow	Black, matt
Max. operating temperature [°C][2)]	105	70	140
Max. operating pressure [MPa (bar)][2)]	1.6 (16)	0.5 (5)	1.6 (16)
Higher thermal resistance (HTR)[3)]	No	Yes	No
Potable water (KTW approval)[4)]	Yes	No	No
Viega press connector system	■ Profipress ■ Sanpress ■ Sanpress LF[5)] ■ Sanpress Inox ■ Sanpress Inox LF[5)] ■ Prestabo ■ Prestabo LF[5)] ■ Megapress ■ Seapress	■ Profipress G[6)] ■ Sanpress Inox G[6)] ■ Megapress G[7)]	■ Profipress S ■ Megapress S

[1)] Max. oil content in compressed air < 25 mg/m³, not resistant to hydrocarbon solvents, chlorinated hydrocarbons, turpentine, petrol

[2)] Potable-water installations according to DIN 1988-200 /DIN EN 806-2: max. operating temperature 80°C / max. pressure 1.0 MPa, up to a temperature of 95 °C for a duration of 60 min. Heating systems according to DIN EN 12828: max. operating temperature 105 °C. The values may vary depending on the medium flowing through, other operating conditions and area of application. Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

[3)] According to DIN 3537-1

4) Evaluation basis for plastics and other organic materials in contact with potable water (KTW)

5) LF = PWIS-free

6) GT 1 according to DIN 3537-1

[7)] GT 5 according to DIN 3537-1

Tab. 6: Viega sealing elements – Technical data

The press connector systems' sealing materials are subject to thermal ageing, which is affected by media temperature and service life. In the case of special operating conditions such as industrial heat recovery systems, it is necessary to compare the specifications of the equipment manufacturer with those of the press connector system. Before using the press connector system outside the described areas of application or if in doubt about the correct material selection, please contact Viega.

Tab. 7: Areas of application of Viega sealing elements

Use	Regulations	Operating temperature	Operating pressure [MPa]	Pipe material	Elasto-mers[6]
Gas house service connections	DVGW-AB G 459-1/G 472	-20°C to 20°C[1]	≤ 1.0	PE/PE-X	NBR/HNBR
Potable water house service connections	DVGW-AB W 400 1-3	≤ 25°C	≤ 1.6	PE/PE-X	EPDM
Gas installations	DVGW Worksheet G 600 (TRGI 2018)	-20 °C up to 70 °C	≤ 0.5 – HTB/GT 5 ≤ 0.5 – HTB/GT 1	Steel[8]/ Copper/stainless steel	HNBR
Liquid gas installations	DVFG-TRF 2021[2]	-20 °C up to 70 °C	≤ 0.5 – HTB/GT 5[7] ≤ 0.5 – HTB/GT 1[7]	Steel[8]/ Copper/stainless steel	HNBR
Heating oil installations	TRbF 50[3]	≤ 40°C	-0.05 to 0.5	Stainless steel/ steel[8]/copper	HNBR
Radiant heating and cooling	DIN EN 1264	≤ 50°C	≤ 0.6	Polybutene/PE-X	EPDM
Potable water systems	DIN 1988; DIN EN 806; VDI/BTGA/ZVSHK 6023	60°C to 85°C	≤ 1.0 DEA ≤ 1.6	Stainless steel/copper Multi-layer pipe	EPDM
Potable water heating systems (therm. disinfection)	DIN 1988-200 DVGW-AB W 291 / W 551 / W 553	≤ 60°C > 70°C	1.0 0.6 (closed PWH)	Stainless steel/copper Multi-layer pipe	EPDM
Potable water heating systems (heating side)	DIN 1988-200 DIN 4753-1	≤ 95°C (PWH closed) > 95°C (PWH indirect)	1.0 0.6 (closed PWH)	Stainless steel/copper	EPDM
Heating systems (INT-PHWHS)	DIN EN 12828	≤ 70 °C	≤ 0.6	Copper/steel Multi-layer pipe	EPDM
Local heat supply systems (ground)	AGFW	≤ 95 °C	≤ 1.0	PE-X pre-insulated local heating pipe	EPDM
Heating systems (industrial), heat recovery	DIN EN 12828	≤ 105°C	≤ 0.6	Copper/steel	EPDM
Solar installations, flat collectors	DIN EN ISO 9806/DIN EN 12976	According to manufac-turer's information[4]	≤ 0.6	Stainless steel/copper	EPDM
District heat supply systems (in the building), secondary circuits with an indirect connection	DIN EN 12828	≤ 105°C	≤ 1.6	Stainless steel/copper/ steel	EPDM
		≤ 140°C	≤ 1.6		FKM
District heat supply systems (in the building) with a direct connection / primary circuits with an indirect connection	Technical connection conditions, district heat supplier[5]	≤ 140°C	≤ 1.6	Steel[9]	FKM
Solar installation, vacuum tube collectors	DIN EN ISO 9806/DIN EN 12976	According to manufac-turer's information[4]	≤ 0.6	Stainless steel/copper/ steel	FKM

1) -20° C test criterion for use in gas supply lines

2) Based on DVGW Worksheet G 600 TRGI 2018

3) In conjunction with approvals from building supervisory authorities

5) Specific utility companies' technical connection conditions of may vary

5) Specific utility companies' technical connection conditions of may vary

6) Short designation for application-specific compounds with the required approvals

7) Maximum pressure refers to the response pressure of the safety shut-off valve4) Product specific

8) Only in combination with Megapress G

9) Only in combination with Megapress S (≤ DN50 / 2 inches)

Replacement of sealing elements in press connectors

The press connectors of Viega piping systems without a letter at the end of their name are generally equipped with EPDM seals in the factory (Tab. 6). The press connectors of Viega piping systems with a "G" in the name (e.g. Profipress G) are delivered with HNBR sealing elements. The press connectors of Viega piping systems with an "S" in the name (e.g. Profipress S) are delivered with FKM sealing elements.
If the installation is not for potable water, it is possible in some cases to manually replace the factory-fitted EPDM sealing elements with Viega sealing elements made of FKM on site if necessary. As a result, the Viega Sanpress, Sanpress Inox, Prestabo and Seapress piping systems can be used at even higher temperatures or with other media if necessary.

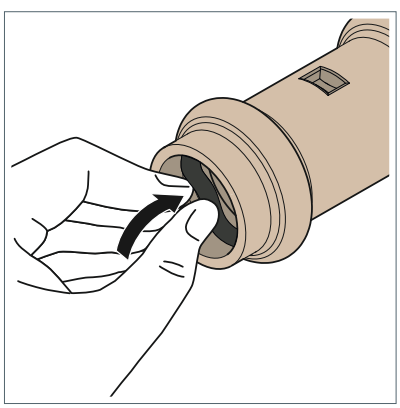
When selecting materials for fittings, pipes and sealing elements, the specific operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Replacement of sealing elements in press connectors 12–54 mm

NOTE!
Do not use pointed or sharp-edged objects to remove the sealing element. They may damage the sealing element or the bead.

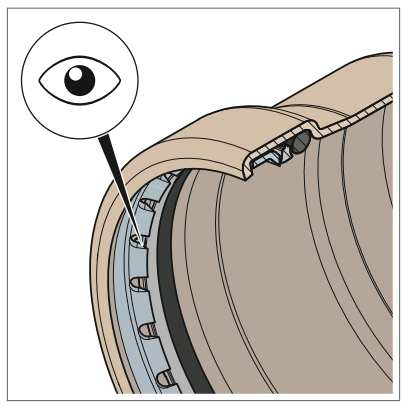
- Remove the sealing element from the bead.



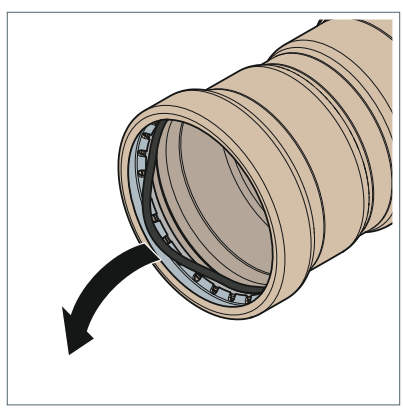
- Insert a new, undamaged sealing element into the bead.
- Ensure that the complete sealing element is in the bead.

Replacement of sealing elements XL press connectors 64 – 108 mm

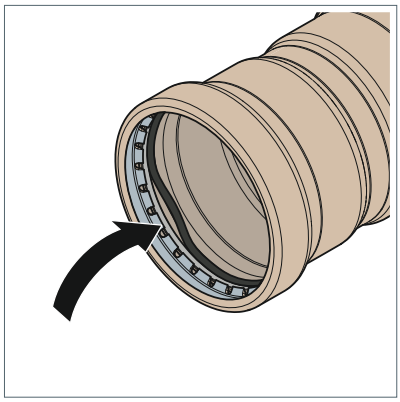
CAUTION!
Risk of injury due to sharp edges
There is a separator ring and a sharp-edged cutting ring above the sealing element. There is a risk of injury (cutting) when replacing the sealing element.
- Do not reach into the press connector with your bare hands.



NOTE!
Do not use pointed or sharp-edged objects to remove the sealing element. They may damage the sealing element or bead.



- Remove the sealing element from the bead, leaving the separator ring in the press connector.
- Proceed carefully to avoid damaging the separator ring and sealing element seat.



- Insert a new, undamaged sealing element into the bead below the separator ring. Make sure that the sealing element is not damaged by the cutting ring.
- Ensure that the complete sealing element is in the bead.

Replacement of the sealing element in Megapress press connectors ⅜–4 inches

The Megapress systems were developed specifically for the intended areas of application concerned. The components (cutting ring, separating ring and sealing element) installed in the press connector in the factory are precisely matched to one another to suit the different requirements of the areas of application. For all Megapress systems, therefore, the factory-fitted sealing element has to be replaced 1:1 (e.g. FKM for FKM).

Megapress and Megapress G press connectors

Megapress and Megapress G press connectors up to 2 inches are equipped with specifically designed EPDM or HNBR profile sealing elements. Integrally moulded sealing lips with several sealing levels reliably seal pipe surfaces, even those with slightly uneven surfaces or grooves.

Fig. 13: Megapress profile sealing element up to 2 inches

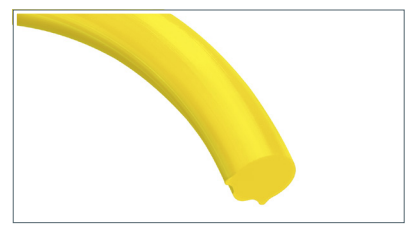


Fig. 14: Megapress G profile sealing element up to 2 inches

Megapress S press connectors

All Megapress S press connectors are fitted with FKM sealing elements. For dimensions of ⅜ to 2 inches, the press connectors include a round sealing element as well as a reinforced separator ring.

The XL press connectors in the dimensions 2½, 3 and 4 inches are equipped with round sealing elements with an increased cord thickness.

Given their design, the Megapress S press connectors have the same sealing properties as the Megapress press connectors and therefore do not require a profile.

Fig. 15: Megapress S round sealing element up to 2 inches

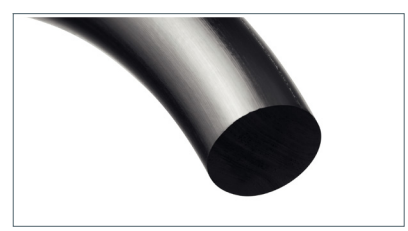
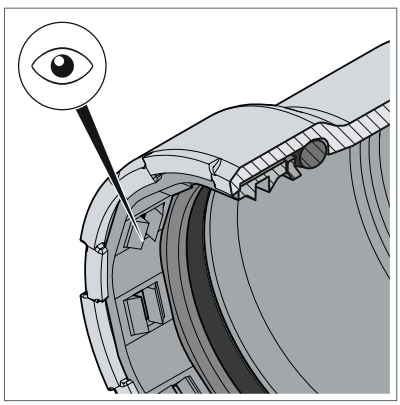


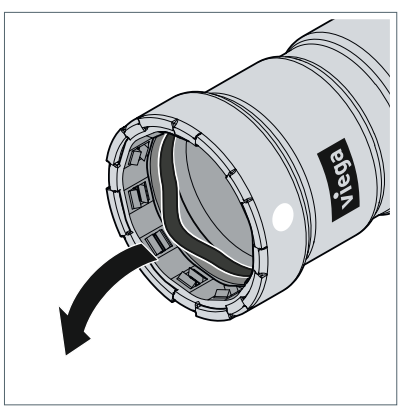
Fig. 16: Megapress S XL round sealing element from 2½ inches

Replacement of sealing elements up to 2 inches

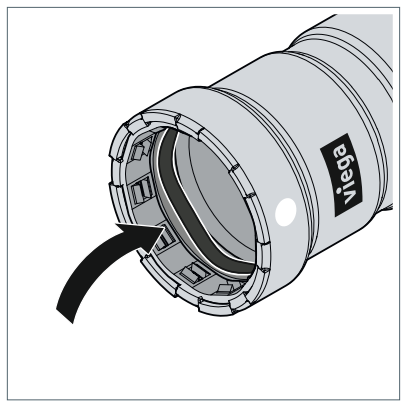
CAUTION!
Risk of injury due to sharp edges
There is a separator ring and a sharp-edged cutting ring above the sealing element. There is a risk of injury (cutting) when replacing the sealing element.
- Do not reach into the press connector with your bare hands.



NOTE!
Do not use pointed or sharp-edged objects to remove the sealing element. They may damage the sealing element or the bead.



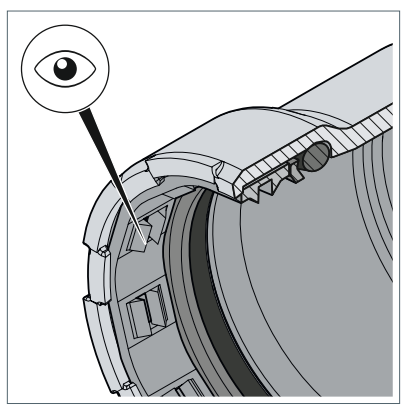
- Remove the sealing element from the bead, leaving the separator ring in the press connector.
- Proceed carefully to avoid damaging the separator ring and sealing element seat.



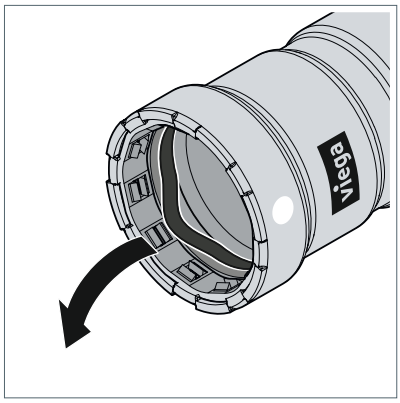
- Insert a new, undamaged sealing element into the bead. Make sure that the sealing element is not damaged by the cutting ring.
- Ensure that the complete sealing element is in the bead.

Replacement of sealing elements from 2½ inches

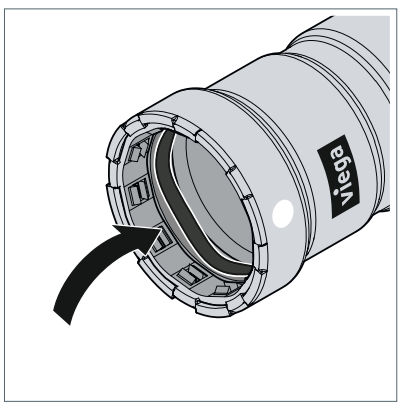
CAUTION!
Risk of injury due to sharp edges
There is a separator ring and a sharp-edged cutting ring above the sealing element. There is a risk of injury (cutting) when replacing the sealing element.
- Do not reach into the press connector with your bare hands.



NOTE!
Do not use pointed or sharp-edged objects to remove the sealing element. They may damage the sealing element or the bead.



- Remove the sealing element from the bead, leaving the separator ring in the press connector.
- Proceed carefully to avoid damaging the separator ring and sealing element seat.



- Insert a new, undamaged sealing element (model 4286XL) into the bead. Make sure that the sealing element is not damaged by the cutting ring.
- Ensure that the complete sealing element is in the bead.

PTFE in 3-part Easytop ball valves

Viega uses PTFE (page 15) for ball sealing in the centre section of 3-part Easytop ball valves with press connections of the Sanpress Inox, Megapress and Megapress S systems. This ensures that these fittings can be used universally for a wide range of media.

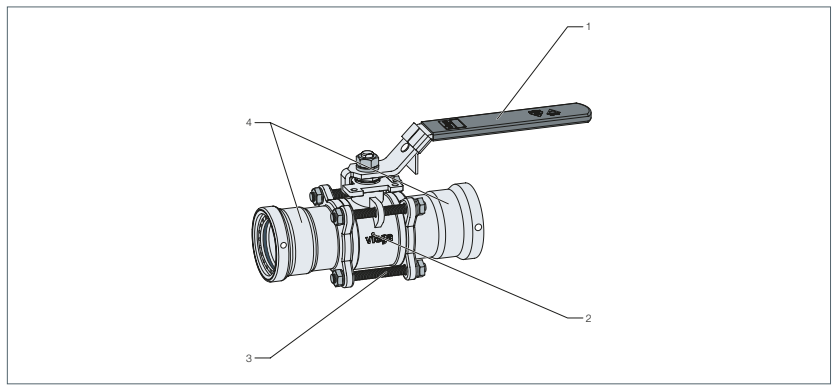


Fig. 17: 3-part Easytop ball valve with Megapress S XL press connections

1 L-shaped actuating lever made of metal
2 Centre section
3 Stud bolt
4 Megapress S XL press connection

Fig. 18: 3-part Easytop ball valves with Megapress press connections

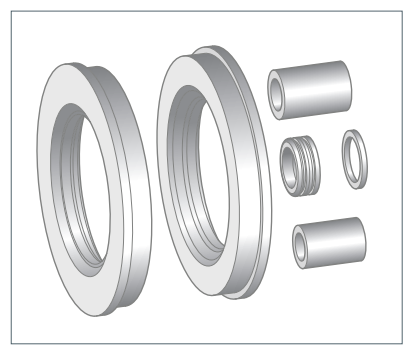


Fig. 19: PTFE seals for 3-part Easytop ball valves

Sealing elements for flange connections

With the Viega press connector systems, a direct transition to flange connections is possible with press connections.
Seals for flange connections must be selected according to the requirements from AFM 34/2 (asbestos-free) and are likewise available from Viega.

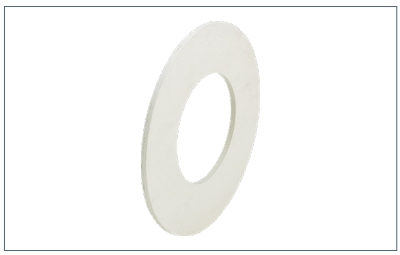


Fig. 20: AFM 34/2 sealing elements for flange connections

Electrically-insulating sealing elements for threaded connections

In an installation with dissimilar metallic pipe materials and a transition from a galvanised steel pipe to e.g. stainless steel or copper, Sanpress insulating unions should be installed for potable water hardness levels > 15°dH in order to prevent contact corrosion and scaling.

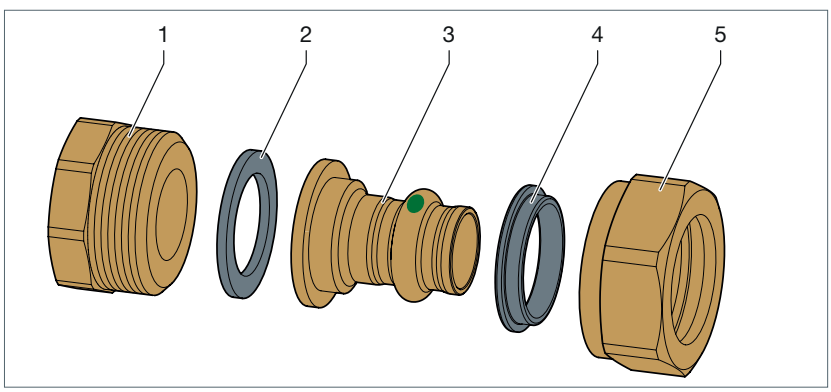


Fig. 21: Insulating union with EPDM flat seal

1 Threaded sockets made of gunmetal or silicon bronze with RP internal thread according to DIN EN 10226
2 EPDM flat seal, not electrically conductive
3 Sanpress press connection for connection screw fittings made of gunmetal or silicon bronze with SC-Contur
4 Insulating ring for electrical isolation
5 Union nut

PWIS-free sealing elements

In certain applications, all components of an installation need to be free of paint-wetting impairment substances (PWIS) (see „PWIS conformity“ on page 183).

PWIS-free press connectors from Viega are specially cleaned and fitted with sealing elements with PWIS-free lubricants after manufacturing. They are then marked with a blue dot and packed.

Fig. 22: Sanpress Inox LF with PWIS-free sealing element

General mounting instructions

Producing a press connection

Bending of pipes

Stainless steel and copper pipes must be bent with suitable machines. The minimum bending radius for Sanpress pipes is R ≥ 3.5x d. Generally, the following applies:

- The expansion bends must be straight and at least 50 mm in order to create a correct press connection.
- Avoid bending stresses between elbows and press connectors.
- Check compatibility with pipe materials before using bending sprays.
- Stainless steel pipes may only be bent when cold. Heat treatment changes the material properties and thus must be avoided.

Flange connections

With metal press connector systems, a direct transition to flange connections is possible with press connections in sizes 28 to 108 mm.
For Sanpress Inox, flanges made of stainless steel with press connections in sizes 22 to 108 mm are available.
Select seals with flange connections according to the requirements from AFM 34/2 or made from asbestos-free sealing material.

Sanpress Inox

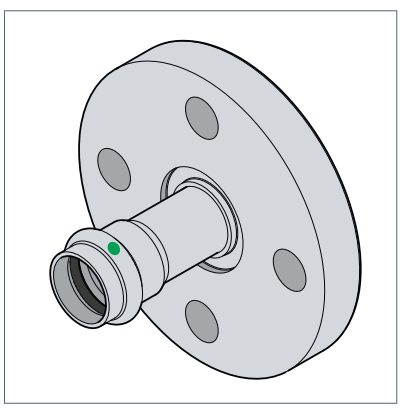


Fig. 23: Sanpress Inox fixed flange

Sanpress Inox

- Material: 1.4401 stainless steel
- Model: 2359
- Press connection size: 22–54 mm

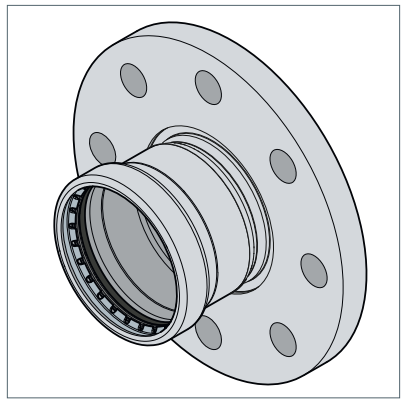


Fig. 24: Sanpress Inox XL fixed flange

Sanpress Inox XL
- Material: 1.4401 stainless steel
- Model: 2359XL
- Press connection size: 64–108 mm

Sanpress

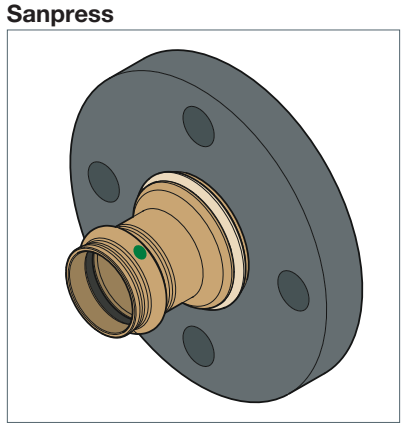


Fig. 25: Sanpress loose flange

Sanpress
- Material: steel, black powder-coated
- Press connection material: Gunmetal/silicon bronze
- Model: 2259.5
- Press connection size: 28–54 mm

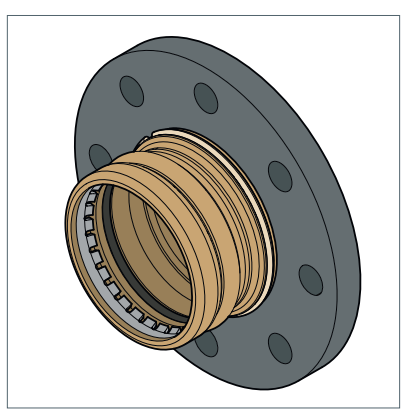


Fig. 26: Sanpress XL loose flange

Sanpress XL
- Material: steel, black powder-coated
- Press connection material: Gunmetal/silicon bronze
- Model: 2259.5XL
- Press connection size: 76.1–108 mm

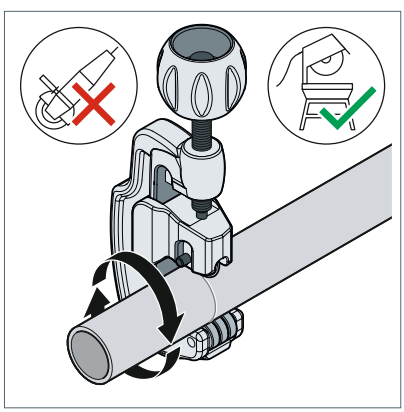
Press connections

NOTE!
Risk of property damage!
For stainless steel, the use of angle grinders for cutting pipes to length is not permitted.

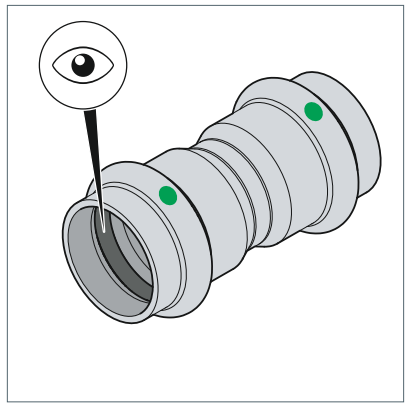
Sanpress, Sanpress Inox, Profipress, Prestabo 12 to 54 mm
Stainless steel, copper and steel pipes are connected simply and safely with Viega press connections.
Required tools:

- Pipe cutter or fine-toothed steel saw – the use of angle grinders is not permitted for stainless steel
- Deburrer and coloured pen for marking the insertion depth
- Suitable press machine with press jaw

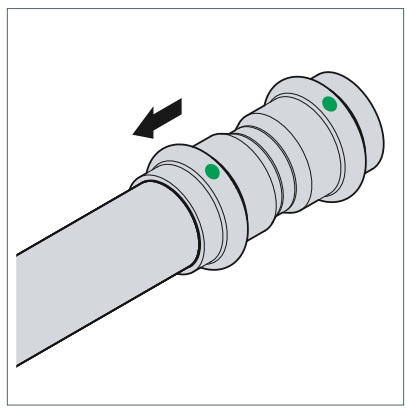
The figures below show the processing of a Sanpress Inox article as an example.



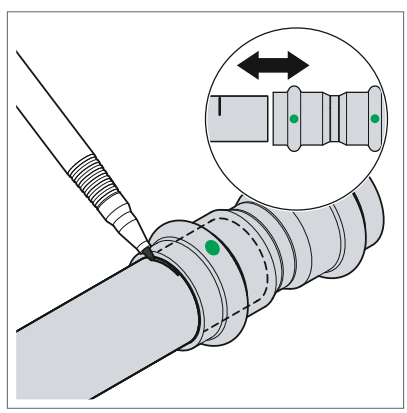
- Cut the pipe at a right angle as accurately as possible using a pipe cutter or a fine-toothed hacksaw to ensure correct and even pipe insertion depth. Avoid grooves on the pipe surface.



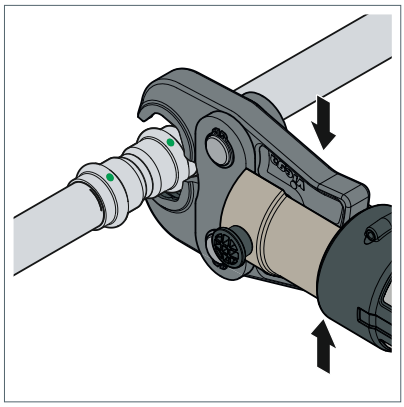
- Check for the following requirements:
- The pipe end is not bent or damaged.
- The pipe is deburred.
- The correct sealing element is in the press connector.
- The sealing element is undamaged.
- The complete sealing element is in the bead.



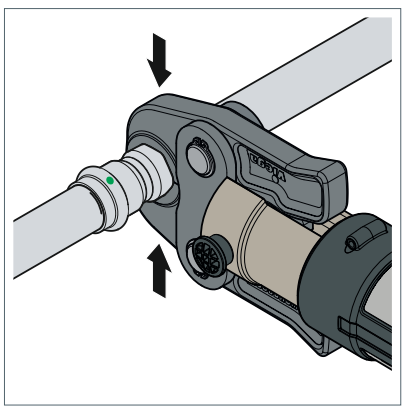
- Push the press connector onto the pipe as far as it will go.



- Mark the insertion depth, and check it by fully removing and refitting the press connector.
- Place the press jaw onto the press machine and push the retaining bolt in until it clicks into place.



- Open the press jaw and place it at a right-angle onto the press connector.
- Check the insertion depth using the marking.
- Ensure that the press jaw is placed centrally on the bead of the press connector.

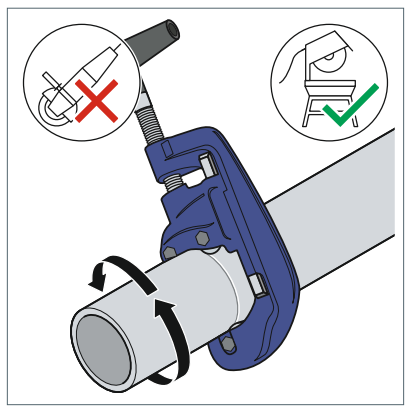


- Carry out pressing.
- Open and remove the press jaw.
  - Connection is pressed.

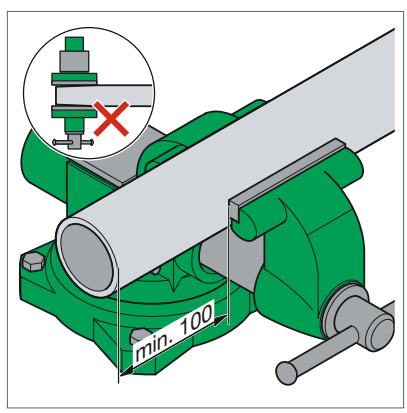
Sanpress XL 76.1 to 108.0 mm
Stainless steel and copper pipes are connected simply and safely with Viega press connections.
Required tools:

- Pipe cutter or fine-toothed steel saw – the use of angle grinders is not permitted for stainless steel
- Deburrer and coloured pen for marking the insertion depth
- Suitable press machine
- Suitable sized press chain and hinged adapter jaw for press chain (press rings are not suitable)

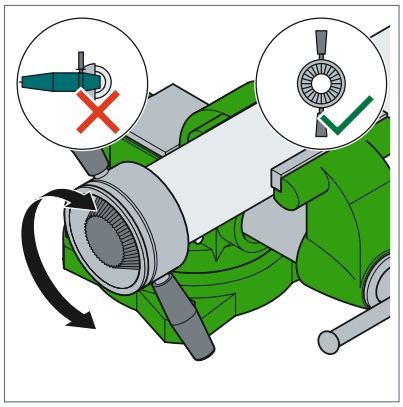
The figures below show only the processing of the Sanpress XL article.



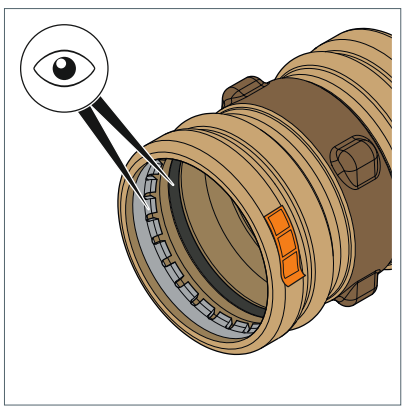
- Cut the pipe at a right angle as accurately as possible using a pipe cutter or a fine-toothed hacksaw to ensure correct and even pipe insertion depth. Avoid grooves on the pipe surface.



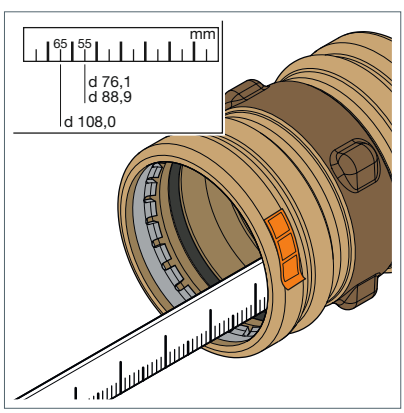
- Secure the pipe in the vice.
- When clamping, leave a distance of at least 100 mm to the pipe end.
  The pipe ends must not be bent or damaged.



- Deburr the inside and outside of the pipe.



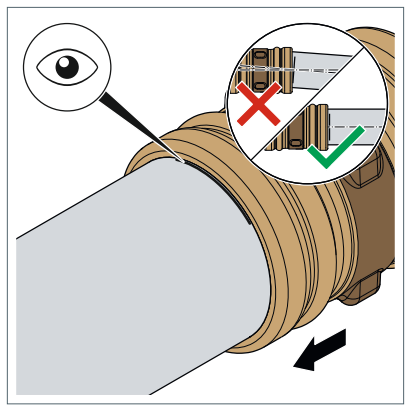
- Check for the following requirements:
- The pipe end is not bent or damaged.
- The pipe is deburred.
- The correct sealing element is in the press connector.
- Sealing element and cutting ring are undamaged.
- The complete sealing element and cutting ring are in the bead.



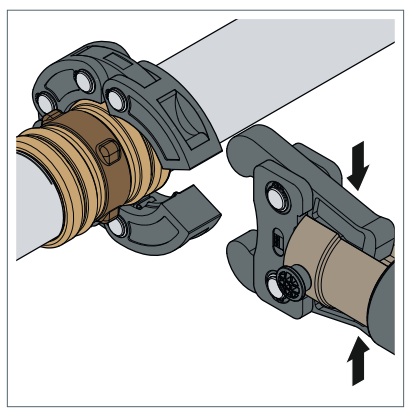
- Measure the insertion depth in the press connector.

ø	Insertion depth
76.1 mm	55 mm
88.9 mm	55 mm
108.0 mm	65 mm

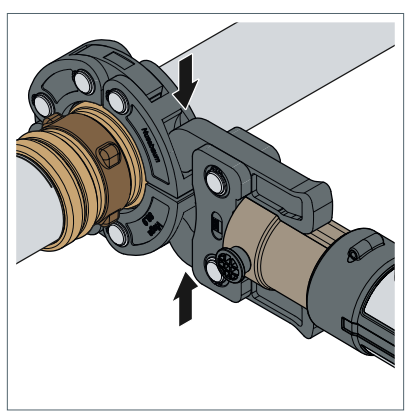
- Mark the insertion depth on the pipe.



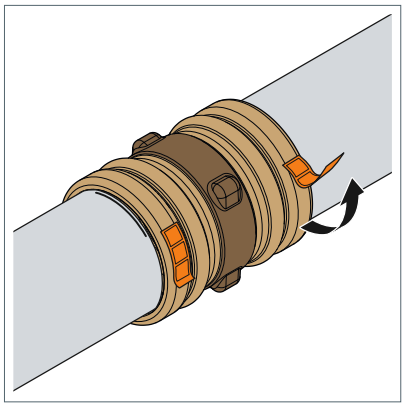
- Push the press connector up to the marked insertion depth on the pipe. Do not twist the press connector.
- Place the adapter jaw onto the press machine and push the retaining bolt in until it clicks into place.



- Position the press chain on the press connector. The press chain must be flush with the outside edge of the press connector.
- Open the adapter jaw.



- Push the adapter jaw into the seat of the press chain.
- Carry out pressing.
- Remove the adapter jaw and the press chain.

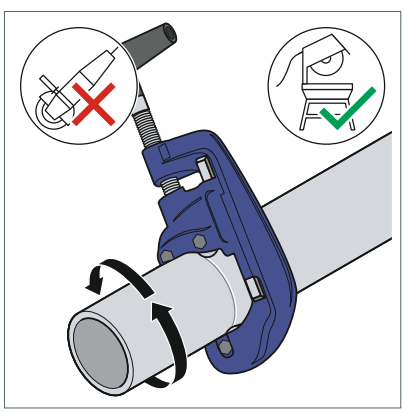


- Remove the checking strip.
  - The connection is marked as having been pressed.

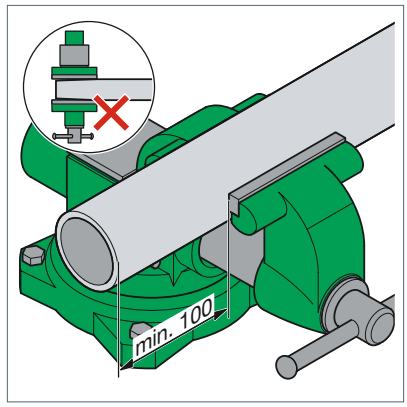
Sanpress Inox XL, Profipress XL, Prestabo XL 64 to 108 mm
Stainless steel, copper and steel pipes are connected simply and safely with Viega press connections.
Required tools:
- Pipe cutter or fine-toothed steel saw – the use of angle grinders is not permitted for stainless steel
- Deburrer and coloured pen for marking the insertion depth
- Suitable press machine
- Suitable sized press rings and hinged adapter jaw

Differences to using Sanpress XL press connectors:
- Different insertion depths
- Use of press rings instead of press chains
- Use of hinged adapter jaws instead of regular adapter jaw

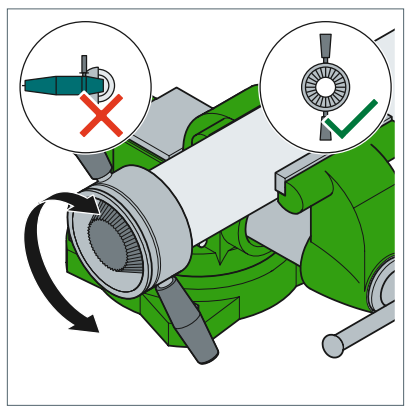
The figures below show the processing of a Sanpress Inox XL article as an example.



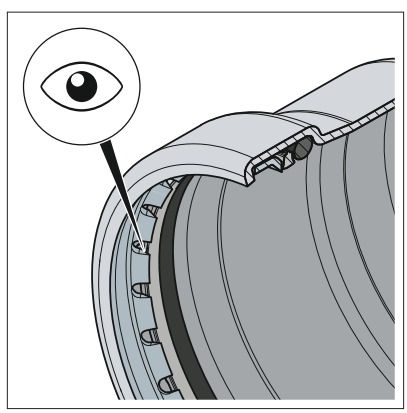
- Cut the pipe at a right angle as accurately as possible using a pipe cutter or a fine-toothed hacksaw to ensure correct and even pipe insertion depth. Avoid grooves on the pipe surface.



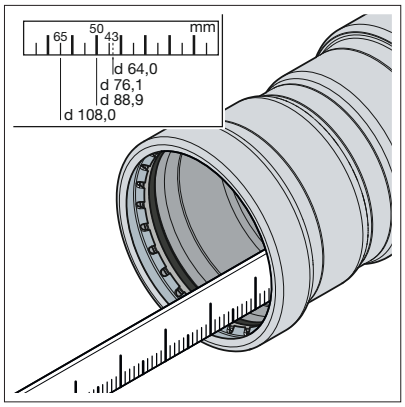
- Secure the pipe in the vice.
- When clamping, leave a distance of at least 100 mm to the pipe end.
  The pipe ends must not be bent or damaged.



- Deburr the inside and outside of the pipe.



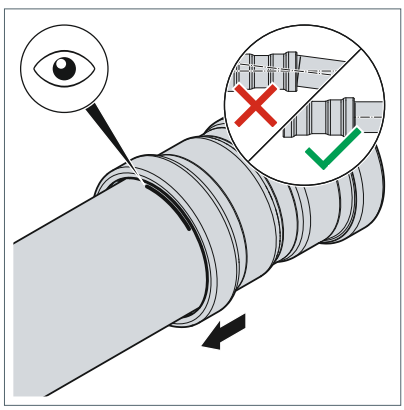
- Check for the following requirements:
- The pipe end is not bent or damaged.
- The pipe is deburred.
- The correct sealing element is in the press connector.
- Sealing element, separator ring and cutting ring are undamaged.
- The complete sealing element, separator ring and cutting ring are in the bead.



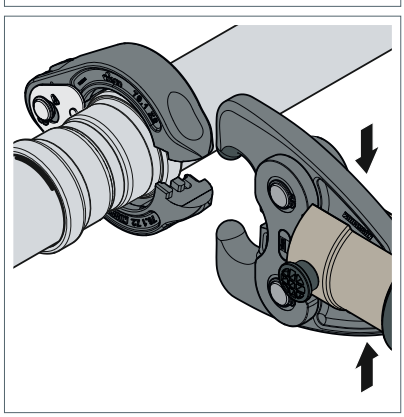
- Measure the insertion depth in the press connector.

ø	Insertion depth
64.0 mm	43 mm
76.1 mm	50 mm
88.9 mm	50 mm
108.0 mm	65 mm

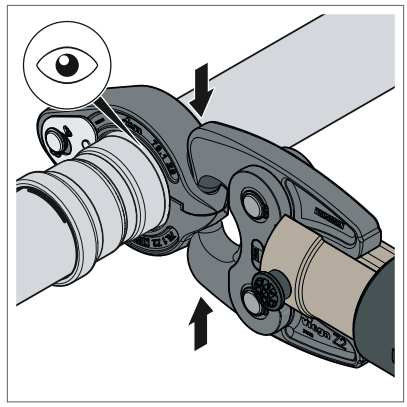
- Mark the insertion depth on the pipe.



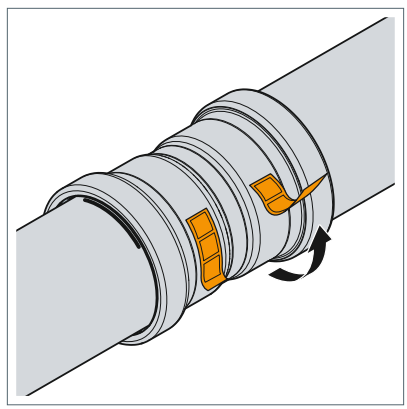
- Push the press connector up to the marked insertion depth on the pipe. Do not twist the press connector.
- Place the hinged adapter jaw onto the press machine and push the retaining bolt in until it clicks into place.



- Place the press ring onto the press connector. The press ring must completely cover the outside ring of the press connector.
- Open the hinged adapter jaw.



- Position the hinged adapter jaw into the seat of the press ring.
- Carry out pressing.
- Open the hinged adapter jaw and remove the press ring.

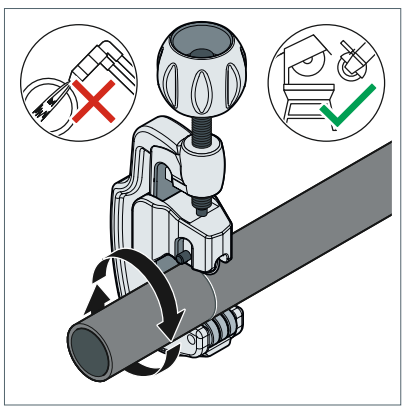


- Remove the checking strip.
  - The connection is marked as having been pressed.

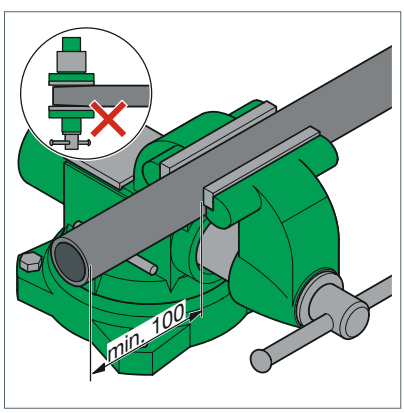
Megapress - Creation of the press connection up to 2 inches
Steel pipes are connected simply and safely using Viega press connections.
Required tools:

- Pipe cutter, angle grinder or fine-toothed steel saw
- Deburrer and coloured pen for marking the insertion depth
- Suitable press machine
- Suitable sized press jaws or suitable sized press rings with hinged adapter jaw

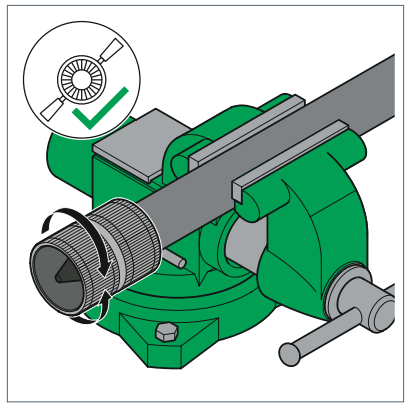
The figures below show the processing of a Megapress S article as an example.



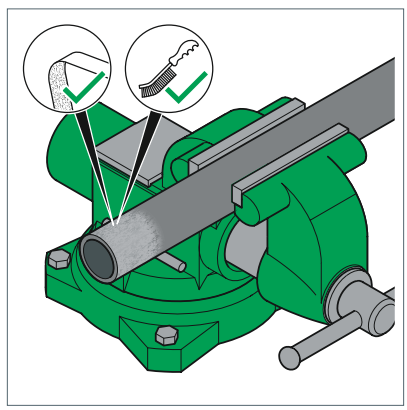
- Cut the pipe at a right angle as accurately as possible using a pipe cutter, an angle grinder or a fine-toothed hacksaw to ensure a complete and even pipe insertion depth. Do not use a flame cutter.
  Avoid grooves on the pipe surface.



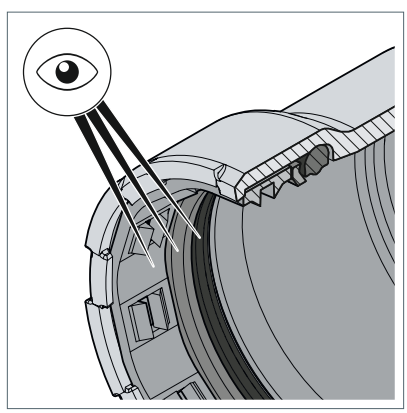
- Secure the pipe in the vice.
- When securing, leave a distance of at least 100 mm to the pipe end.
  The pipe ends must not be bent or damaged.



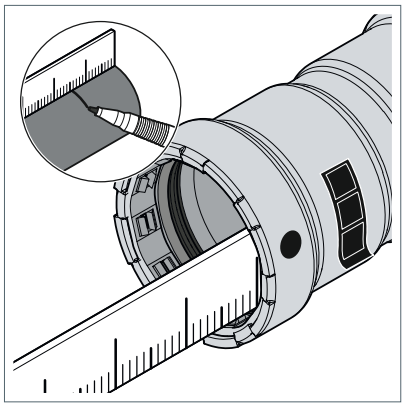
- Deburr the inside and outside of the pipe.



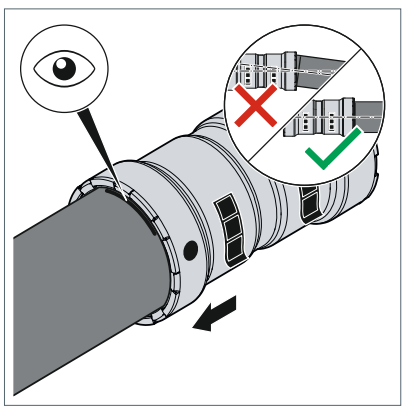
- With the help of a wire brush, cleaning fleece or sanding paper, remove loose dirt and rust particles from the pressing area.



- Check for the following requirements:
- The pipe end is not bent or damaged.
- The pipe is deburred.
- The correct sealing element is in the press connector.
  FKM = matt black
- Sealing element, separator ring and cutting ring are undamaged.
- The complete sealing element, separator ring and cutting ring are in the bead.

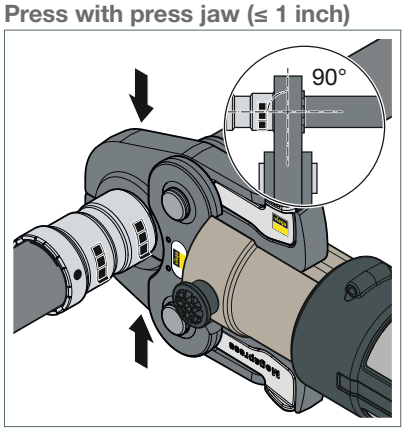


- Measure and mark the insertion depth.
  For values, see „Tab. 8: Minimum insertion depths for Megapress press connector“ on page 54.



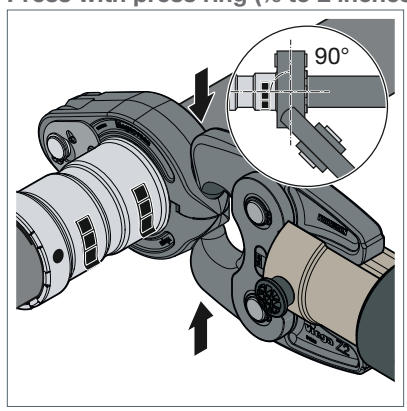
- Push the press connector up to the marked insertion depth on the pipe. Do not twist the press connector.

Press with press jaw (≤ 1 inch)

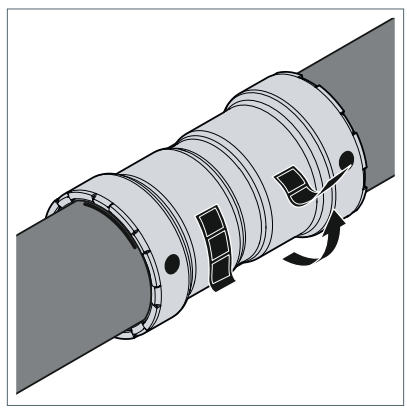


- Place the press jaw onto the press machine and push the retaining bolt in until it clicks into place.
- Open the press jaw and place it at a right-angle onto the press connector.
- Check the insertion depth using the marking.
- Ensure that the press jaw is placed centrally on the bead of the press connector.
- Carry out the pressing process.
- Open and remove the press jaw.

Press with press ring (⅜ to 2 inches)



- Place the hinged adapter jaw onto the press machine and push the retaining bolt in until it clicks into place.
- Place the press ring onto the press connector. The press ring must completely cover the outside ring of the press connector.
- Position the hinged adapter jaw into the seat of the press ring.
- Check the insertion depth using the marking.
- Ensure that the press ring is placed centrally on the bead of the press connector.
- Carry out the pressing process.
- Open the hinged adapter jaw and remove the press ring.

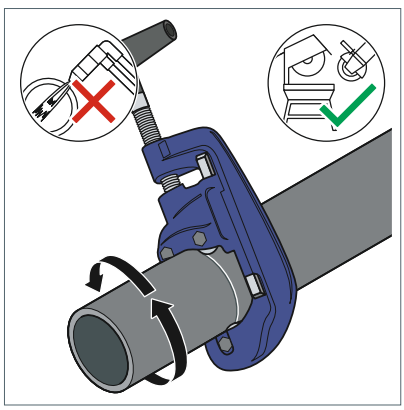


- Remove the check label.
  - The connection is marked as having been pressed.

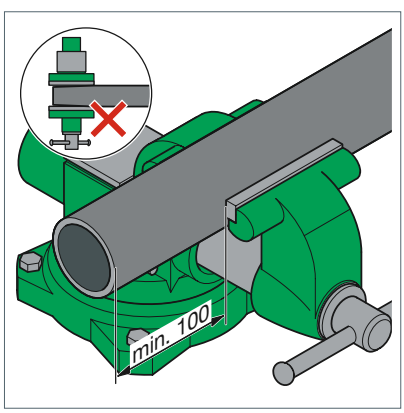
Megapress S XL – Creation of the press connection from 2½ to 4 inches
Steel pipes are connected simply and safely using Viega press connections.
Required tools:

- Pipe cutter, angle grinder or fine-toothed steel saw
- Deburrer and coloured pen for marking the insertion depth
- Suitable press machine
- Pressgun Press Booster
- Suitable sized press rings

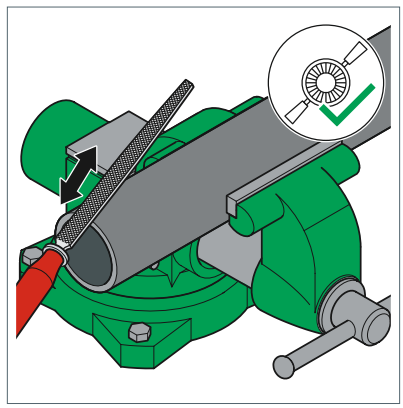
The figures below show the processing of a Megapress S XL article as an example.



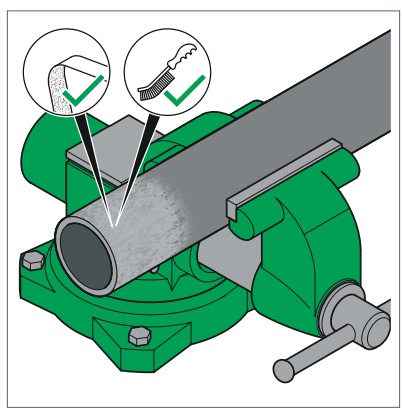
- Cut the pipe at a right angle as accurately as possible using a pipe cutter, an angle grinder or a fine-toothed hacksaw to ensure complete and even pipe insertion at the right depth. Do not use a flame cutter.
  Avoid grooves on the pipe surface.



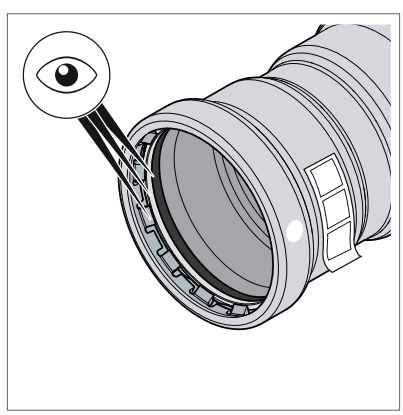
- Secure the pipe in the vice.
- When securing, leave a distance of at least 100 mm to the pipe end.
  The pipe ends must not be bent or damaged.



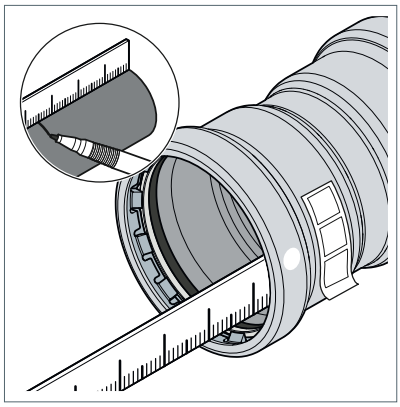
- Deburr the inside and outside of the pipe.



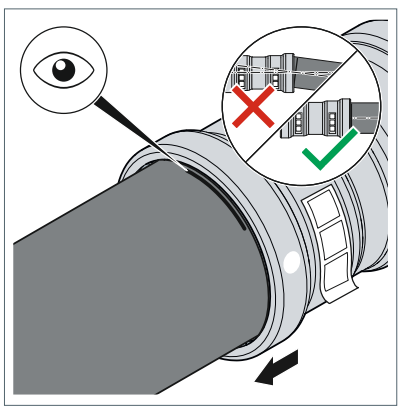
- With the help of a wire brush, cleaning fleece or sanding paper, remove loose dirt and rust particles from the pressing area.



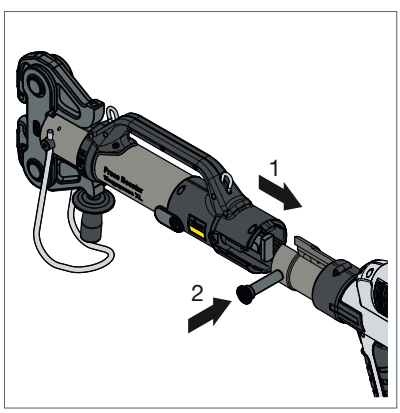
- Check for the following requirements:
- The pipe end is not bent or damaged.
- The pipe is deburred.
- The correct sealing element is in the press connector.
  FKM = matt black
- Sealing element, separator ring and cutting ring are undamaged.
- The complete sealing element, separator ring and cutting ring are in the bead.



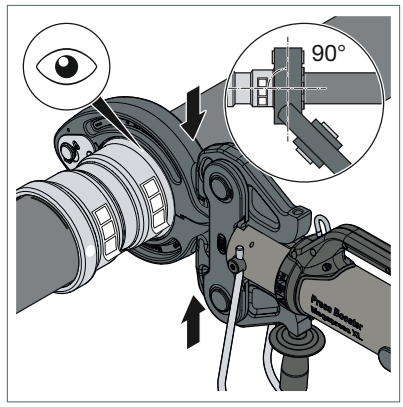
- Measure and mark the insertion depth.
  For values, see „Tab. 8: Minimum insertion depths for Megapress press connector“ on page 54.



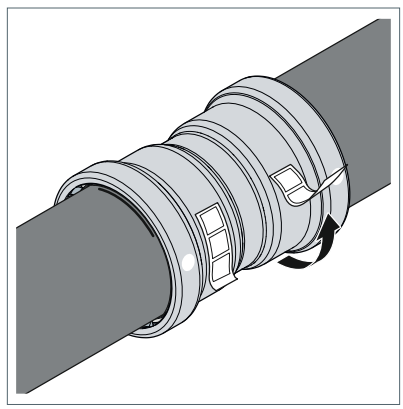
- Push the press connector up to the marked insertion depth on the pipe. Do not twist the press connector.



- Place the Pressgun Press Booster into the press machine, and push in the retaining pin until it clicks into place.



- Place the XL press ring on the press connector. Observe the proper fit of the press ring.
- Position the hinged adapter jaw of the Pressgun Press Booster on the recesses of the press ring.
- Carry out two pressings.
- If necessary, carry out a reset stroke.
- Open the hinged adapter jaw and remove the press ring.



- Remove the check label.
  - The connection is marked as having been pressed.

Observe the following insertion depths for the Megapress systems:

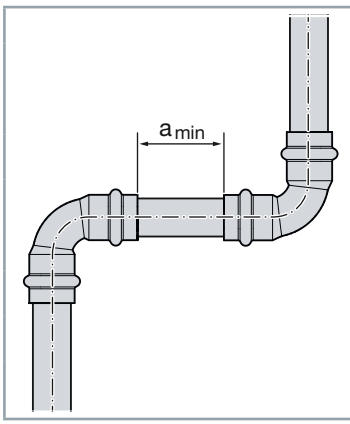
Dimension		Insertion depth
inch	[mm]	[mm]
⅜	17,2	24
½	21,3	27
¾	26,9	29
1	33,7	34
–	38,0	42
1¼	42,4	46
–	44,5	48
–	48,3	48
1½	57,0	48
2	60,3	50
2½	76,1	46
3	88,9	59
4	114,3	80

Tab. 8: Minimum insertion depths for Megapress press connector

Space requirement when pressing
For technically fault-free pressing, some space is required for placing the press machine. See the following tables for information on the minimum space required between the pressings.

Minimum distance between the pressings

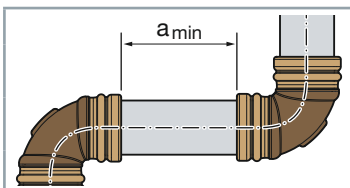
Pipe sizes 12 to 54 mm
For Sanpress, Sanpress Inox, Profipress and Prestabo



d [mm]	Minimum interval a [mm]
12	0
15	
18	
22	
28	
35	10
42	15
54	25

Tab. 9: Interval between the pressings

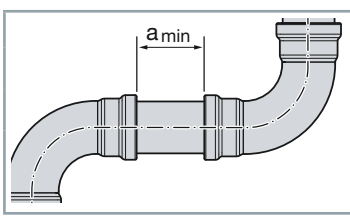
Pipe sizes 76.1 to 108.0 mm – with press chain
Exclusively for Sanpress XL



d [mm]	Minimum interval a [mm]
76,1	0
88,9	
108,0	

Tab. 10: Interval between the pressings

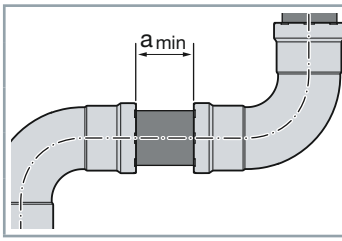
Pipe sizes 64.0 to 108.0 mm – with press ring
For Sanpress Inox XL, Profipress XL (64.0 mm) and Prestabo XL



d [mm]	Minimum interval a [mm]
64,0	0
67,1	
88,9	
108,0	

Tab. 11: Interval between the pressings

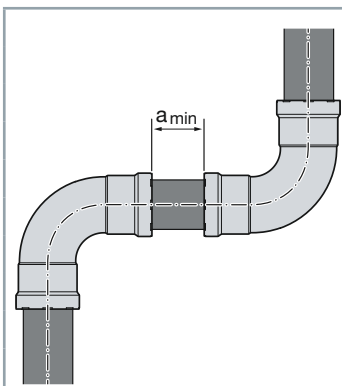
Megapress press jaws to DN25



d [inch]	Minimum interval a [mm]
⅜	5
½	
¾	
1	

Tab. 12: Minimum space required between the pressings – press jaws up to DN25

Megapress press rings DN 10 – DN100



d [inch]	Minimum interval a [mm]
⅜	15
½	
¾	
1	
1¼	
1½	
2	
2½	
3	
4	

Tab. 13: Minimum space required between the pressings – press rings DN10–DN100

Length expansion

Heat-induced linear expansion in installation systems causes severe stress in piping and device connections. Therefore, compensators (page 63) or expansion compensators must be installed in very long pipe sections. Expansion compensators are pipe routes with U- or Z-shaped expansion bends which, given their length and fixation type, are able to absorb movements.

Pipe material	Heat expansion coefficient [mm/m·K]	Length expansion at pipe length = 20 m and ΔT = 50 K [mm]
Stainless steel (1.4401)	0,0165	16,5
Stainless steel (1.4520)	0,0104	10,4
Stainless steel (1.4521)	0,0108	10,8
Steel (non-alloyed/galvanised)	0,0120	12,0
Copper	0,0166	16,6
Plastic	0.08–0.18	80.0–180.0

Tab. 14: Linear expansion of pipe materials

Expansion compensation

If the installation situation allows U-shaped and Z-shaped expansion compensators, their expansion bend lengths can be calculated as follows:

- Determine the largest possible temperature difference Δϑ.
- Determine the pipe length l_0.
- Use these values to calculate the total length by which the pipeline section is extended.
- Then read off the necessary pipe bend length L_{BZ} or L_{BU} for the respective pipe sizes using the diagrams on the following pages.

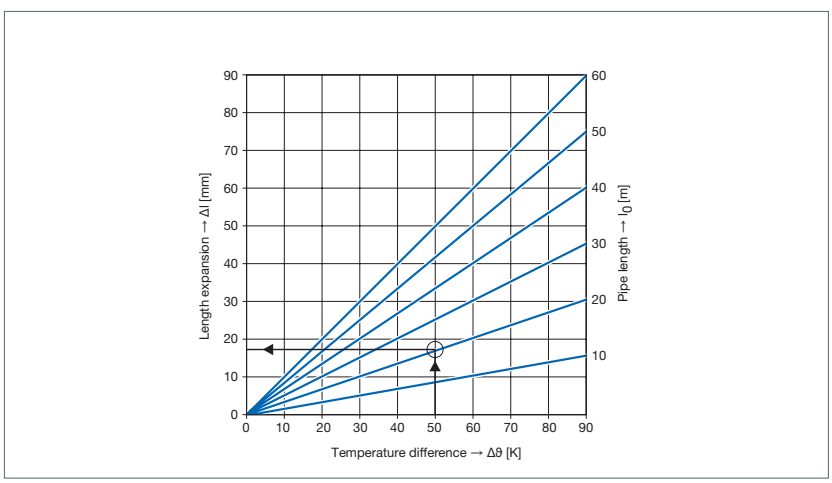


Fig. 27: Linear expansion of pipes made of copper and 1.4401 stainless steel

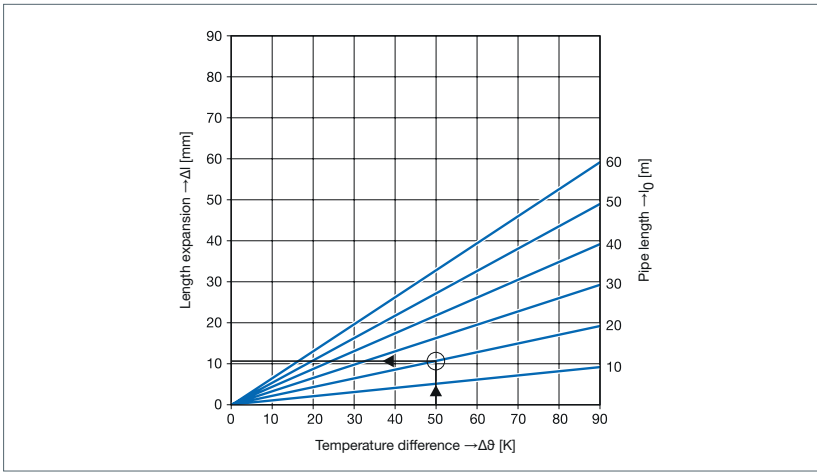


Fig. 28: Linear expansion of 1.4521/1.4520 stainless steel pipes

Example

- The operating temperature is between 10 and 60°C. Hence, Δϑ = 50 K.
- The pipeline section has a length of l_0 = 20 m.
- The coefficient of length expansion for copper pipe is α = 0.0165 [mm/m·K].
- Insert the values into the formula Δl = α[**mm/m·K**] · L[m] · Δϑ[K]. Hence, the length expansion Δl = 0.0165 [**mm/m·K**] · 20[m] · 50[K] = 16.5 mm
- Selection of the U or Z shape depending on the available space.
- Reading off of the necessary expansion bend length L_B from the U or Z diagram (page 59). In this example for a Z-shaped expansion bend: On the vertical axis at 16.5 mm, trace horizontally to the line of the pipe size used and read off the necessary expansion bend length below on the horizontal axis.

If a nominal pipe diameter of d = 28 mm is selected, the expansion bend length will be L_{BZ} = 1.3 m.

Determination of the expansion bend length for stainless steel and copper pipes with d ≤ 54 mm

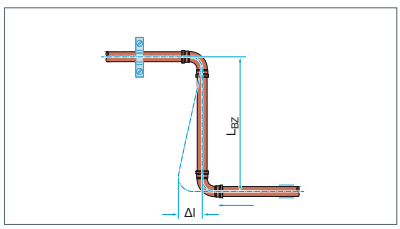


Fig. 29: For the Z shape with expansion bend L_{BZ}

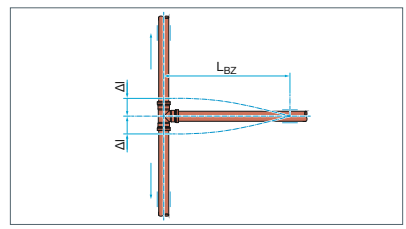


Fig. 30: For the T shape with expansion bend L_{BZ}

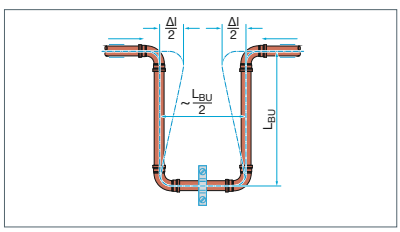


Fig. 31: For the U shape with expansion bend L_{BU}

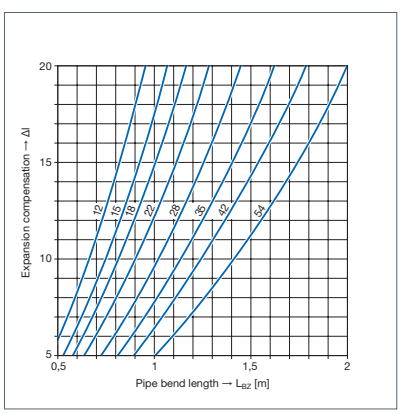


Fig. 32: Length determination for Z-shaped and T-shaped expansion bend

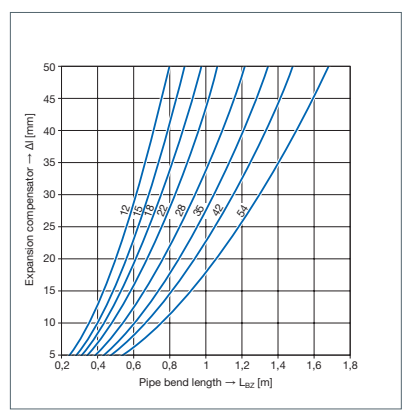


Fig. 33: Length determination for U-shaped expansion bend

Determination of the expansion bend length for stainless steel and copper pipes with d ≥ 64 mm

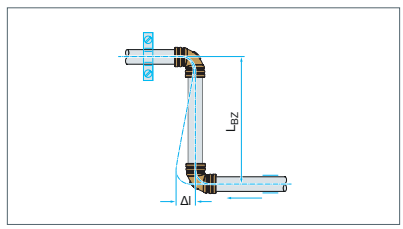


Fig. 34: For the Z shape with expansion bend L_{BZ}

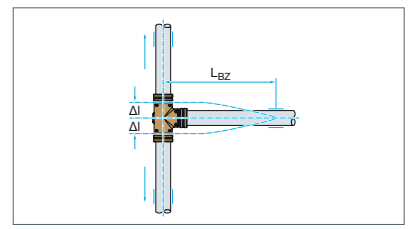


Fig. 35: For the T shape with expansion bend L_{BZ}

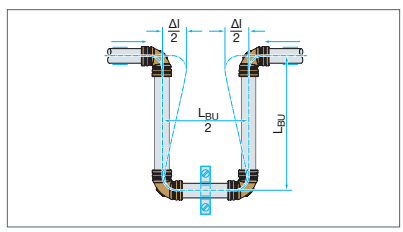


Fig. 36: U shape with expansion bend L_{BU}

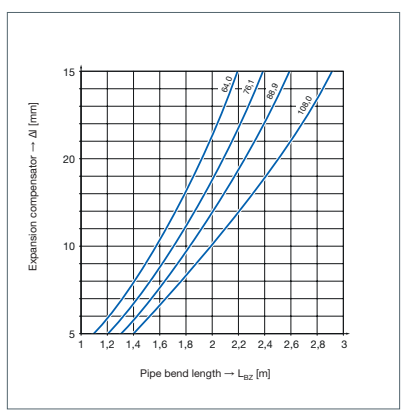


Fig. 37: Length determination for Z-shaped and T-shaped expansion bend

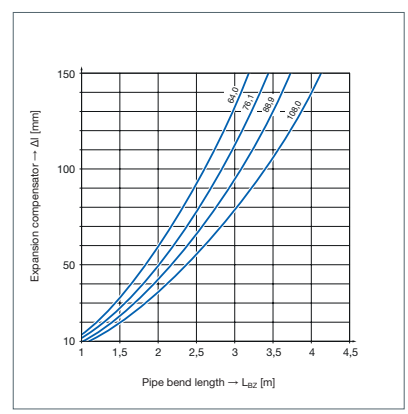


Fig. 38: Length determination for U-shaped expansion bend

Determination of the expansion bend length for steel piping from ⅜ to 4 inches

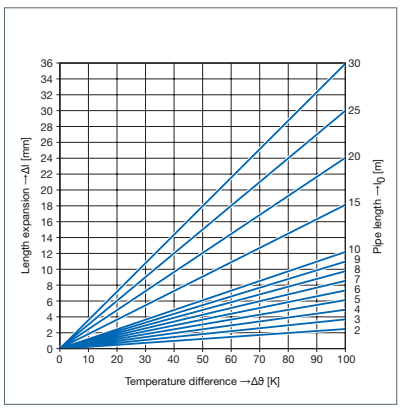


Fig. 39: Linear expansion steel pipes

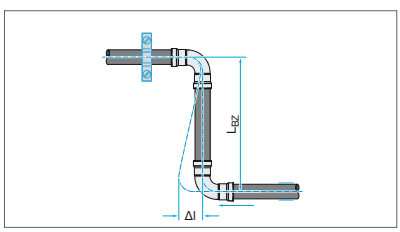


Fig. 40: For the Z shape with expansion bend L_{BZ}

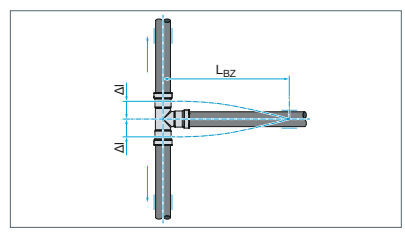


Fig. 41: For the T shape with expansion bend L_{BZ}

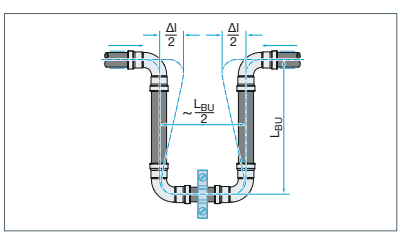


Fig. 42: U shape with expansion bend L_{BU}

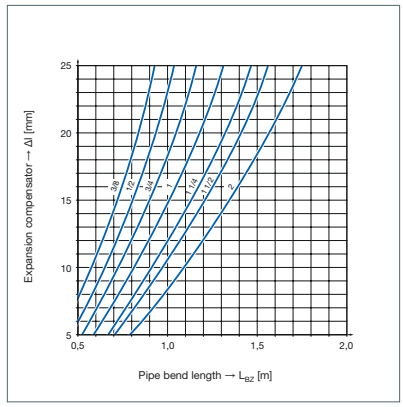


Fig. 43: Z-shaped and T-shaped expansion bends for Megapress/Megapress S ⅜–2 inches

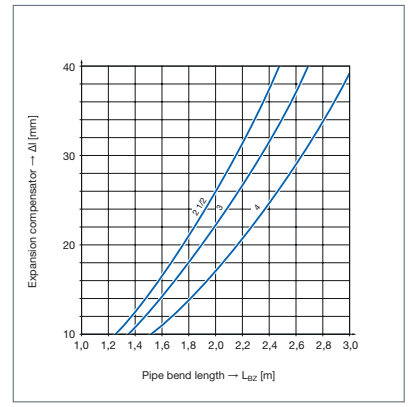


Fig. 44: Z-shaped and T-shaped expansion bends for Megapress S XL 2½–4 inches

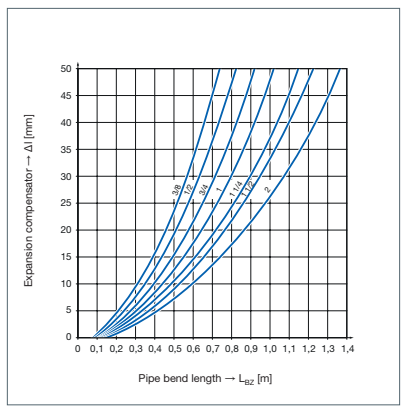


Fig. 45: U-shaped expansion bend for Megapress/Megapress S ⅜–2 inches

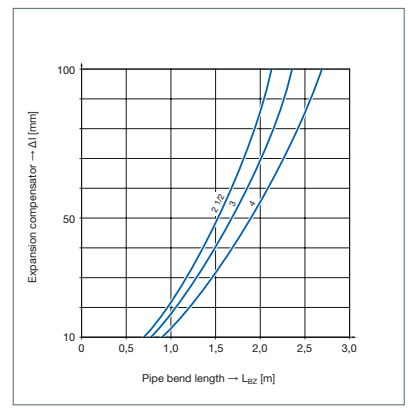


Fig. 46: U-shaped expansion bend for Megapress S XL 2½–4 inches

Compensators

The alternative to expansion compensators are compensators. They are ideal for absorbing axial movements in piping installations at operating temperatures between 20 and 110 °C.

Advantages

- Space-saving alternative to expansion compensators
- No preloading required
- Sound-absorbing
- Long-lasting and corrosion-resistant
- Suitable for mixed installations

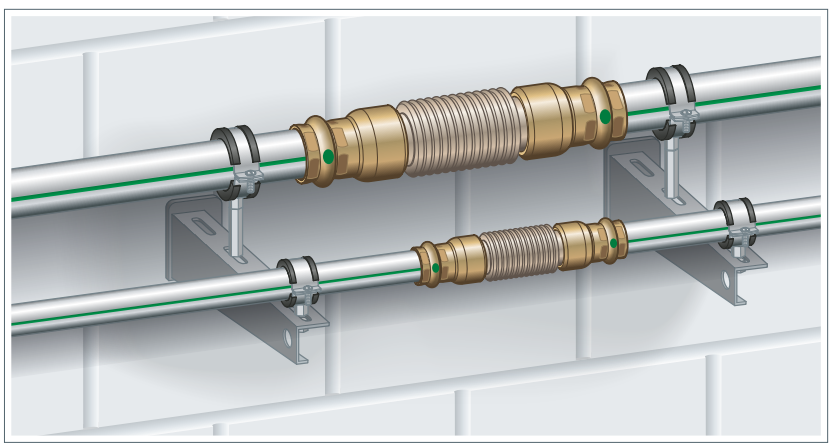


Fig. 47: Axial compensators

Mounting instructions

Piping is to be fixed in such a way that non-permitted radial and torsion loads are avoided. The fixing points must be dimensioned in such a way that they can absorb the considerable forces caused by temperature-related changes in length.

It is important that the fixing points and sliding pipe connections are arranged correctly.

- Always lay piping in a straight line.
- Prevent radial and torsion loads.
- Only one compensator may be placed between two fixed points.
- Do not use compensators to change direction.
- Protect the stainless steel bellows from mechanical damage.

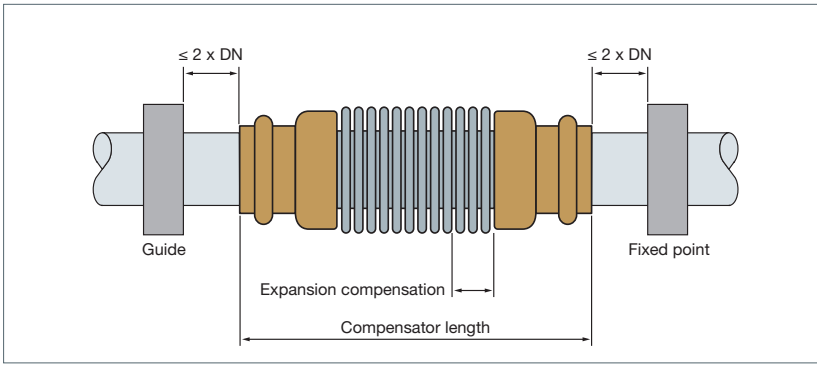


Fig. 48: Dimensions of axial compensators

Compensator	Pressure	More effective bellows cross section	Maximum fixed point load	Expansion compensator [1]
d_i/DN	[MPa]	A [cm²]	F_{max} [N]	[mm]
15/12	1.0	3.10	620	-7
18/15	1.0	3.97	794	-9
22/20	1.0	6.15	1230	-11.5
28/25	1.0	9.02	1814	-14
35/32	1.0	13.85	2770	-13
42/40	1.0	20.42	4048	-15.5
54/50	1.0	30.90	6180	-16

[1] Dimensioning: 10,000 full movement cycles at nominal pressure, design temperature 85 °C

Tab. 15: Characteristic properties of compensators

Function of fixed points and gliding points

Fixed points connect the pipeline firmly to the supporting installation body and direct the expansion movement in the desired direction. Piping that is not interrupted by a change in direction or which does not have an expansion compensator may have only one fixed point. With long sections of piping, it is advisable to have the fixed points in the middle of the section in order to allow linear expansion in both directions.

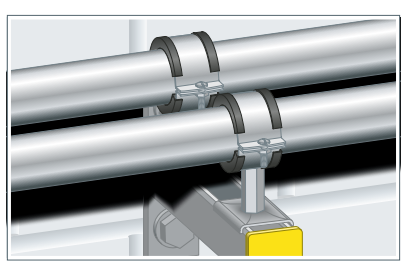


Fig. 49: Fixing as a fixed point

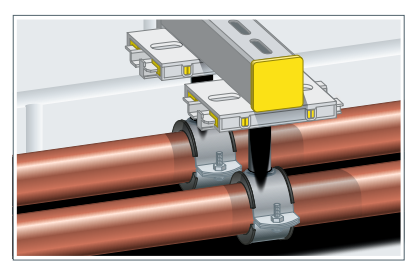


Fig. 50: Fixing as a gliding point

Pressure test

The pressure test is normally done with water or another approved testing medium at the test pressure specified for the respective application in the corresponding regulations. Directive 2014/68/EU (Pressure Equipment Directive) specifies that the hydrostatic test pressure for pressure vessels must not fall below the higher of the following two values:

- 1.25 times the value of the maximum load on the pressure equipment in operation, taking into account the maximum allowable pressure and temperature
- 1.43 times the value of the maximum allowable pressure

This requirement is also laid down in the AD 2000 data sheets HP 30 and HP 512 R and is also stated in DIN EN 13480-5. An exception is the test pressure for domestic potable-water installations, which is set at 1.1 times the maximum permissible operating pressure in accordance with DIN EN 806-4. This has also been incorporated into BTGA[1] Rule 5.001 and in BG RCI[2] data sheet T039.

Alternatively, in accordance with the Pressure Equipment Directive an inert gas – mostly air or nitrogen – at 1.1x the operating pressure can be used. Here too, a test pressure limited to a maximum of 0.3 MPa applies under the building services engineering rules based on DVGW-TRGI 2018.

Special precautions are prescribed for the use of liquid testing media at testing pressures above 10 MPa. Details on this and the procedure as a whole can be found in AD data sheet HP 30. With underground piping, the pressure test must be performed before closing the trench. If this is not possible, the pressure test can be performed using other suitable methods, e.g. VdTÜV data sheet MB ROHR 1051 “Wasserdruckprüfungen von erdverlegten Rohrleitungen nach den D-T-Messverfahren”.
In special cases, e.g. particular laying methods, the presence of components/fittings in the piping, the function of which would be impaired by the pressure test, the pressure test can be replaced by other suitable procedures, e.g. non-destructive testing in connection with leakage tests. These procedures must be agreed between the operator, expert and manufacturer. The test results must be documented in such a manner that they serve as a basis for recurrent tests.

[1] BTGA: Federal Industrial Association for Building Services Engineering
[2] BG RCI: Employer's Liability Insurance Association for Raw Materials and the Chemical Industry

Documentation – manufacturer certificate

With the manufacturer's certificate, the manufacturer confirms that the system complies with the applicable legal regulations. In particular the manufacturer confirms that all official requirements are satisfied and the work has been performed properly. Special importance is attached to:

- Manufacturer's qualifications
- Materials used
- Calculations for the design and dimensions
- Professional manufacturing and laying practices
- Components used
- Marking of the pipelines and components
- Insulation and corrosion protection

Furthermore, the manufacturer confirms that when subjected to the test pressure of the pressure test the pipeline was tight and there were no deformations of relevance to safety.
If alternative procedures are used instead of the pressure test, both these and the results must be documented.
The subcontracting of work to other manufacturers must be documented.
The proper production of the system is only fully confirmed once certifications stating that this work has been executed properly have been submitted. The documents required to identify/mark the piping must be included with the manufacturer certificate.
During the acceptance test, the expert must be provided with the documents that served as the basis for the manufacturer's certificate upon request. These documents must correspond to the actual state of the pipeline.
Any information from the manufacturer that has to be noted in the acceptance test or the recurring tests must be stated in the manufacturer certificate.

Marking of piping

Piping in buildings are mostly laid in bundles. The pipes which lay alongside each other must be marked according to the media they transport in order to rule out the risk of mix-ups and accidents when performing repairs. The size, appearance and spacing of the media markings and their arrangement on manifolds and outlets are regulated in DIN 2403.

Medium	Group	Colour	RAL
Water	1	Green	6023
Vapour	2	Red	3001
Compressed air	3	Grey	7004
Gas flammable	4	Yellow / red	1003/3001
Gas non-combustible	5	Yellow / black	1003/9004
Acid	6	Orange	2010
Lyes	7	Violet	4008
Oxygen	0	Blue	5005

Tab. 16: Marking of pipes according to DIN 2403 (excerpt)

Press tools

Intended use

Viega system press machines are used for pressing connections with the associated piping systems. In combination with Viega system press jaws, the press tool is suitable for use with all Viega sanitary and heating installation systems.
These system press tools have been developed and tailored specifically for use with Viega press connector systems. The functional safety of Viega press connector systems primarily depends on the faultless condition of the press tools used.
Viega does not verify if these system pressing jaws, chains and rings can be used for pressing systems from other manufacturers. In particular, no statement can be made in this case on whether it is possible to create permanently leak-proof connections. Detailed information about applications, restrictions and national standards and directives can be found in the product information, either printed or on the Viega website.

Fig. 51: Viega Pressgun 6 Plus and Pressgun Picco 6 Plus

Model overview

Safe, low-maintenance press tools are an important part of the Viega system. Below, you will find an overview of possible areas of application for the various system press machines in the Viega press connector system ecosystem:

Viega system press machine	Viega press connector systems		
	Metallic systems (excluding Megapress)	Megapress	Plastic piping systems
Pressgun 6 Plus	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm
Pressgun Picco 6 Plus	12–35 mm	D⅜–D¾	12–32 (40)[2)] mm
Pressgun 6	12–108 mm	D⅜–D2	12–63 mm
Pressgun Picco 6	12–35 mm	D⅜–D¾	12–32 (40)[2)] mm
Pressgun 5	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm
Pressgun Picco	12–35 mm	D⅜–D¾	12–32 (40)[2)] mm
Pressgun 4 E	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm
Pressgun 4 B	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm
PT3-H/EH	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm
PT3-AH	12–108 mm	D⅜–D2	12–63 mm
PT2	12–108 mm	D⅜–D2 D2½–D4[1)]	12–63 mm

[1)] for Megapress XL dimensions (D2½–D4/DN 65–DN100), use of the Pressgun Press Booster is required in addition

[2)] Only with Raxofix

Tab. 17: Overview of the area of application for Viega system press machines

Compatibility

Picco (24 kN)	Press jaws and rings compatible with Picco and Pressgun Picco, Picco 6 and Picco 6 Plus press machines
PT2 (32 kN)	Press jaws, rings and chains compatible with type-2 press machines (PT2), PT3-H, PT3-AH, PT3-EH and Pressgun 4E, 4B and 5, 6B, 6 and 6 Plus
Hinged adapter jaw P1 (article 622 657) for Picco	Up to and including d32 or d35 and D¾
Hinged adapter jaw Z1 (article 472 733) for PT2	Up to and including d32 or d35 and D¾
Hinged adapter jaw Z2 (article 472 740) for PT2	All pipe dimensions above this up to and including d108.0 or D2
Press Booster Z3 (article 753 924) for PT2	Megapress XL press rings D2½, D3 and D4

System overview of metal press connector systems (PMP) with mutually compatible press contours:

- Profipress
- Profipress G
- Profipress S
- Sanpress
- Sanpress Inox
- Sanpress Inox G
- Prestabo
- Temponox
- Easytop
- Gas Fittings

Compatibility with third-party products
One of the prerequisites for certification of Viega piping systems is successful testing of the connection technology according to DVGW Worksheet W 534 by an approved testing institute. To this end, the press connections are only produced using Viega press machines and Viega press jaws, chains and rings. If the specialist tradesman uses press tools from other manufacturers, in the interests of protecting against liability claims it is recommended to get proof of suitability from the other manufacturers of press tools (press jaws, rings and chains).
An overview of the pressing machines recommended by Viega, including third-party products, is also published in the product catalogue and in the download area on the Viega website *viega.de* as a compatibility list.

System press jaws, chains and rings

Press jaws for press machines of the Picco series for
- Metal press connector systems 12–35 mm
- Press connector system Megapress D⅜–D¾
- Plastic piping system Raxofix 16–40 mm
- Plastic piping system Sanfix 16–32 mm
- Plastic piping system Fonterra 12–17 mm
- Smartloop 12 mm

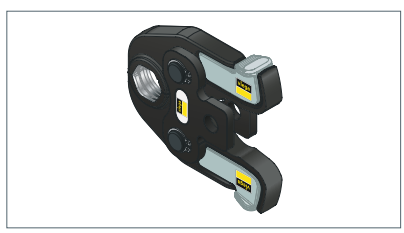


Fig. 52: Picco press jaws for all metal press connector systems

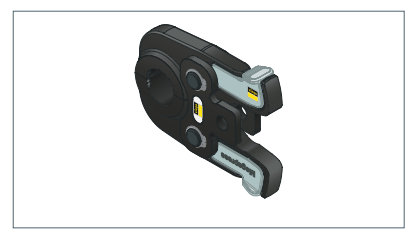


Fig. 53: Picco press jaw for Megapress

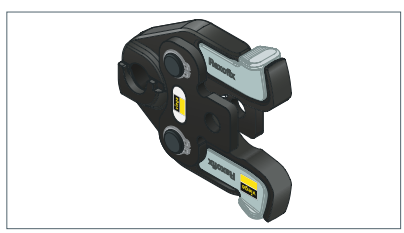


Fig. 54: Picco press jaws for Raxofix

Press jaws for all other press machines with a PT2 interface for

- Metal press connector systems 12–54 mm
- Press connector system Megapress D⅜–D1
- Plastic piping system Raxofix 10–63 mm

Fig. 55: Press jaws for metal press connector systems

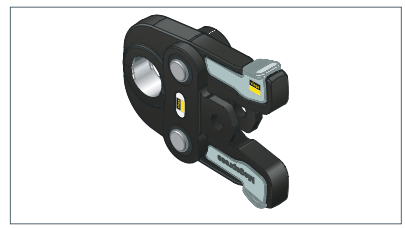


Fig. 56: Press jaws for Megapress

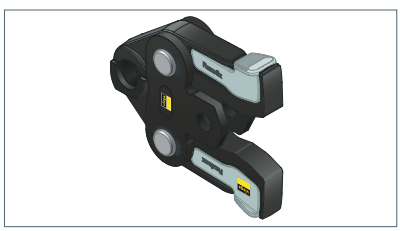


Fig. 57: Press jaws for Raxofix

Press rings and hinged adapter jaws

Thanks to an infinitely variable pivoting feature, Viega press rings and hinged adapter jaws can be used for pressing in the most challenging of spatial conditions, e.g. in installation shafts and pre-wall installations. They are compatible with all Viega press machines.

Press rings and hinged adapter jaws are available for the following nominal widths:

- Metal press connector systems 12–108 mm (excluding Sanpress XL – see press chain with adapter jaw)
- Press connector system Megapress D½–D2 (see Pressgun Press Booster for Megapress XL dimensions D2½–D4)
- Plastic piping system Raxofix 16–63 mm
- Plastic piping system Geopress K 25–63 mm

Fig. 58: Press rings and adapter jaws for metal press connector systems

Fig. 59: Press ring and hinged adapter jaw for Megapress ≤ D2

Fig. 60: Press ring for Raxofix

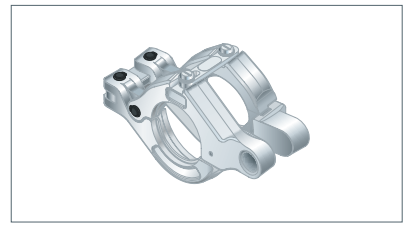


Fig. 61: Press ring for Geopress K

Press chain with hinged adapter jaw

The combination of press chain and adapter jaw is exclusively for use for Sanpress XL connectors made of gunmetal / silicon bronze. Press chains are available for nominal widths 76.1 to 108.0 mm.

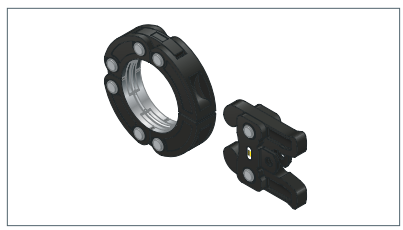


Fig. 62: Press chain / adapter jaw for Sanpress XL press connectors

Pressgun Press Booster for Megapress XL dimensions D2½–D4

- Innovative force amplifier with integrated hinged adapter jaw for Megapress XL dimensions of 2½, 3 and 4 inches.
- Optimally dimensioned pressing force for maximum safety.
- Pressing of Megapress XL press connectors in less than 16 seconds.
- A weight of just 9 kg and a handy carrying strap ensure ideal ergonomics and simple handling.
- Can be used for all Viega press machines from type 2 to Pressgun 5 and Pressgun 6 Plus (not compatible with Picco types, PT3-AH and Pressgun 6).
- The specific ball heads of the hinged adapter jaw prevent confusion with other Viega press rings.
- Long service intervals.

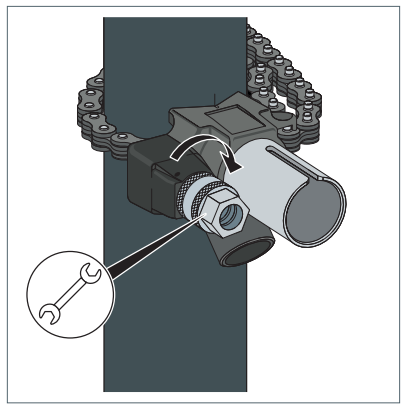
Fig. 63: Pressgun Press Booster with press ring for Megapress XL dimensions

Megapress/Megapress S press-in branch connectors

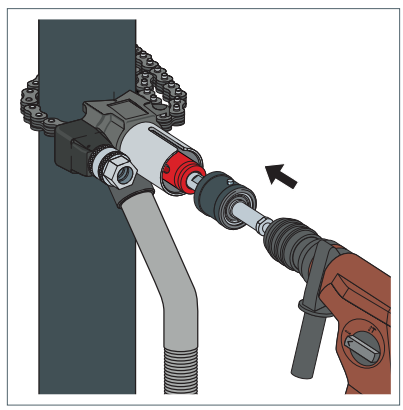
The Megapress press-in branch connectors (available with EPDM or FKM sealing elements) can be used to make connections retrospectively in existing steel pipe installations (1½, 2, 2½, 3, 4, 5 and 6 inches).
The corresponding tool set is used to drill a hole in the steel piping (not pressurised), and the Megapress press-in branch connector is then pressed in. This makes it possible for example to mount a thermometer quickly and without labour-intensive preparations to an existing steel pipe installation. The system is then ready for use immediately afterwards.

Assembly steps

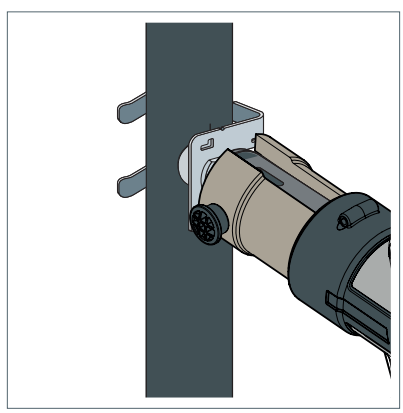
Making a threaded connection in just four steps:



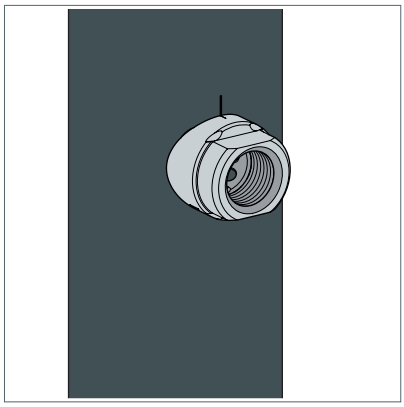
- Fasten the special drilling device for guiding the drilling shaft to the steel pipe (1½-6 inches) using a ring or fork spanner.



- The hole is drilled by means of a commercially available drilling machine. The steel chips can be extracted by means of the vacuum cleaner nozzle. Afterwards, remove the drilling device again.



- Press the press-in branch connector to the steel pipe by means of the press machine and the positioning aid.



- This is a fast and clean way of making the connection with the pipeline.
- The Rp ¾ press-in branch connector can be used for thermometers, temperature sensors, pressure gauges, drains or pipe connections, for example.

Maintenance and service

Maintenance instructions

System press tools

Functional safety and permanent leak tightness of the Viega press connector systems primarily depends on the functional and operational safety of the Viega system press tools – i.e. on Viega press machine plus suitable Viega press jaw, ring, chain and (hinged) adapter jaw.
Viega strongly recommends having press jaws, rings, chains and (hinged) adapter jaws checked during press machine maintenance.
This may involve replacing wearing parts, reworking press contours and checking the press jaws, press rings, chains and (hinged) adapter jaws.
Please exercise due diligence and follow these maintenance instructions!
The general principle of "safety through maintenance" applies!

System press machines

Viega system press machines generate a specified pressure for the pressing process. To guarantee the required level of operational safety, a leakproof hydraulic system is required. However, natural wear and tear on such heavily used components is unavoidable. To ensure the continuous operational safety and reliability of the system press machines, they must be maintained regularly by authorised service partners.
Relevant addresses can be found in the instructions for use, the care instructions for Viega system press tools or on the Viega website.
Usually, tools are sent for maintenance to the authorised service partners specified by Viega or maintained during service partner calls at specialist wholesalers' locations.

Store the press machine in a dry and clean place. Clean the press tools with a cloth after each use. If necessary, oil moving parts such as bolts and press rolls. Regularly polish and oil the contours of the press jaws, rings, chains and inserts with fine steel wool or a cleaning fleece. For more information, see also the *care* instructions *for Viega system press tools*.

Type	Maintenance intervals
Pressgun 6 Plus	After 40,000 pressings, service information is shown as a LED display. Safety shutdown will take place after a further 2,000 pressings. Maintenance after 4 years at the latest.
Pressgun Picco 6 Plus	
Pressgun 6	After 30,000 presses, service information is shown as a LED display. Safety shutdown will take place after a further 2,000 pressings. Maintenance after 4 years at the latest.
Pressgun Picco 6	
Pressgun 5	After 40,000 pressings, service information is shown as a LED display. Safety shutdown will take place after a further 2000 pressings. Maintenance after 4 years at the latest.
Pressgun Picco	After 30,000 presses, service information is shown as a LED display. Safety shutdown will take place after a further 2,000 pressings. Maintenance after 4 years at the latest.
Pressgun 4E	
Pressgun 4B	
Type PT3-H/EH	After 20,000 presses, service information is shown as a LED display. Safety shutdown will take place after a further 2,000 pressings. Maintenance after 4 years at the latest.
Type PT3-AH	
Picco	
Type 2	Every 2 years
model 2478	At least once a year
Model 2475	After 20,000 presses, an LED display is shown. Maintenance after 4 years at the latest.

Tab. 18: Viega press machines – maintenance intervals

Fig. 64: Maintenance label

Viega highly recommends that the system press jaws, press chains and press rings are also inspected while the system press machines are undergoing maintenance. Moving parts are cleaned and lubricated, press contours are reworked, and the press jaws, chains and rings are checked for damage and dimensional accuracy.
Since 2012, Viega press jaws, chains and rings have been provided with maintenance stickers, which show the next recommended inspection date.

Fig. 65: QR code sticker

Since 2023, a QR code for maintenance instructions has been present on the maintenance sticker and the date has been omitted.

Planning information for selected media

Potable water

Water is the basis of life. Streams, rivers, lakes and seas are habitats for a great variety of plants and animals, and they are important components of a natural balance. Groundwater provides us with potable water and living space at the same time. Clean potable water is one of our basic human needs, and we use it for our food, daily hygiene and leisure activities. For Germany, potable-water quality and its monitoring is regulated by the Potable-Water Ordinance (TrinkwV)[1]. According to it, the consumption or use of potable water must not be a danger to human health through pathogens or chemical substances. The hazards presented by potable-water installations range from unsuitable materials and substances to high stagnation times and unfavourable temperature ranges, which can lead to microbial contamination. As a result of increasing comfort requirements associated with hot-water applications and due to energy-saving efforts, legionella in particular can cause considerable problems in potable-water installations in buildings.

During the Capnetz Study in 2008, scientists found that, in Germany, 15 000 to 30 000 clinical cases per year are caused by legionella. The mortality rate was estimated to be between 1 500 and 2 000.[2] However, it is not possible to determine with absolute certainty how many of these cases are caused by infection from contaminated potable-water installations. In an initial status analysis in 2015, which was commissioned by the Working Group for Potable-Water Analysis of the German Association of Gas and Water Companies (figawa), over one million data sets from samples from all building types, provided by five German potable-water monitoring service providers, were analysed by the Institute for Hygiene and Public Health (IHPH) at the University of Bonn. The investigation revealed that, during the period under review from 2012 to 2015, legionella was found in approximately one in three buildings in at least one instance. An overrun of the technical intervention value was detected in around one in six buildings.[3] Another status analysis based on better data quality, which the IHPH presented in 2018, revealed as similar picture. In addition to hot potable water, cold potable water is also a risk factor because the critical value of 20°C is exceeded more and more often. German public-health authorities' evaluation of 30 000 water samples taken from 2003 to 2009 in 4 400 public buildings showed, among other things, that the technical intervention value for legionella of 100 colony-forming units (CFU) per 100 ml was exceeded in about 13 % of the samples.

[1] Potable-Water Ordinance (TrinkwV), 24.06.2023.

[2] Robert Koch-Institut, "Legionellose RKI-Ratgeber für Ärzte".

[3] S. Völker, S. Luther, T. Kistemann, Bundesweite Statusanalyse. Vorkommen von Legionellen in Trinkwasser-Installationen, IKZ Fachplaner 10/2015, p. 14–19.

Hygiene

Hygiene encompasses all efforts and measures to prevent indirect and direct impairments of the individual users' health. The aim is to maintain adequate potable-water quality in the potable-water installation. Impairments may be caused not only by microbiological, chemical or physical-chemical changes to the potable water in potable-water installations but also develop over time due to changes in operating conditions.[1] Initially, the local water supplier is responsible for proper potable-water quality all the way to the service connection. Within the potable-water installation itself, its operator is responsible. The operator must ensure that potable water is drawn off regularly in accordance with the AVBWasserV. To ensure that the regularly tapped water quantity is sufficient to guarantee the complete water exchange in the installation, the expert planner and/or the installer has to meet the necessary preconditions. They use certified components and systems to ensure that the nominal pipe diameters are dimensioned according to requirements and that the piping is routed in a hygiene-conscious manner – including draw-off points where usage interruptions are to be expected (e.g. garden hose taps).

Generally recognised rules of engineering

The responsibility for compliance with the quality requirements for potable water in domestic installations lies with the owner and operator. They must ensure adequate potable-water quality.[2],[3]
The hygienically safe operation of the potable-water installation plays a crucial role. In order to achieve this goal at all, operators are advised to at least use the generally recognised rules of engineering () as a guiding principle. Since May 2012, the European series of standards DIN EN 806-1 to 5 with the national supplementary standards of DIN 1988, which are currently still being revised, have been applicable.

[1] VDI 6023 Blatt 1, Hygiene in Trinkwasser-Installationen – Anforderungen an Planung, Ausführung, Betrieb und Instandhaltung, Beuth, Berlin, 09/2023.
[2] Potable-Water Ordinance (PWO), 24 June 2023.
[3] Ordinance on the general conditions for water supply (AVBWasserV), 11 December, 2014.

European basic standards	National collateral standards	Additional directives and rules
DIN EN 1717 “Schutz des Trinkwassers vor Verunreinigungen ...”	DIN 1988-100 “Schutz des Trinkwassers, Erhaltung der Trinkwassergüte”	UBA recommendations BTGA rules DVGW Worksheets VGI Directives
EN 806 Part 1 "General"	–	
EN 806 Part 2 "Design"	DIN 1988-200 "Installation Type A, planning, components, devices, materials"	
EN 806 Part 3 "Pipe sizing, simplified method"	DIN 1988-300 "Pipe sizing"	
EN 806 Part 4 "Installation"	–	
EN 806 Part 5 "Operation and maintenance"	–	
	DIN 1988-500 "Pressure boosting stations with RPM-regulated pumps	
	DIN 1988-600 “Trinkwasser-Installation in Verbindung mit Löschwasser- und Brandschutzanlagen”	

Tab. 19: Standards and regulations

This means that users, for planning and installation purposes, should take into account the requirements of DIN EN 806-2, DIN 1988-200, DIN EN 806-3, DIN 1988-300, DIN EN 806-4 and, additionally, the directives and worksheets of the VDI, DVGW and ZVSHK. For this reason, professional associations and organisations, e.g. the ZVSHK, have developed commentaries to facilitate an understanding of the correlation between the European and national standards.

An appealing design of bathrooms and eat-in kitchens is essential for feeling right at home, but clean potable water is the basis for meal preparation and cleaning. It contributes to quality of life and serves to protect health. To achieve this, compliance with the generally recognised rules of engineering for planning, construction, commissioning and operation as intended, including regular maintenance, is indispensable.

Test parameters in the potable-water installation

Microbiological parameters

Regulators reacted to the dangers posed by contaminated potable water by implementing an amendment to the Potable-Water Ordinance, defining various thresholds for microbiological parameters (see Tab. 21 on page 83) as well as a technical intervention value for legionella, see Tab. 20 on page 81. The technical intervention value is 100 “colony-forming units” in 100 ml of water (100 CFU / 100 ml).[1] With the new Potable-Water Ordinance, the UBA has issued a new recommendation for systemic testing for legionella. According to the new recommendation, a laboratory may only declare a batch valid if at least three legionella colonies have been identified. In future, therefore, only results from 300 CFU / 100 ml will be evaluated. The technical intervention value is an empirically derived value that will not be reached or exceeded if the generally recognised rules of engineering and the necessary care are observed by the operator of a potable-water installation.[2] According to a recommendation by the German Environmental Agency of 2005, a target value for legionella contamination of high-risk areas of 0 CFU / 100 ml applies to hospitals as well as other medical and care facilities. The hazard value is defined as ≥ 1 CFU / 100 ml.[3]

If the technical intervention value is reached, avoidable circumstances are said to occur that may raise concerns over a health hazard or in fact cause a health hazard. The technical intervention value is determined by means of a laboratory analysis of water samples taken.

Microbiological parameters	Technical intervention value
Legionella	100 CFU / 100 ml

Tab. 20: Technical intervention value for legionella[4]

To define the expression 'concerns over a health hazard', the regulatory authority used an auxiliary quantity described as a technical intervention value. The technical intervention value is defined in Annex 3, Part II of the Potable-Water Ordinance as 100 CFU / 100 ml (legionella spec. / potable water). Annex 3, Part II of the Potable-Water Ordinance is entitled “Special

[1] Potable-Water Ordinance (PWO), 24 June 2023.

[2] Recommendation of the Federal Environmental Agency (UBA), Systemische Untersuchungen von Trinkwasserinstallationen auf Legionellen nach Trinkwasserverordnung - Probenahme, Untersuchungsgang und Angabe des Ergebnisses, 9 December 2022.

[3] Recommendation of the Federal Environmental Agency (UBA), Periodische Untersuchung auf Legionellen in zentralen Erwärmungsanlagen der Hausinstallation nach § 3 Nr.2 Buchstabe c TrinkwV 2001, aus denen Wasser für die Öffentlichkeit bereitgestellt wird, Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 7 (2006), pp. 697–700.

[4] Potable-Water Ordinance (PWO), 24 June 2023.

indicator parameter for potable-water installations". In accordance with the Potable-Water Ordinance, legionella are generally only an indicator parameter for failure to implement the technical procedures required to achieve the protection objective stated under § 37 of the Infection Protection Act.

Specifically, § 5, section 1, and § 13, section 1, of the Potable-Water Ordinance require at least compliance with the generally recognised rules of engineering for water treatment and water distribution. If the generally recognised rules of engineering are adhered to in the planning, construction and operation of building waterworks (potable-water installations), then it can be expected that the limit values and requirements for parameters of the Drinking-Water Ordinance, which may deteriorate within the potable-water installation, will also be adhered to.[1]

Despite precautions taken by regulators, the technical intervention value for Legionella spec. of the Potable-Water Ordinance continues to be reached according to routine tests in accordance with §§ 31 and 42 or people fall ill due to the use of potable water from potable-water installations.
Legionella is used as an auxiliary quantity in the Potable-Water Ordinance and is named as a pathogen in § 7 of the Infection Protection Act. This means that legionella are not only considered a technical auxiliary quantity but also a pathogen. Consequently, a relationship of circular reference exists between the technical auxiliary quantity and the pathogen. If technical deficiencies occur, the presence of pathogens must be suspected.

If pathogens are identified, a technical deficiency must be assumed.

If legionella is considered in its function as a technical auxiliary quantity, then technical measures must be taken by the operator in accordance with obligations to act under § 51 TrinkwV to protect the users of the potable-water installation and to remedy technically avoidable inadequacies.

However, if legionella are considered to act as pathogens transmitted by water in accordance with § 7 of the Infection Protection Act, the state of medical and epidemiological science and technology for protecting users of potable-water installations ought to be applied according to § 1, section 2, of the Infection Protection Act.[1]
However, since the majority of users are not necessarily aware of the state of medical and epidemiological science, the regulatory authority has decided to use the generally recognised rules of engineering – a lower protection level, but recognised in practical applications – in § 51 of the Potable-Water Ordinance, considering how frequent potable water is contaminated with legionella.[2]

[1] Act on the Prevention and Control of Infectious Diseases in Humans (Infection Protection Act – IfSG), 07/2000.

[2] Potable-Water Ordinance (PWO), 24 June 2023.

In summary, it can therefore be said that the detection of legionella makes technical measures necessary in order to restore the drinking water installation to a state in which at least the generally recognised rules of technology are complied with.

The obligation to notify if the technical action value for legionella is exceeded can be found in Section 53 of the Drinking Water Ordinance. The procedure is based on the existing obligation to notify under the Infection Protection Act. According to this, laboratories have an obligation to report the reaching or exceeding of the technical intervention value for legionella directly to the health authority responsible for the location of the water supply system. Until 2018, it was not the laboratory but the operator who had to report evidence of pathogens in potable water to the health autority. This was changed by modification of the regulations. To allow countermeasures to be taken immediately once a case of legionella has been established, the examination bodies will notify the health authority responsible of the critical legionella concentration in the potable water. This is intended to eliminate health risks to consumers in case an operator fails to meet their obligation to notify.[2]

Besides the subject of legionella, which are examined with respect to any technical measures that might be required, the Potable-Water Ordinance provides for further microbiological parameters in Annexes 1 and 3. These relate to microorganisms that allow conclusions to be drawn about the quality of the circulated potable water.

Microbiological parameters	Limit value
Colony count at 22 !C and 36 °C	without abnormal variance
Enterococci	0/100 ml
Escherichia coli	0/100 ml
Coliform bacteria	0/100 ml

Tab. 21: Limit values for microbiological parameters

The Potable-Water Ordinance does not specify a limit value for Pseudomonas aeruginosa. Nonetheless, this parameter must be observed, especially in buildings with increased hygienic requirements. For example, the parameter must not be detectable in 100 ml in buildings with medical facilities.[1]
Scientific findings have indicated the possibility that, in stressful situations (e.g. plant disinfection, thermal treatment), bacteria will survive the process in the VBNC state (viable but not culturable). [2][3] This also applies to facultative pathogens such as pseudomonads and legionella. This may make it difficult to assess the effectiveness of measures. After the restoration of environmental conditions which are favourable to them, the bacteria can return to the reproductive state, causing renewed contamination in the system. Sustainable refurbishment work always aims to keep the living conditions for microorganisms (temperature range, nutrients, residence times) in the potable-water installation as unfavourable as possible. This can be achieved if the potable-water installation is planned, built and operated in accordance with the generally recognised rules of engineering.[4]

[1] Recommendation of the Federal Environmental Agency, Empfehlung zu erforderlichen Untersuchungen auf Pseudomonas aeruginosa, zur Risikoeinschätzung und zu Maßnahmen beim Nachweis im Trinkwasser, 13 June 2017.
[2] Findings from the BMBF joint project “Biofilm in der Trinkwasser-Installation” version 2.0, 2010, IWW, Prof. Dr Hans-Curt Flemming.
[3] Findings from the BMBF joint project “Biofilm-Management” version 1.1, 2014, IWW, Prof. Dr. Hans-Curt Flemming.
[4] DVGW Worksheet W 551-2, Hygienisch-mikrobielle Auffälligkeiten in Trinkwasser-Installationen, Methodik und Maßnahmen zu deren Behebung, DVGW, Bonn, 08/2022.

Chemical parameters

Chemical substances must not be present in concentrations that may raise concerns for human health (§ 7, Clause 1, of the Potable-Water Ordinance). In line with the principle of minimisation, such concentrations should be kept at the lowest level possible with reasonable efforts to be undertaken in accordance with the generally recognised rules of engineering. (§ 7, Clause 4, of the Potable-Water Ordinance).[1]

Among the chemical requirements, those whose concentration can increase in the piping network including the potable-water installation are of particular interest for the installation (Potable-Water Ordinance, Annex 2, Part II). For some of the total of twelve parameters, the concentration is directly linked to materials that have been or will be installed or used in the potable-water installations (piping, devices, fittings, soldering agents, seals).

The table below shows the relevant parameters with the respective limit values.

Chemical parameters	Limit value {mg/l]
Lead	0,01
Cadmium	0,003
Antimony	0,005
Copper	2,0
Nickel	0,02
Arsenic	0,01
Manganese	0,05

Tab. 22: Limit values for selected chemical parameters in accordance with the Potable-Water Ordinance (see Annex 2, Part II, of the Potable-Water Ordinance)[2]

The concentrations of the metals lead, copper and nickel in potable-water samples taken from the consumer's draw-off point (tap) depend largely on the following factors:

- Materials used in the potable-water installation
- Operating conditions (flow times and stagnation time, user behaviour, formation of protective layer)
- Age and complexity (flow paths) of the potable-water installation
- Chemical constitution of the potable water
- Water temperature

[1] Potable-Water Ordinance (PWO), 24 June 2023.

[2] Potable-Water Ordinance (PWO), 24 June 2023.

Sphere of influence of the quality of potable water

Based on current knowledge, potable water hygiene as a whole is based on four basic principles:

- Compliance with the temperature limits for cold potable water (PWC) and hot potable water (PWH)
- Regular water exchange at draw-off points in the potable-water installation taking into account the operating conditions used as a basis by the system planners in the floor plan and materials catalogue (extracted quantity, volumetric flows and simultaneous use)
- Slim pipe dimensions with turbulent flow
- Limiting nutrients for microorganisms, primarily through use of suitable materials

The entire field of materials is regulated by law through the assessment criteria of the German Environmental Agency as set out in § 15 of the Potable-Water Ordinance. Consequently, according to § 16 of the Potable-Water Ordinance, the requirements of the Federal Environmentel Agency for the materials can be considered fulfilled if a certifier accredited for the potable-water sector confirms fulfilment. Therefore, planners, installers and operators need to consider how adherence to the temperature limits and a sufficient regular water exchange can be ensured in the system. Flow, temperature, water exchange and nutrient availability are essential and, at the same time, permanently interacting factors affecting potable-water ecology and hence potable-water quality from a hygienic and microbiological perspective. The circular chain of cause and effect pertaining to potable-water quality comprises these four variables (Fig. 66). In terms of how the ecology of potable water is understood, it is at least these factors in the potable-water installation' ecosystem that interact and jointly influence the hygienic stability and hence the system's potable-water quality. The effects can be both parallel and opposing.[1]

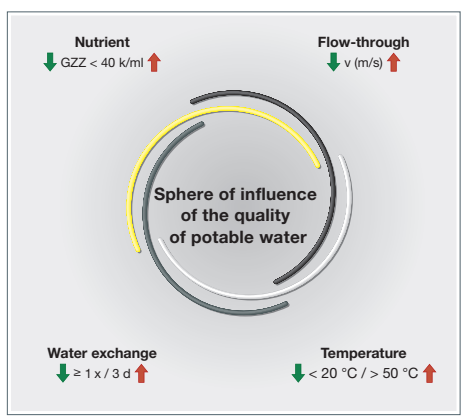


Fig. 66: Sphere of influence of the quality of potable water

[1] T. Kistemann, K. Bausch, Prozessziel Trinkwassergüte. In: C. van Treeck, T. Kistemann, C. Schauer, S. Herkel, R. Elixmann (Hrsg.): Gebäudetechnik als Strukturgeber für Bau- und Betriebsprozesse, Springer Verlag Berlin, pp. 167–275, 2018.

Temperature

Temperature is an especially critical factor for potable water hygiene. It is imperative to avoid the temperature range of 25–55 °C especially favourable to numerous pathogenic microorganisms in order to discourage propagation. Cold potable water must not exceed a temperature of 25 °C (recommended is 20 °C) in the entire potable-water installation up to the draw-off point and should always be as cold as possible.[1] Although legionella can occur in cold water, they are unable to propagate appreciably at temperatures below 20 °C.[2] In practice, it has also been shown that legionella are only very rarely detected at potable-water temperatures below 20 °C.[3]

It is assumed that for the normal water exchange no critical growth of micro-organisms takes place below this temperature. The parameters of temperature at entering the building, ambient temperature, insulation and pipeline routing along the entire flow path of the potable-water installation play a key role for the external heating of cold potable water and the associated increased hazard.
Circulation systems for hot potable water hot must be operated in such a way that temperatures of at least 55 °C are maintained in all of their parts. The outlet temperature at the potable-water heating system must be at least 60 °C.[1],[4],[5],[6],[7]

[1] VDI 6023 Blatt 1, Hygiene in Trinkwasser-Installationen – Anforderungen an Planung, Ausführung, Betrieb und Instandhaltung, Beuth, Berlin, 09/2023
[2] Robert Koch-Institut, RKI-Ratgeber für Ärzte, Legionellose, 2013.
[3] DVGW-Information Wasser Nr. 74, Hinweise zur Durchführung von Probennahmen aus der Trinkwasser-Installation für die Untersuchung auf Legionellen, DVGW, Bonn, 01/2012.
[4] K. Rühling, C. Schreiber, C. Lück, G. Schaule, A. Kallert, EnEff: Wärme-Verbundvorhaben, Energieeffizienz und Hygiene in der Trinkwasser-Installation, Schlussbericht, 2018.
[5] Robert Koch-Institut, Richtlinie für Krankenhaushygiene und Infektionsprävention, Elsevier Urban & Fischer, München 2004.
[6] Erkenntnisse aus dem BMBF-Verbundprojekt „Biofilme in der Trinkwasser-Installation“, Teilprojekt 1 (Leiter: Prof. Dr. Thomas Kistemann): Entwicklung und Evaluierung eines rationalen räumlich-zeitlichen Probenahme-Regimes zur effizienten und verlässlichen Erfassung, Beobachtung und Interpretation mikrobieller Kontaminationen in Trinkwasserinstallationen Version 2.1, Projektdauer: 01.10.2006 – 30.04.2010, Koordination: Prof. Dr. Hans-Curt Flemming.
[7] DVGW Worksheet W 551, Trinkwassererwärmungs- und Trinkwasserleitungsanlagen; Technische Maßnahmen zur Verminderung des Legionellenwachstums; Planung, Einrichtung, Betrieb und Sanierung von Trinkwasser-Installationen, DVGW, Bonn, 4/2004

Furthermore, a hydraulic balance between the legs must be ensured in accordance with DIN 1988-300.[1]

In a potable-water installation built and operated in accordance with the generally recognised rules of engineering, the temperature of hot potable water throughout the circulating system should, according to the state of science and technology, be above 55 °C in order to reduce the risk of legionella contamination significantly. This is also described in DVGW Worksheet W 551, where a requirement is set out that the temperature at the outlet of the potable-water heating system must not drop by more than 5 K until re-entry. Flow balancing of the circulation lines is essential to ensure that the thermal conditions required by the generally recognised rules of engineering can be maintained at every point in the hot-water installation.[2] However, the volume of terminal areas appear to be a subordinate factor in terms of legionella colonisation.[3]

To be able to achieve a temperature reduction of hot potable water while guaranteeing safe potable water at the same time, technical measures are required to prevent, especially in the critical range of < 55 °C, the propagation of legionella and, in turn, exceeding the technical intervention value of 100 CFU / 100 ml (see Nutrients).

A deviation from the specifications of the DVGW Worksheet W 551 is only permissible if the measures are proven to be their hygienic equivalent in microbiological tests and thus, above all, the objective of W 551 is avoided, which is mass propagation of legionella. Research projects aimed at using new technical approaches to enable a hygienically safe temperature reduction in hot-water systems are still in progress until 30.06.2023 and are currently being successfully implemented in pilot projects.[4]

So far, model projects show that a temperature reduction to a minimum of 45 °C with active ultrafiltration in a circulation bypass has no negative effect on the systemic hygienic stability of the central system.
This means that AquaVip Solutions (AVS) technology with an ultrafiltration module might offer a viable method in future that will be able to effectively

[1] DIN 1988-300, Codes of practice for potable-water installations – Part 300: Determining pipe diameters, Beuth, Berlin, 05/2012.

[2] DVGW Worksheet W 551, Trinkwassererwärmungs- und Trinkwasserleitungsanlagen; Technische Maßnahmen zur Verminderung des Legionellenwachstums; Planung, Einrichtung, Betrieb und Sanierung von Trinkwasser-Installationen, DVGW, Bonn, 4/2004

[3] K. Rühling, C. Schreiber, C. Lück, G. Schaule, A. Kallert, EnEff: Wärme-Verbundvorhaben, Energieeffizienz und Hygiene in der Trinkwasser-Installation, Schlussbericht, 2018.

[4] Communication from the Federal Environmental Agency (UBA) on a conflict rule for the Potable-Water Ordinance and the Building Energy Act – minimum temperature of heated potable water from large potable-water heating plants, 11 December 2020.

contribute to solving the trade-off between energy saving and potable-water hygiene. In this way, the use of regenerative heat generators, for example heat pumps, can be supported in a sustainable way.

Water exchange

According to VDI 6023 sheet 1, drinking water installations must be planned in such a way that water is exchanged at least every three days at all draw-off points. This refers to the complete exchange of water in all sections and in the potable-water heating system. Water exchange is defined as a complete exchange of the water volume contained in the relevant piping section by means of extraction or draining. According to DIN 1988-200, it must be taken into account during planning, including any potential water- and energy-saving considerations, that a water exchange will be provided during proper operation that is adequate in terms of hygiene.[1]

The anticipated simultaneous uses of potable water draw-off points are determined based on the information in the room sheet data (type of use). Oversized potable-water pipelines, storage tanks and devices must be avoided. Non-flow pipes and devices holding stagnant water are generally not permitted. For this reason, the pipe routing and arrangement of the draw-off points must be planned in such a way that the highest possible water exchange is achieved.[1][2] During planning, the component-specific zeta values (resistance coefficients) should be taken into consideration in order to achieve the smallest possible pipe cross-sections and system volumes.

Flow-through

As a rule, pipelines as vessels for potable water affect water hydraulics in the entire system – a significant aspect of compliance with potable-water hygiene. The selection and dimensioning of the piping system have a direct influence on water exchange and flow-through. Only if the pressure losses of the connectors and fittings of a piping system are low, the nominal diameter and thus the pipeline volume can be optimised. This benefits regular water exchange during intended use and increases the flow-through rate.

Another major factor for potable-water hygiene is the dynamic of water movement in the potable-water installation, which is defined by water exchange and flow-through (= flow rate). Even under less favourable environmental conditions with regard to temperature and nutrient supply, slow microbial growth may occur over a sufficiently long time frame if water movement is slow and/or the water in the piping is stagnant. In oversized piping in particular, there is a risk that only a laminar flow will pass through the centre of the pipe, which means no adequate water exchange is provided along the pipe walls.

[1] DIN 1988-200, Codes of practice for potable-water installations – Part 200: Installation Type A (closed system) – Planning, components, apparatus, materials, Beuth, Berlin, 05/2012.

[2] VDI 6023 Blatt 1, Hygiene in Trinkwasser-Installationen – Anforderungen an Planung, Ausführung, Betrieb und Instandhaltung, Beuth, Berlin, 09/2023

If there is an adequate flow-through and hence shearing forces, a relatively stable biofilm forms, whereas stagnation causes a loose accumulation of bacteria.[1] To prevent them from detaching and putting users at risk, it is just as important to dimension the piping in line with actual demand as it is to use the draw-off points regularly. If possible, the dimensioning of potable-water installations should take into account recent experience from similar projects. Pipe dimensions must be calculated according to DIN 1988-300. The aim is to plan with the smallest possible pipe dimensions with due consideration for the peak volume flow.[2]

Nutrients

Bacteria depend on nutrients for growth and reproduction. C-heterotrophic bacteria, which are relevant to health, need organic carbon compounds as a source of energy and carbon (DOC = dissolved organic carbon). Bacteria in biofilms of potable-water installations and in the aquatic phase of potable-water supply may use nutrients from installation materials or the supplied potable water as well as orthophosphates from a corrosion protection dosage.

[1] L. Hall-Stoodley, J.W. Costerton, P. Stoodley: Bacterial Biofilms: From the natural environment to infectious deseases, Nature Reviews Microbiology, Vol. 2, 2004, pp. 95–108.

[2] DIN 1988-300, Codes of practice for potable-water installations – Part 300: Determining pipe diameters, Beuth, Berlin, 05/2012.

Selecting the installation system

According to the Ordinance on General Conditions for the Supply of Water (AVBWasserV), only components complying with the recognised rules of engineering are allowed to be used in a potable-water installation. The mark of a testing centre accredited according to DIN EN ISO 17065 provides evidence that this requirement has been met (§ 16 of the Potable-Water Ordinance). In addition, the Ordinance on General Conditions for the Supply of Water stipulates that work on potable-water installations may only be carried out by a contract installer registered with a water supply company or by the water supply company itself.

While soft and hard soldering was the dominant method used from 1970 to 2000, press connection technology has now taken over as a market leader in connection technology. As pipes can now be joined cold and in a matter of seconds, the method previously used for copper pipes has become obsolete and new markets for stainless steel and plastic pipes have opened up. Depending on the pipe material and manufacturer system, a distinction is made between radial, axial and raxial press connection technology.

Design supply temperature	Time with	Maximum temperature	Time with	Temperature for malfunction	Time with malfunction	Typical area of application
T_D	T_D	T_{max}	T_{max}	T_{mal}	T_{mal}	
°C	Years	°C	Years	°C	h	
70	49	80	1	95	100	Hot-water supply at 70 °C

Tab. 23: Minimum requirements for operating temperatures for hot potable water (70 °C)

Expert planners now have a wide range of criteria that need to be borne in mind in choosing a piping system and the corresponding connection technique. The first pointer for selecting a high-quality product is an approval mark from an accredited testing body. In addition, pipe connections in potable-water installations according to DIN 1988-200 must withstand at least the expected operating loads as per Tab. 23 and corrosion protection measures should not be necessary according to DIN EN 806-2. System selection is also often based on stock and equipment as well as purchasing conditions available to the companies carrying out the work.

Installers prefer systems with which they have already had positive experience on site. For instance, if it is not necessary to calibrate a multi-layer pipe of a given make before insertion into the connector, the resulting easier handling might be a relevant factor. This could easily represent an important argument for an expert planner in consultation with the building owner. Ultimately, an operationally reliable system is the primary planning objective, but financial advantages might be available during installation as fast processing saves time and personnel, in turn reducing capital costs. The piping systems available on the market are always specific to the respective manufacturer and differ in their construction and materials used. This also applies to the differences between the moulded pieces and connection parts with regard to their resistance coefficients. Such differences are fairly small in stainless-steel and copper pipe systems but significant in multi-layer pipes. There, the size-dependent values vary a great deal, mainly on account of construction and the way the support sleeve is designed. Influencing factors are primarily the internal pipe diameter, the design of the press connectors with or without sealing element as well as the design of the flow deflectors, with small radii unfavourably affecting the components' resistance coefficients and soft radii having a positive impact. This results in deviations of factors up to 10 or more, which has a variety of effects on determining nominal diameters, system volume, water exchange and, in turn, potable-water quality.

Although moulded pieces for welding and bonding systems with pipes made from polypropylene or PVC-C do not need a support body and therefore have the advantage of a full flow cross-section, the manufacturing process gives rise to angular deflections that in turn lead to unfavourably increased resistance coefficients. The same applies to plastic plug connectors, which are categorised as externally sealing for plastic pipes (PE-X, PB etc.) and internally sealing (PE-X/Al/PE-X etc.). For the latter, support bodies with at least one sealing element are required, which in turn leads to comparatively small flow cross-sections in the support body and thus to higher resistance coefficients. According to DIN 1988-300, the product-specific resistance coefficients of the fittings must be taken into account for system design. To this end, they can be measured in accordance with DVGW W 575 (P) and provided to the expert planner or installer by the manufacturer.

Selection of materials

According to the generally recognised rules of engineering, potable-water quality, among other things, must be taken into account as early as the planning phase.

Every pipe material has limits of use which, although generally not reached if the system is operated as intended, can easily be reached if special measures are implemented. Therefore, it is advisable to contact the component manufacturers in case of doubt.

The physical properties of metal piping differ fundamentally from those of plastic piping. The most important system selection criteria include:
- Low pH
- Very high chloride concentrations, e.g. during shock disinfection
- High temperatures (with thermal disinfection)
- Length compensation coefficients

Where certified piping systems are used according to specifications and taking the material-specific scope of usage into account, the expert planner need not adopt any other measures in order to ensure safe system operation. As a result, many different system solutions involving various pipe materials and types of connection technology are available on the market. In Germany, the market is dominated by pipes made of copper, stainless steel (1.4401, 1.4521 etc.), PE-X and composite materials combined with mechanically sealing connectors made from copper, stainless steel, gunmetal, silicon bronze, brass or injection-moulded plastics such as PPSU.

Press connector systems are suitable for creating potable-water installations in accordance with DIN 1988-200 and EN 806-2, taking into consideration material selection in accordance with DIN EN 12502-1 and DIN 50930-6. For use in other areas of application and in case of doubt concerning correct material selection, please contact Viega:
- Sanpress/Sanpress Inox
- Raxinox
- Raxofix
- Profipress
- Sanfix Fosta

Copper pipes and compression fittings can be used for potable-water installations:
- If the pH value is ≥ 7.4 or
- If the pH value is between 7.0 and 7.4 and the TOC value of 1.5 mg/l is not exceeded.

If the pH value is < 7.0, copper pipes must not be used.

Old systems still operating with lead pipes must be redeveloped as quickly as possible.

In order to reduce time-consuming individual tests on products, the German Environment Agency has been tasked with specifying the hygienic requirements for materials and substances and defining the basis for evaluation.
The evaluation bases may include test specifications or positive lists for raw materials or materials and substances.
Positive lists conclusively define the source materials or materials and substances that can be used. When using metal materials from the positive list, there is no need for a component-related check of metal release into the potable water. The products are considered suitable for ensuring potable-water hygiene.
Lead as the sole material for potable-water installations is no longer included in the assessment principles for metallic materials and therefore no longer permissible to use in potable-water installations. Also, existing lead installations must be replaced, as the water absorbs so much lead as it flows through that the Potable-Water Ordinance's thresholds regularly will not be met.
Silver, which is often used due to its disinfectant effect, is also not included in the Federal Environmental Agency's assessment basis, which is why its use as a metal in contact with potable water (e.g. as support threads, internal coating etc.) is not permitted. However, its use in potable-water systems as a disinfectant is subject to the provisions of § 11 of the Potable-Water Ordinance and only permitted if the process is included in the Federal Environmental Agency's § 11 list.

Hot dip galvanised iron materials

Hot dip galvanised steel cannot be used for all potable waters because it is susceptible to corrosion (rust) and, due to the high degree of pipe roughness, prone to mineral deposits such as limescale. According to the UBA evaluation basis and DIN EN 12 502, hot-dip-galvanised ferrous materials may be used for cold potable water if:

- the base capacity K_B is 8.2–0.2 mol/m^3 and
- the neutral salt quotient $s_1 < 1$.

The use of hot-dip-galvanised piping for hot potable water is not permitted. The effects of temperature and temperature fluctuations on uniform surface corrosion are complex because the composition of the corrosion products in the surface layer changes with temperature. Up to temperatures of around 35°C, the velocity of uniform surface corrosion increases as the temperature increases.

For hot-dip-galvanised steel pipes, connections are made with threads that often use hemp as a sealing material. Threaded connectors constitute a significant vulnerability of potable-water installations. If, during assembly, the threaded pipe is cut to the required length from commercial straight length using a saw or other suitable cutting tool and a thread is cut open, these points will not be galvanised, which may lead to crust formation and corrosion.

Fig. 67: Galvanised steel pipe with clearly visible corrosion

Generally, providing a potable-water installation using hot-dip-galvanised steel pipes with threaded connectors is considerably more time-consuming than a comparable installation made from copper, stainless steel, plastic or plastic composite pipes with press connectors.
The zinc layer on hot-dip-galvanised steel pipes may also be contaminated with lead due to the manufacturing process. As a result, lead thresholds for potable water may be exceeded.

Combination of different materials

The generally recognised rules of engineering allow for various materials being used in potable-water installations. (DIN 1988-200). For example, a combination of pipes made of copper, internally tin-plated copper, stainless steel and PE-X is possible. When combining pipes made of galvanised ferrous materials with other pipe materials, DIN EN 806-4 must be observed.

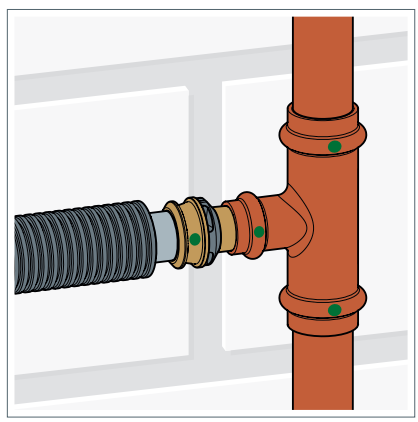


Fig. 68: Profipress–Raxofix transition

During partial renovations or repairs of installations, the flow rule is to be taken into account concerning the use of metallic materials. The flow rule applies if different metallic materials are used within the same potable-water installation. That affects pipes, fittings and containers. According to DIN 1988, a mixed installation like that cannot be completely ruled out and still meets the generally recognised rules of engineering.

However, mixed installation of dissimilar metallic materials carry the general risk of local elements forming. Local elements are where metal corrosion starts, the effect being that the less noble of two metals dissolves to the point of complete destruction. In potable-water installations, base metals include galvanised steel in pipes and press connectors, while higher-grade metals include copper used in the same components.

If the potable water flows through components made of base materials first and then comes into contact with higher-grade materials on its way from the service connection to the draw-off point, the risk of corrosion will be significantly reduced. If the order of materials is reversed, copper ions may build up on iron or zinc surfaces, causing those lower-grade materials to dissolve. This results in pitting. Therefore, components and equipment made of copper, copper alloys, tinned copper and copper solders must not be placed in the flow direction ahead of those made of galvanised ferrous materials.

Press connector (or fitting)	Pipe		
	Stainless steel	Hot-dip-galvanised steel	Copper
Stainless steel	Possible	See manufacturer's recommendations	Possible
Hot-dip-galvanised steel	Not possible	Possible	Not possible
Copper	Possible	See manufacturer's recommendations	Possible
Copper alloys	Possible	Possible	Possible

Tab. 24: Combination of pipes and press connectors[1]

If connections have to be made between stainless-steel and galvanised-steel pipes, components made of copper alloys (e.g. gunmetal) must be used in order to reduce or eliminate contact corrosion depending on the water quality. This can be done, for example, by installing a shut-off valve. The length of this component must be at least equal to the pipe dimension.

[1] In accordance with table 5 from EN 806-4

Expansion compensators and compensators

The amount of material-specific thermal length expansion of piping for hot potable water or for the circulation system is proportional to the difference between the installation temperature and the maximum operating temperature, which is 70–85 °C for thermal disinfection, for instance. The anticipated length differences must be compensated by structural means such as expansion bends, U-elbows or compensators. The thermal length expansion of metal piping is lower than that of plastic and metal composite pipe systems. This is why basement headers and riser pipes are usually made from copper or stainless steel to reduce efforts to provide compensation for length expansion. In pre-wall installations or in floor constructions, most pipes are laid short and change direction several times. As a result, no special measures are required when plastic and multi-layer pipes are used.

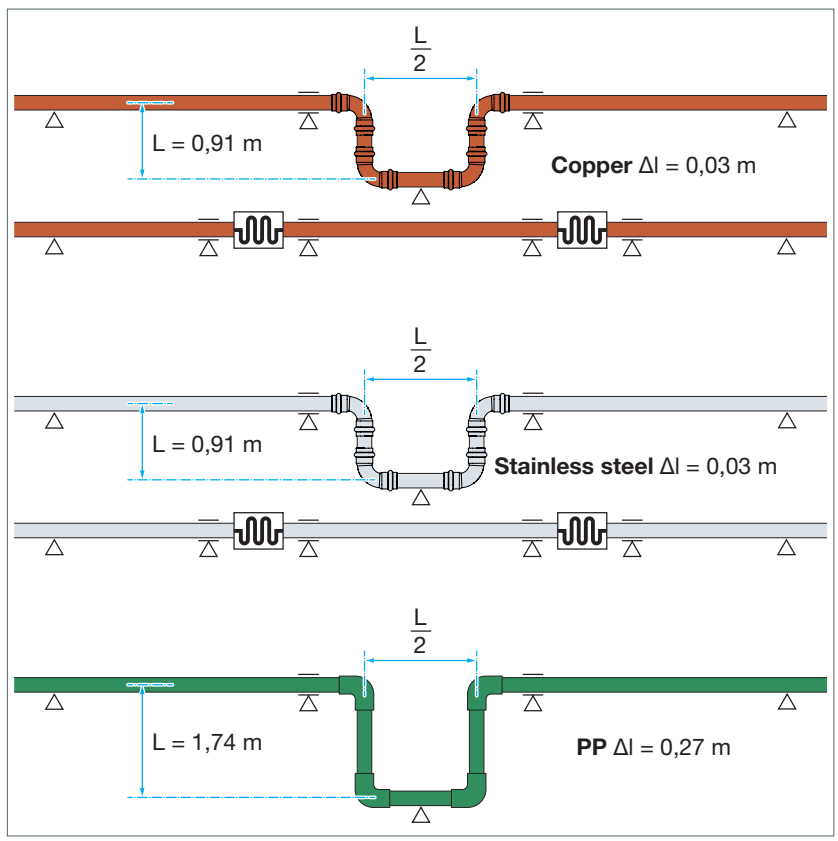


Fig. 69: Linear expansion in piping

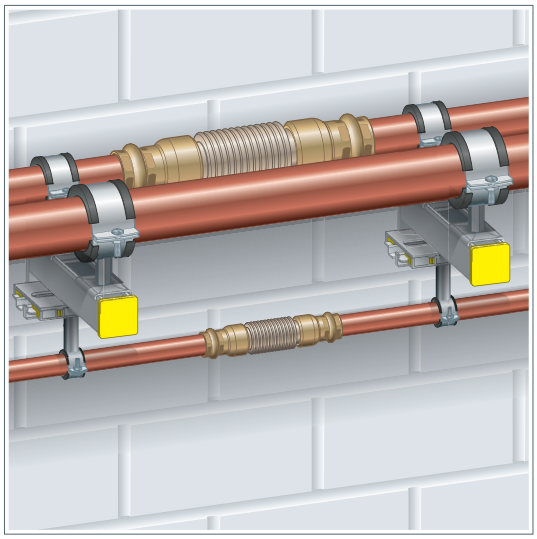


Fig. 70: Installation with axial compensators

The thermal length expansion of copper and stainless steel is almost identical and relatively low (Fig. 6979). The more severe changes in length that polypropylene pipes undergo have to be intercepted by expansion compensators, and these require a significant amount of space.

Expansion compensation
If the installation situations allow U-shaped or and Z-shaped expansion compensators to be used, their expansion bend lengths can be calculated as follows:

- Determination of the greatest possible temperature differential $\Delta\vartheta$.
- Determination of pipe length l0.
- These values are used to calculate the total length by which the piping section will expand.
- The resulting necessary pipe bend length LBZ or LBU for the relevant pipe sizes is shown in the diagrams on the following pages.

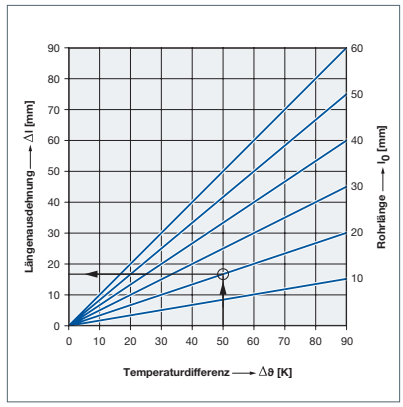


Fig. 71: Linear expansion of metal piping

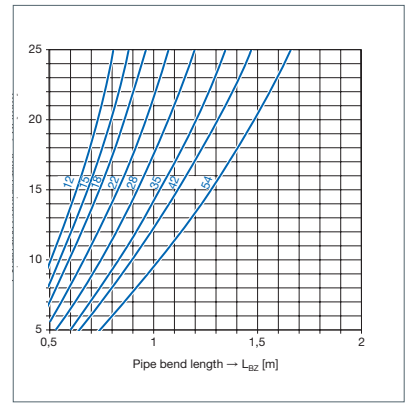


Fig. 72: Z-shaped or T-shaped expansion bend

Example

Given operating conditions:

- The operating temperature is between 10 and 60°C. Hence, $\Delta\vartheta = 50\,K$
- The piping section has a length of $l_0 = 20\,m$
- The coefficient of length expansion for stainless-steel and copper pipe is $\alpha = 0.0165$ mm/m·K
- Insert values into the formula $\Delta l = \alpha$ [mm/m·K] · L [m] · $\Delta\vartheta$ [K] This results in: $\Delta l = 0.0165$ [mm/m·K] · 20 [m] · 50 [K] = 16.5 mm
- Selection of the U or Z shape depending on the available space.
- Read off the required expansion bend length L_{BZ} from the U or Z diagram.

In this example for a Z-shaped expansion bend: On the vertical axis at 16.5 mm, trace horizontally to the line of the pipe size used and read off the necessary expansion bend length below on the horizontal axis.
With a selected nominal pipe diameter of Ø 28 mm, the expansion bend length L_{BZ} = 1.3 m. For metal piping, compensators can be used as a space-saving alternative to expansion bends. In such cases, the greatest possible expansion compensator must not be exceeded. If necessary, the calculated length expansion needs to be spread over several compensators.

Piping with compensators must be laid straight so that length expansion can be accommodated axially. Torsion and shear forces must be avoided. During piping installation, the manufacturer's specifications for the correct arrangement of fixed points and sliding pipe guides must be observed. The placement of the non-sliding piping for potable water cold stabilises the fixing system (SIKLA) to prevent lateral displacement, and therefore no additional inclined bracing is needed in this case.

Pipe routing past the service connection
In all cases, the contract installer is responsible for installing service connections.
In this chapter, however, special attention is to be paid to the temperature in the plant room. The new version of DIN 18012 from April 2018 clearly states in section 5.4.3 that temperatures in the service connection room that constantly exceed a limit of 25 °C are not to be tolerated and that therefore countermeasures must be taken. Also, a clear definition of "constantly" is provided, which refers to exceeding the temperature for a duration of over an hour. This temperature value is important because a temperature above 25 °C during periods of stagnation also leads to a rise in the temperature in cold potable water and may encourage the growth of pathogenic microorganisms. If components such as potable-water filters, softening units or water treatment systems are installed in the room, bacteria are provided with a huge surface on which to thrive.

Even according to VDI 6023 sheet 1, the new version and VDI 2050 sheet 2, the temperature of potable water in service connection rooms must not exceed 25 °C. As a consequence, heat sources must be avoided. Downstream of the water meter, the first few meters are usually the most critical to the hygienic operation of a potable-water installation. Here, unmaintained filters or softening units may act as a breeding ground for pathogenic microorganisms and contaminate the entire potable-water installation. Therefore, they must be included in routine maintenance measures. This provides not only an opportunity to keep hygiene risks low but also to reduce the financial investment. If the outlet to the water heater branches off the cold-water pipe early on, the dimension of the cold-water piping downstream from the branching point can be reduced in some cases, potentially resulting in considerably lower risks for hygiene following a period of stagnation. The same is true for process water outlets and extinguishing water lines. Risk assessments show that branching off these pipes early on significantly reduces the risk of contamination. This installation method is already followed in practice quite often, but it is not usually implemented consistently. It is not only the early branching downstream of the service connection that reduces the risk to hygiene for the entire installation, but also the positioning of the safety device immediately behind the branch from the cold water pipe. Separating cold and hot potable water, process water or extinguishing water lines close to the connection reduces the hygiene risk for cold potable water, since unprotected supply lines hold barely any water that might stagnate.
To install the manifold, the run with the largest dimension should be positioned furthest downstream and elbows should be used for the transition

(Fig. 73). This arrangement ensures an optimal flow through the entire manifold, since the biggest decrease occurs in the final leg.

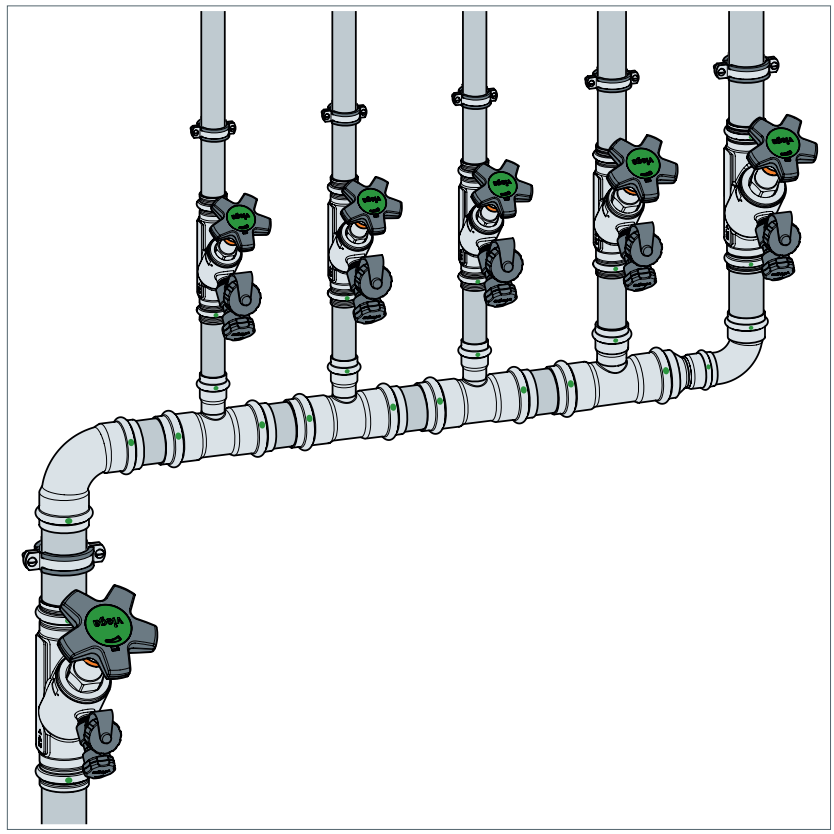


Fig. 73: Hygienically optimised manifold installation

Especially in existing buildings, however, hygienically critical installations that were installed according to the generally recognised rules of engineering at the time can still be found. The installations pictured below clearly show why regulators have chosen to use the phrase “generally accepted rules of engineering”. This is because, whenever new findings provide evidence for hygiene issues within installations, the operator of a potable-water installation must arrange for improvement and repair work immediately.

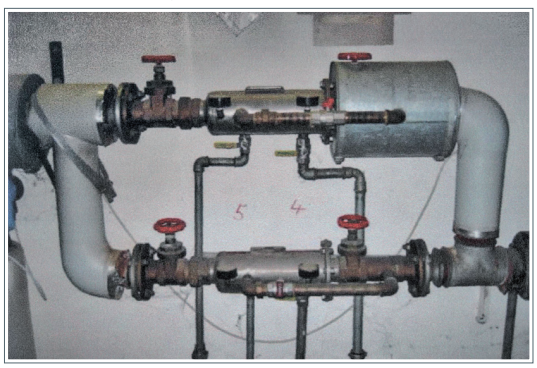


Fig. 74: Filter system (redundant design)

- R 2½ Bypass for filter
- Visual inspection of the filter not possible
- Filter elements missing

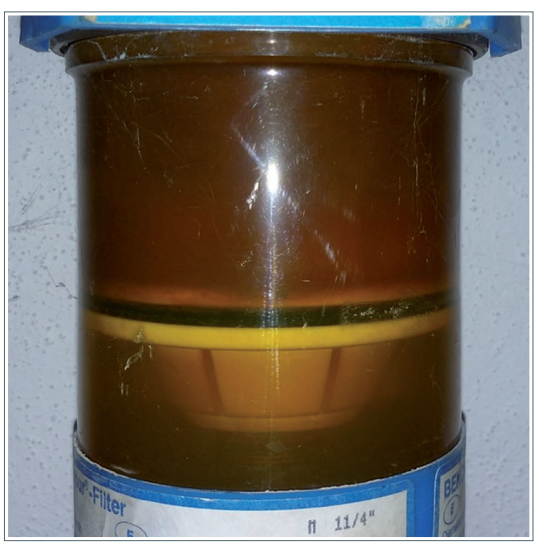


Fig. 75: Unmaintained and uninspected filter at the entry point

- Inadequately maintained filter
- Large surface encouraging growth of bacteria
- System-wide contamination of a potable-water installation

Distribution concepts for potable water cold

When planning a potable-water installation, it must be ensured that a potable-water temperature of 25 °C (recommended is 20 °C) is not exceeded for cold potable water.[1] Although legionella can occur in cold water, they are unable to propagate appreciably at temperatures below 20 °C.[2] Buildings usually have additional heat loads, which, in an unfavourable scenario, might heat up cold potable water. Physical heat transfer always takes place from the warmer to the colder area. This particularly affects installations in installation shafts, facing shells, suspended ceilings as well as directly below underfloor heating systems (see also DIN CEN/TR 16355). Therefore, potable-water installations must be thermally separated or laid at a distance from heat sources or lines that might get hot. During planning and installation, the installation rule “cold potable water below hot potable water” must always be observed (heat flow). Although pipe insulation delays the release of heat, it cannot completely protect cold potable water from heat loads originating in its immediate surroundings (external heating). From the point of view of potable-water hygiene, potable-water installations (cold) in spaces with high ambient temperatures, e.g. control centres, must also be classified as particularly critical as a consequence. If the room temperature exceeds 25 °C, no pipes for cold potable water should be planned or laid in that location. Cooler adjoining rooms are better suited.
The protection of cold potable water from thermal loads should be considered from the outset in the planning phase as a passive safety measure and constitutes a mark of quality for any technical design. Problems caused by inadequate planning or execution are usually impossible or very difficult to resolve after the fact.[3]

Downstream of the service connection, the pipework for cold potable water can be laid in the building according to two installation principles: vertical or horizontal distribution. Put briefly, the terms vertical and horizontal refer to the position of the storey connection pipes. One example of horizontal distribution is hospitals, where the supply pipes for hot and cold potable water to the individual service units run in a suspended ceiling (not recommended, see above) and originate from a common shaft.

[1] VDI 6023
[2] RKI-Ratgeber Legionellose
[3] https://www.amev-online.de/AMEVInhalt/Planen/Maschinenbau-und-Versorgungstechnik/Sanitaeranlagen_2021/Sanitaeranlagen_2021.pdf

Vertical distribution concepts for cold potable water are found mainly in existing buildings, since this is typically where all piping was planned in one common shaft due to a lack of space (not recommended, see above). In such buildings, heating pipes with hot water and circulation pipes run parallel to the cold water pipes. Frequently, this will result in shaft temperatures of over 25 °C and cause cold-water temperatures to exceed 20 °C during periods of stagnation. Compensating for this effect using 100-% insulation adapted from the hot-water piping is not the answer, because, in an insulated pipe, heat absorption is counteracted only slowly and external heating cannot be cancelled out completely.

If a purely vertical distribution needs to be used, it is generally possible to consider distributing pipes carrying hot and cold water in two separate shafts. For this, it is necessary to check of the building is equipped with shafts for sewer lines and other lines carrying cold media. This is where the cold-water pipes could be laid to provide a spatial separation of heat sources and cold-water lines.
Horizontal distribution was the established standard for the distribution of cold potable water for some time. However, it is no longer recommended due to the external heating effect on the potable water. The methods considered standard to date (100-% insulation, thermally insulated components at extraction fittings) have been shown in practice to fail to adequately prevent the hygiene-critical temperatures that may occur with this type of installation. The external heating effect on cold potable water is mainly due to the long parallel runs of hot and cold pipes in suspended ceilings.

As these variants cannot be implemented in all types of buildings, cooling of the cold-water circulation will be necessary in some cases. For this purpose, a cold-water circulation pipe is routed to a central cooling unit for cooling, which is similar to how hot-water circulation is handled. Since this is relevant in periods of stagnation in particular, positioning the cooling unit in the potable water cold circulation and, in contrast to potable water hot preparation, making its use temperature and time-dependent is sufficient. The circulation system for potable water cold is closed by returning the cooled water to the potable water cold pipe at a suitable point. This is usually close to the service connection and, for energy optimisation, ideally where the potable water cold has already been drawn off to prepare the potable water hot. However, it must be noted that cooling the cold-water circulation is merely a compensatory measure for non-compliance with the generally recognised rules of engineering. If the requirement for thermal separation of cold pipes to hot objects is not properly fulfilled, there is a risk of legionella growth at temperatures above 20 °C, which constitutes an avoidable health hazard.

The planning of such circulation systems should be done digitally with Viptool Engineering. Cold-water circulation not only offers the advantage of hygienically ideal temperatures in the cold-water piping system but also the benefit of better compliance with comfort times for cold water, as it is not uncommon for the required ejection times for cold potable water to be impossible to meet in multi-storey residential buildings. The Smartloop inliner

technology (DVGW-certified for potable water cold and hot) is the ideal solution for refurbishment projects. It eliminates the need for additional piping in the shaft as the in-line pipe is simply placed in the cold-water pipe as a retrofitting measure. This technology cannot be used if the potable water cold is subsequently distributed up to the storeys and circulated, but does prove to be a cost-effective solution in residential buildings. As with hot-water pipes, an additional pipeline section should be used. However, the use of inliner technology is also suitable for hot water, as it will significantly reduce the heat-emitting surface, making it possible to lower the shaft temperature under certain circumstances. Above all, this reduces the external heating effect of the cold potable water during periods of stagnation.

One solution to plan for protecting cold potable water from external heating, without installing a cold-water circulation system, is to lay the cold potable water pipes vertically, e.g. parallel to the waste water downpipes, and to lay all hot pipes horizontally, e.g. in a suspended ceiling. This is advantageous because no additional measures for maintaining temperature are necessary and resources are conserved as the power and maintenance requirement for a cooling unit is eliminated.

Pre-wall installation offers the potential for further optimisation. The external heating of potable water cold can be solved by positioning the potable water cold lines as close as possible to the bottom of the pre-wall and the potable water hot lines as close as possible to the top. Both pipes should be designed as series pipelines to minimise heat input into the pipe for cold potable water.

If the line for cold potable water in a service unit is installed as a ring system and the line for hot potable water with a circulation pipe is routed to the final draw-off point, including thermal decoupling, heat will be permanently admitted into the cold potable water, which may cause it to become contaminated by legionella. If there is flow-through of cold potable water through the ring system based on the Venturi effect, a local contamination may turn into a system-wide contamination very quickly.

If the circulation of hot potable water takes place outside of the service unit, in the corridor for example, the cold potable water within the service unit cannot get hotter than room temperature, which, with few exceptions, is below 25 °C. The connection of the piping itself is also relevant to the temperature of the cold potable water. If hot and cold potable water are routed to the extraction fitting in parallel from above or below, the cold potable water will inevitably heat up whenever hot potable water is drawn from this draw-off point. If, on the other hand, potable water hot is routed to the draw-off point from above and potable water cold from below, the individual piping sections will be thermally isolated from one another.

The illustration below shows what such a service unit might look like:

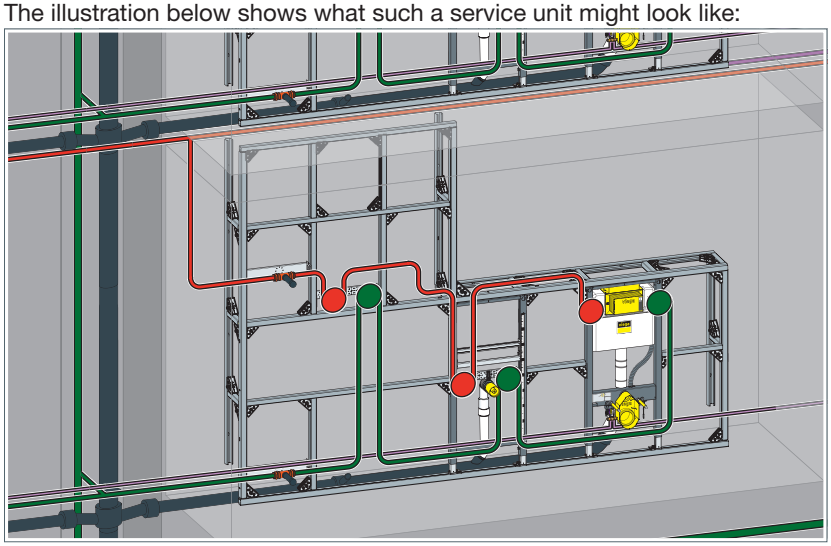


Fig. 76: Connection of a service unit to the potable water cold and potable water hot distribution, connection of the circulation outside the service unit.

Regardless of pipeline routing, the potable-water installation is required to provide a complete exchange of water across all draw-off points.

Distribution concepts for potable water hot

Buildings and the associated building services engineering must be planned, built and operated in a manner that conserves resources and is economical and sustainable. Particularly, this applies to the potable-water installation, the potable-water heating system and the routing concepts for lines for hot potable water.

For example, hot potable water pipes release between 7 and 11 W/m of energy into the environment, even if they are well insulated.[1] Hence, from the planning stage onward, the goal should be to consistently reduce the piping system's pipeline volume for hot potable water. This objective can be achieved partly by using the actual zeta values for the piping system calculations to create a lean piping layout and partly by giving the plans for piping sections to be integrated into the circulation system a critical examination. It would not be productive to integrate any service unit with a water volume of < 3 l into the circulation system. Apart from the associated undesirable admission of thermal energy into the pre-wall, which heats up the cold potable water (see also "Distribution concepts for cold potable water"), series installation will result in shorter pipes, less water volume in the system, less insulation material needed and smaller heat loss. An installation of this type therefore conserves resources and energy. For this reason, the circulation system should be designed only in central areas (in the leg for vertical distribution or in the corridor for horizontal distribution). The type of routing outlined above also makes sampling in accordance with "Schema F" (as described in DVGW Worksheet 551) possible, since the flow paths of the hot potable water can be clearly understood.

Circulating storey connection pipes can be implemented in installations with central potable-water heating wherever no decentralised consumption measurement is planned for the floor concerned. Classic examples of this are the distribution and circulation pipe networks in the suspended ceilings in hospital corridors. Storey and single connection pipelines in service units with a volume of < 3 l must not be integrated into the circulation system. There is a long-held belief that to maintain hygienic conditions in hot water installations, a circulation system has to be routed up to the wall plate. This was based on a misunderstanding of the RKI Directive on hospital hygiene and infection prevention, which states: "For the installation of systems, the objective is to have circulation pipes with the shortest possible connections to the draw-off point." However, in the application of the RKI Directive, there is a second point that should have been followed. In addition to the phrase "shortest possible", which in conjunction with the generally recognised rules of engineering does not require circulation via the wall plate, as well as the secondary point that cold water should be protected against heating. The generally recognised rules of technology permit a hot-water volume of up to 3 litres[2] to be used in the design of the potable-water installation in compliance with the RKI guideline. Comfort should not be considered an argu-

[1] DVGW Worksheet W 551

[2] DIN 1988-200

ment for using hot-water circulation right up the draw-off point as applying comfort level 3 as per VDI 6003 will result in a maximum ejection time of 7 seconds at the shower mixer. With a standard shower, this ejection time can also be achieved using a single supply line of up to 10 m in 16-mm multi-layer pipe. This number also clearly shows that the circulation of hot water need not be routed into the service unit as the comfort and hygiene criteria can be fulfilled even without doing this. Another aspect that has received little attention in the application of the RKI Directive is that of preventing cold water from being heated. Routing the hot water circulation pipe into the service unit generates high heat loads in the pre-wall installation. These loads then cause the cold water to exceed the specified temperature, not only locally at the extraction fittings, but also systemically in the supply lines. In this case, too, it is clear that extending hot-water circulation as far as possible is not a suitable measure to maintain hygiene as the operator has an obligation to provide for regular water exchange regardless of pipe routing.

Riser pipes and horizontal-distribution runs with a pipe volume > 3 litres must be integrated into a circulation system in accordance with DIN 1988-200, item 9.1, or be fitted with a heating cable. This maximum volume does not mean the sum of all branches of a storey distribution system, it refers instead only to the flow path under specific consideration. Generally, this is also in the correct proportion to the maximum permitted ejection time of 30 seconds, which corresponds to an average draw-off quantity of approx. 0.1 l/s. In residential buildings, for example, a target ejection time for hot potable water of a maximum of approx. 10 seconds effectively results in a 1-litre rule. In practical terms, longer ejection times therefore require a special agreement. In the final analysis, any determination of basic requirements should take this aspect into account. In VDI 6003, ejection times are listed with so-called comfort levels and offer a framework that can be agreed with the principal or user in advance when planning a potable-water installation.

In the case of heating of potable water too, a critical examination of how this ought to be implemented should be carried out right from the planning stage. The view persists that decentralised heating of potable water by flowthrough heaters prevents Legionella as no water is stored. The German Environment Agency (UBA) corrected this assumption in a 2018 report. This is an excerpt: “Decentralised potable-water heaters have been considered safe with regard to legionella contamination. However, more recent findings indicate that legionella can also multiply in decentralised potable-water heaters and in pipes downstream of them. When investigating legionella infections, decentralised potable-water heaters must also be included in the search for the cause”.[1] The use of renewable energy sources is undoubtedly of growing importance in arriving at an energy rating for a building. If, for example, more than 55 % of the energy requirements for space heating and hot water are met by renewable energy, considerably higher subsidies are available. This is stipulated in the new German federal funding initiative for

[1] Mitteilung des Umweltbundesamts (UBA), Vorkommen von Legionellen in dezentralen Trinkwassererwärmern, 12/2018

residential and non-residential buildings (BEG WG and BEG NWG). Ambient heat in particular is very easy to use in the central heating of potable water. This can be achieved, for example, by using a heat pump and/or a solar heating system with a multifunctional tank as an energy buffer, which heats up potable water and provides space heating by means of heat exchangers. In addition, this ensures that electricity is used in the most effective way for heating potable water. This is because at a coefficient of performance (COP) of 3.5 – a typical output for an air-to-water heat pump – the electrical drive energy of the heat pump generates 3.5 times the thermal energy. By contrast, flowthrough heaters convert electricity into heat at a ratio of 1:1. From the perspective of hygiene, conservation of resources and economy, a central potable-water heater should be preferred over decentralised potable-water heating.

The outlet temperature of a potable-water heater (reservoir-based or central continuous-flow potable-water heater) that constitutes part of a circulation system must be at least 60 °C, with the temperature differential with the circulation system, measured at the potable-water heater's inlet, not exceeding 5 K.[1] An operating temperature of ≥ 55 °C for potable-water systems is a generally recognised safety margin for the prevention of critical legionella growth in hot potable water. Generally, this assumes operation as intended with water exchange through the whole system (branches and storage volume) after 3 days at the most.

Lowering the operating-temperature threshold to ≥ 50 °C for potable-water heaters with frequent water exchange is possible where an exchange of water across the whole system is sure or generally expected to take place within 3 days.[2] This arrangement makes it possible to ensure economical operation of potable-water heaters especially in single-family homes that are heated by regenerative energy. With the exception of occasional periods without regular usage (e.g. holidays), favourable hygienic conditions are to be expected at all times. However, this creates an obligation for the installer to inform the principal of an increased risk of critical legionella propagation when the system is handed over. Despite expected frequent use, the temperature parameter is within a range that encourages the growth of legionella.[3][4] The relatively short flow paths involved in such installations lead to high available pressure gradients for pipe friction, which leads to minimised pipe diameters and adequate flow-through. Irrespective of the size of the installation, the aim should always be to achieve such operating conditions wherever possible. To this end, it is crucial to plan with demand in mind, especially when designing the potable-water heater.

[1] DVGW Worksheet W 551
[2] DIN 1988-200
[3] DIN 1988-200
[4] UBA-Mitteilung 2019

In well-insulated new buildings meeting the energy standard KfW Effizienzhaus 40 and higher, the preparation of hot potable water now accounts for a disproportionately large share of the total energy requirement. Depending on the insulation standard, it can be as much as 40% of the primary energy requirement. The requirement to store hot potable water at a temperature of 60/55 °C is a hindrance to the introduction of regenerative thermal systems. The optimum operating point of an energy-efficient heating pump, for example, is around 45°C. Such temperatures are ideal for heat generation with the heat distributed through surface heating, but not for heating hot potable water to a high temperature. To reach the 60/55 °C required, hot-water tanks are often reheated in an expensive process using power from fossil fuels by way of an electric heating cartridge. Ecologically and economically, this makes little sense.

The conflict between improved energy efficiency and meeting the protection objective of "maintaining potable water quality" cannot be resolved through the conventional approach. According to Section 9.1 of DIN 1988-200, alternative technical measures can be taken to guarantee the hygiene of potable water.

The latest research results and pilot studies (state-of-the-art in science and technology) suggest that a gradual reduction of the supply temperature of hot potable water to 48/45 °C, for example, can be achieved if the relevant framework conditions are met.
This calls for

- hygiene-conscious planning of the potable-water installation with safe flow balancing,
- guaranteed operation as intended and
- an additional reduction of the total cell count in accordance with the circular chain of cause and effect pertaining to potable-water quality by means of ultrafiltration in the circulation bypass.

In this way, the possible growth potential for legionella and other pathogens can be sustainably minimised beyond the temperature limits. The aim is neither operating temperatures nor energy efficiency, but that of achieving the required potable water quality.
The German Environment Agency (UBA) has already described the energy-efficient optimisation of operating temperatures in hot water without any compromise on potable water hygiene. Ultrafiltration technology (UFC) in combination with potable water heating zoned in case of need can play a key role here.

This is discussed in greater depth in the “Potable-water heating and design” section.

Piping for hot potable water and circulation pipes must be insulated in accordance with the German Buildings Energy Act (GEG). The GEG has replaced the Energy Conservation Act (EnEG), the Energy Saving Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmeG). The GEG limits the amount of heat lost through hot piping and fittings in buildings. § 69 regulates insulation measures during initial installation and the replacement of heat distribution piping, hot-water pipes and fittings in buildings. It also assigns responsibility for retrofitting existing buildings[1]:

- § 69 Heat distribution and hot-water pipes and fittings
  (1) If heat distribution pipes, hot-water pipes and fittings are installed for the first time or replaced in a building, the principal or owner must ensure that the heat dissipation of the piping and fittings is to be limited in accordance with Annex 8.[2]
- § 69 Insulation of heat distribution and hot-water pipes
  (2) Regarding heating systems, the building owner must ensure that, for previously uninsulated, accessible heat distribution and hot-water pipes not located in heated spaces, the heat dissipation of the piping is to be limited in accordance with Annex 8.[3]

The minimum thickness of the insulating layer is the same in both cases and is specified in Annex 8 (Requirements for the heat insulation of piping and fittings), Clause 1, Item a, of the GEG. The requirements listed from aa to hh are summarised in the following table:

[1] Buildings Energy Act – GEG
[2] Buildings Energy Act – GEG
[3] Buildings Energy Act – GEG

Line	Type of pipelines/fittings	Minimum thickness of the insulating layer based on a thermal conductivity of 0.035 W/(m·K)
1	Internal diameter up to 22 mm	20 mm
2	Internal diameter over 22 mm up to 35 mm	30 mm
3	Internal diameter over 35 mm up to 100 mm	Same internal diameter
4	Inner diameter over 100 mm	100 mm
5	Pipes and fittings as in rows 1–4 in wall and floor breakthroughs, at intersections, at pipe connection points and for central manifolds	50 % of the requirements of the lines 1-4
6	Heat distribution lines according to lines 1–4 installed after 31January 2002 in building sections between heated rooms of different users	50 % of the requirements of the lines 1-4
7	Pipes in acc. with line 6 in the floor construction	6 mm
8	Lines adjacent to outside air	Double the requirements from rows 1–4

Tab. 25: Heat insulation of heat distribution and hot-water pipes and fittings[1]

Exceptions to this table are regulated in Annex 8, Clause 1, Items b and c.
b: “In cases as per § 69, Clause 1, Item a shall not apply where heat distribution pipes in accordance with Item a, Subitems aa to dd, are located in a user’s heated rooms or in components between heated rooms and their heat emission can be influenced by exposed shut-off systems.”
c: “In cases as per § 69, Item a shall not apply to hot water pipes up to a water volume of 3 litres that are neither included in the circulation circuit nor equipped with electrical trace heating (single supply lines) and are located in heated rooms.”

Consequently, hot-water pipes in pre-wall installations that are not integrated into the circulation, as described above, require no insulation in under the GEG. This is advantageous from a hygiene perspective because, after being used, this piping will cool down quickly and is able to adapt to the ambient temperature, usually 20 °C. As a result, it passes the critical range between 20 °C and 55 °C, in which legionella propagate, as rapidly as possible. In addition, because in this case heat is admitted into the pre-wall during use only temporarily, the pipeline for potable water cold likewise located in the pre-wall is protected against inadmissible external heating.

[1] Buildings Energy Act – GEG

DVGW W 551

DVGW Worksheet W551, entitled “Potable-water heating and distribution systems; Technical measures for reducing legionella growth [...]”, from 2004 addresses the planning, construction, operation and refurbishment of potable-water installations. The worksheet aims to describe the technical measures and other safeguards required to prevent health risks posed by legionella in potable-water installations. The worksheet sets out the requirements for planning and construction, operation, maintenance, refurbishment following contamination, as well as the process of hygiene and microbiological examinations and evaluations. Essentially, a distinction is drawn between the small and large systems for which different requirements apply. The distinctions between small and large systems are explained in Tab. 26.

The 3-litre rule should be considered an upper limit in non-circulating potable water. Smaller volumes are preferrable. Regardless of the system, it must be ensured that a temperature of 60 °C can be set at the outlet of the potable-water heating system and, if circulation is present, that the maximum temperature drop does not exceed 5 kelvins.

For the operation of large-scale systems, there is a legal requirement to permanently maintain a temperature of at least 60 °C at the potable-water heater’s outlet. However, short-term drops in the minute range are to be tolerated, as legionella will not have a sufficiently long time window for reproduction.

For small systems, a temperature of 60 °C is recommended and a minimum temperature of 50 °C at the potable-water heater’s outlet is required. In this case, however, the operator must be made aware of the increased risk to health. This is another example of technical regulations not necessarily reflecting the generally recognised rules of engineering, as recent research has shown that a temperature of < 55 °C reliably increases the risk of legionella propagation. This means the statement that temperatures of below 55 °C are to be tolerated in small systems is inconsistent with the protection objective as stated in § 1 of the Potable-Water Ordinance, as human health can no longer be shown to be protected from negative effects in those cases.

For further information on operational, procedural and structural measures in case of contamination, as well as on the process of hygiene and microbiological examinations and evaluations, see DVGW Worksheets W 551 and W 556.

The basic distinction is made in large and small installations, although these expressions are also defined in the Potable Water Ordinance.

	Small system	Large system
Definition (DVGW 551)	Systems with storage potable water heaters or central through-flow potable water heaters ■ installed in single or two-family homes, irrespective of the system volume (potable water heater, piping) ■ with a potable water heater with a volume of ≤ 400 l and ≤ 3 l in each pipeline between the outlet at the potable water heater and the draw-off point. Volumes in any circulation pipes are not taken into consideration.	All systems with storage potable water heaters or central through-flow potable water heaters, e.g. systems ■ installed in apartment buildings, hotels, homes for the elderly, hospitals, spas, sports facilities, industrial premises, camping sites, swimming baths. ■ with a potable water heater with a volume of > 400 l and/or > 3 l in each pipeline between the outlet at the potable water heater and the draw-off point.
Outlet temperature PWH at the potable water heater (1988-200) (DVGW 551) (VDI 2072 draft)	Besides the recommendation for small systems specifying a general value of 60 °C, a temperature of 50 °C may also be applied if it is ensured that the water will be exchanged within 3 days. For potable-water heaters, an outlet temperature of at least 50 °C is recommended.	Large-scale systems must be designed to provide at least 60 °C at the potable-water heater's outlet. A temperature reduction is generally possible if the alternative method has demonstrated its efficiency through microbiological investigations.
Circulation system (DVGW 551) (VDI 2072 draft)	Circulation systems should be installed in small systems and decentralised systems with pipeline volumes > 3 l between the potable water heater outlet and the draw-off point. They must be operated at a minimum of 60 °C with a maximum cooling of 5 K until the water re-enters the reservoir.	Circulation systems should generally be installed in large systems. They must be operated at a minimum of 60 °C with a maximum cooling of 5 K until the water re-enters the reservoir.
Requirements of the Potable-Water Ordinance		For large systems, there is a mandatory requirement to test the potable water in domestic installations for legionella every three years and in public buildings every year

Tab. 26: Summary of the key criteria for the differentiation and operation of systems for potable water heating

Construction, operation and maintenance

Storage and assembly

All components of a potable-water installation must be delivered to the construction site in a perfectly hygienic condition. Nowadays, dry leakage tests that aim to exclude the possibility of the products having been exposed to microbial risk are preferred in the manufacturing process. Residual water in a fitting that has been tested for leaks using water may actually give rise to the propagation of microorganisms, especially during long storage periods in summer. Pipes, moulded pieces and fittings must always be stored in such a way that the ingress of dirt and wastewater can be ruled out with certainty. Otherwise there is a major risk of components becoming contaminated during the construction phase (which often extends over a long period) before commissioning has even taken place.

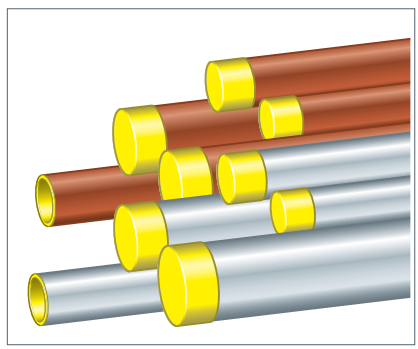


Fig. 77: Pipe plugs as hygiene protection

Viega pipes are generally supplied sealed with plugs, and therefore hygienic transport conditions may be assumed. Protective plugs should also be used for sealing riser pipes during assembly, because ingress of dry cement dust or similar debris must be expected, especially in shafts. Although the ingress of such materials is generally considered non-critical from a microbiological perspective, a lot of flushing may be required to clear complex piping networks prior to operation.

In contrast, repair and extension work may present a much more serious hygienic risk. A qualified installer will be aware of the need to wash their hands thoroughly after working with soiled material (such as a drainage system) and using the bathroom before continuing work on the potable-water installation. The risks for potable-water quality and therefore for the protection objective of preserving health need to be evaluated quite differently for work on existing buildings or during operational interruptions than with work on new installations. This should also guide the interpretation of the requirements applicable to localised repairs (DIN EN 806-4, Item 6.3.5) regarding the disinfection of components to be installed in existing pipework.

For example, press connectors must be removed from their original packaging just before being used to avoid the need for disinfection.

Caps on equipment such as potable-water heating systems etc. should only be removed immediately before installation. This eliminates any chance of contamination by small animals that might live or build nests in these devices in the period before installation. If a potable-water installation is contaminated by the carcasses of small animals, it can become polluted by salmonella, E. coli or enterococcus to such an extent that a complete refurbishment is required to solve the problem.

Leakage test, dry

To maintain potable-water hygiene as well as for corrosion and frost protection, the potable-water installations should only be filled immediately before the start of normal operation. Water left inside a full or partially full system for prolonged periods has negative implications and must therefore be avoided. For this reason, a leakage test using water in accordance with the requirements of DIN 1988-200 should be performed only in certain cases, e.g. if the test is carried out immediately before commissioning. It should be noted that once a potable-water installation has been filled with potable water, it usually cannot be completely emptied again, which would entail risks for potable-water hygiene. This makes the dry leakage test essential to eliminating risks for potable water hygiene. Human health, and therefore the quality of potable water, must always be prioritised as a protection objective over the prevention of material damage. Planners who select the materials for a project are also instrumental in meeting this objective. They must carry out an assessment of the materials from the perspective of chemical processes leading to corrosion for the potable-water installation in advance. DIN EN 12502, which concerns corrosion protection, must be taken into consideration. It, too, specifies a dry pressure test.

According to DIN EN 806-4, dry leakage tests and a subsequent wet load test are to be carried out. A wet leakage or load test must take place immediately before commencing operation as intended, meaning a complete exchange of water is required every 3 days (in accordance with VDI 6023, Sheet 1) or 7 days at the latest (in accordance with DIN EN 806). As it is virtually impossible to do this in practice for all sections, leakage tests using dry, oil-free compressed air or inert gases are recommended. These should then be followed by load tests which are suitable and approved as an alternative to a wet load test. The requirements in the relevant data sheets, e.g. those issued by ZVSHK or BTGA Technical Rule 5.001, must be observed. These data sheets also contain specific instructions for alternative load tests.

During the wet load test, the test pressure must be 1.1 times the maximum operating pressure, as per DIN EN 806-4. The test time for metal pipes is 10 minutes after the temperature has equalised. For plastics, the established initial and main tests are performed.

Generally speaking, a dry load test is permissible for all Viega installation systems. In larger construction projects, potable-water installation are often installed in stages and sometimes even divided into several lots. The dry leakage test is standard for such projects. This is carried out using compressed air or inert gas at 150 mbar of pressure. Once test pressure has been reached, the test duration must be at least 120 min for a pipeline volume of up to 100 l. For larger systems, the test duration increases by 20 min for each additional step of 100 l. The subsequent dry load test must be carried out for 10 min at a maximum operating pressure of 3 bars for nominal diameters of up to DN50 and 1 bar for nominals diameters > DN50. Crucially, the load test must be accompanied by a visual inspection of all connections for leak tightness.[1]

However, as visual inspections are not always possible in practice and will often be uneconomical, separate regulations exist for connection systems that are considered leaking in an unpressed condition. This is the case for press connectors with SC-Contur from Viega. They have been tested by both DVGW and the Institute for Damage Prevention and Loss Research of Public Insurers. The SC-Contur feature ensures tell-tale leakage from the press connector across the entire pressure range from 22 mbar to 3 bar (dry) and 1 bar to 6.5 bar (wet), regardless of the sealing element, should one be required for sealing the press connector. In addition, a cylindrical pipe guide protects the sealing elements in the press connectors of the Viega metal piping systems. During assembly, the pipe guide ensures straight insertion of the pipe into the connector and prevents damage to the sealing element. This means that unpressed connections will show up during leakage and load testing.

Threaded connections and screw fittings must be checked manually beforehand. An analysis has shown that these connections cannot be reliably tested centrally, whether by means of a dry or wet leakage test at low or high pressures.

The initial filling of a potable-water installation must always be with potable water, irrespective of the type of leakage test employed. Failure to observe this often results in long-term microbiological contamination. Records and documentation on the commissioning procedure are therefore very important. Sampling of the fill-up water is highly recommended (cf. DIN 1988-200).

[1] Dichtheitsprüfungen von Trinkwasser-Installationen mit Druckluft, Inertgas oder Wasser, Merkblatt, Zentralverband Sanitär Heizung Klima, Januar 2011.

Commissioning

The foundations for commissioning are laid with the successfully completed and documented initial hygiene inspection and the dry leakage test performed in advance. A step often overlooked, however, is the handing over of the documents required for operation as intended. This is because the building's operator is usually not involved in its construction and, as a consequence, might not be aware of all the planning specifications. Since the operator of a potable-water installation must hold available the asset ledger for operation as intended, the following documents must be handed over at commissioning as per VDI 3810-2/6023-3:

General information

- **Project data**
  The project data communicate the general specifications of the building. They detail general usage as well as any structural specifics.
- **Technical data of the potable-water installation**
  These are more specific data on the potable-water installation, including the type of energy supply or the potable-water heating system used.

Planning documents

- **Room books**
  With regards to potable-water hygiene, the entrepreneur or owner (operator) is responsible for complying with the parameters of the Potable-Water Ordinance. In order to fulfil these obligations, it is essential to maintain the correct temperatures in the pipe network, to adapt the dimensions based on demand and to operate all draw-off points according to their intended use. However, these latter properties are usually not within the operator's control, as the dimensioning is carried out by an expert planner in the planning phase and the operator is not always solely responsible for operation as intended. To deal with these aspects, a room data sheet and the associated utilisation concept for the building are indispensable and required by VDI 6023 Sheet 1 or DIN 1988-200 and thus VOB/B.

- **Calculations (cf. Section 3.5.1 of DIN 18381)**
  These documents provide the subsequent operator with the pipeline network calculation. This makes it possible to check, during operation, whether structural additions can still be integrated into the system hydraulically or whether more extensive construction measures have to be factored in. The target values for circulation regulation valves (Cv values and target temperatures) are also often overlooked. Regardless of the function, Section 3.5.1 of DIN 18381 requires that the hydraulic balancing is carried out using the computed target values. Following commissioning, it is necessary to check whether the determined temperatures actually occur at the circulation valves. DIN 18381 is relevant because it is part of VOB Part C and hence part of most service contracts.
- **Plans of the piping networks**
  The pipeline plans – the diagrams of the runs and the floor plans in particular – are indispensable to the operation of a potable-water installation. Only these plans show which pipes are intended to be laid where and at which points along the potable-water installation regular maintenance measures are required. This final aspect especially plays a key role since it is not always obvious from the finished system where maintenance activities are required. During commissioning, it is also necessary to check whether these points are accessible and whether the requisite revision openings have been installed (fittings and devices).

Commissioning documents

- **Record for initial hygiene inspection**
  In this record, several aspects that should have been addressed by this execution date are set out and the completeness of these is checked. The basis for the initial hygiene inspection is contained in Section 6.9.2 of VDI/DVGW 6023. This includes checking the documents for completeness, checking the system for compliance with the requirements in the room data sheet and checking the connections to non-potable water systems and the correct separation between the two.
- **Pressure test records**
  The commissioning procedure also includes handing over the pressure test records which, ideally, show a test carried out using dry, oil-free compressed air or inert gases.
- **Analysis report for initial sampling**
  The construction of a system involves mandatory initial sampling and the analysis results obtained belong in the documents that are handed over during the commissioning procedure.

- **Records for handover and instructions**
  Approval of a potable-water installation includes the transfer of risk, which should be documented as it is the time when the obligation to ensure system operation as intended passes from the specialist tradesman to the system operator. Moreover, on completion of their work, the specialist tradesman should provide their signature to assure that they have instructed the entrepreneur's employees and the owners in the hygienic procedures for the potable-water installation. Training in accordance with VDI/DVGW 6023 Cat. C is suitable for this purpose.

Manufacturer's documentation

- **Instructions for use**
  As the basis for future maintenance documentation, the relevant instructions for use must also be provided when the potable-water installation is handed over.
- **Maintenance instructions**
  In their documentation, manufacturers often provide important information on preventive measures to prevent damage to the potable-water installation.
- **Maintenance instructions**
  If these documents are provided by the product manufacturers, they should be handed over as well since they help the contractor and other owners to establish a maintenance plan.

Logbook

- **Maintenance documents**
  The manufacturer's documentation on maintenance, supplemented by the documents on maintenance procedures additionally prepared by the operator, makes up an essential part of the logbook. By collating this documentation, the operator will be able to prove at any given time that they are fulfilling their obligations regarding routine maintenance. Ideally, they include standard work instructions for every component that is relevant to maintenance. All fittings and devices with a regulating function perform a functionality that should be checked at regular intervals. The hygiene plan is an extension of the maintenance plan that adds potable-water checks for predefined parameters and provides documentation that all measures have been performed. It can be a sub-section according to the Protection Against Infection Act (IfSG) or a hygiene regulation.
- **Description of malfunction and energy management**
  Although not essentially part of the planner's remit either, this procedure does ensure that malfunction and energy management is addressed at an early stage rather than leading to expensive retrofits afterwards.

- **Operating instructions**
  The provision of operating instructions is not the sole responsibility of the planner. Indeed, the preparation of such documentation calls for cooperation with the future operator. The more complex the system is planned, the more extensive the operation afterwards. Simple piping layouts and manageable systems help significantly reduce the number of components required and, in turn, the personnel requirement. Nonetheless, the planner is able to achieve a cost-efficient operation, as required by DIN 1988 and DIN 18381, through simple, well-arranged installations. Low-maintenance installations can ultimately avoid high maintenance and monitoring costs.

Intended operation

Microbiologically impeccable potable-water quality at the draw-off points can be guaranteed in potable-water installations that are planned, built, commissioned, operated and maintained in accordance with the generally recognised rules of engineering. The hygienically safe operation of the potable-water installation, defined as “operation as intended” in accordance with the generally recognised rules of engineering, is crucial in providing adequate potable-water quality. According to DIN 1988-200, Section B 1 and VDI 6023 Sheet 1, this means “operation of the potable-water installation across all draw-off points with regular checks for proper function as well as the implementation of the requisite maintenance measures to provide an operationally safe state in compliance with the operating conditions used as a basis for planning and erection (manual or automated flushing)”. From a hygiene perspective, manual and automated removal of potable water at draw-off points are the same.

Regular maintenance is a prerequisite for the proper operation of a potable-water installation. This is considered to be the case if:

- the potable-water installation is operated as specified in the planning,
- stagnation in the entire potable-water installation is avoided (including regular extraction of water),
- the temperature requirements for hot and cold potable water are adhered to and
- the measures for the protection of potable water in accordance with DIN EN 806-5, DIN EN 1717 and DIN 1988-100, as well as the maintenance intervals – the service intervals in particular – are implemented.

During operation, an inadequate water exchange in potable-water pipelines that are unused or used insufficiently must strictly be ruled from the outset. Otherwise, there will be an increased risk of microbiological contamination. The design objective must be to ensure that a complete exchange of water takes place at every point of the potable-water installation over a period of 72 hours, i.e. over three days at the latest. Anything else will be considered an interruption of operation. If necessary, usage interruptions such as a vacated building, seasonal operation or school holidays must be compensated for by suitable measures at the extraction fittings. Special circumstances applying to the specific use or execution of the building (e.g. food processing plants, hospitals, care homes for the elderly, increased external heating effects on cold potable water) may necessitate reduced intervals for water exchange (≤ 24 h).

If the water remains in the potable-water installation for longer, water quality can be impaired by the propagation of microorganisms and by dissolving materials and media. The degree of impairment depends on the quality of the water supply, the materials used in the potable-water installation, operating conditions, potable-water temperature and the potable water's stagnation time. The measures to be implemented in case of unavoidable operational interruptions are described in Tab. 33.

Duration of the operational interruption	Measures at the start of the interruption	Measures at return (end of interruption)
≥ 4 hours to 3 days	None	Allow stagnant water to drain until the temperature is constant
> 72 hours to a maximum of 7 days	Operational interruption	
	Closing the shut-off system	Opening the shut-off system, allowing water to flow for at least 5 minutes at several draw-off points simultaneously
	In rarely used parts of the system, e.g. guest rooms, garage or basement connections, refreshing the water in the single supply line by extraction from fully opened draw-off points at least once per week	
Up to a maximum of 4 weeks	Closing the shut-off system	At recommissioning, full water exchange at all draw-off points by flushing with water in accordance with DVGW W 551-3 (A)
> 4 weeks to a maximum of 6 months	On closing, leave the shut-off systems filled (unless there is a risk of frost)	On recommissioning, flushing in accordance with DVGW W 551-3 (A), performing microbiological inspections of hot and cold potable water as per the Potable-Water Ordinance and inspections of hot and cold potable water for legionella
> 6 months	Have the connection line separated from the supply line by a water supply company or a trade professional	Notification of WVU, recommissioning in accordance with DIN EN 806-4 by a registered installation company – on recommissioning, flushing in accordance with DVGW W 551-3 (A), performing microbiological inspections of hot and cold potable water as per the Potable-Water Ordinance and inspections of hot and cold potable water for legionella

Tab. 27: Measures to be implemented during operational interruptions in accordance with VDI 3810 Sheet 2/VDI 6023 Sheet 3

If, for example, there is a change in the
- number of draw-off points,
- extraction frequency,
- simultaneity of use or
- peak volume flows,

the corresponding parts of the asset ledger (e.g. room data sheets, line diagrams, inventory documentation, maintenance plan) must be updated. If operating conditions or usage change, structural, organisational or operational measures must be taken to adapt the existing potable-water installation to the new operating conditions.

The proper operation of a potable-water installation requires
- demand-based planning in accordance with the specifications of the room data sheets,
- execution, approval and handover in accordance with applicable standards and directives,
- a documented instruction of the operator,
- sufficiently trained personnel (hygiene training, e.g. in accordance with VDI-MT 6023 Sheet 4 or ZVSHK “specialist for potable-water hygiene”)[1],
- availability of the relevant planning and operational documentation (asset ledger),
- a clear assignment of responsibilities (for the owner and/or operator).

[1] VDI 3810 Teil 2 / VDI 6023 Teil 3, Betreiben und Instandhalten von Gebäuden und gebäudetechnischen Anlagen – Trinkwasser-Installationen / Hygiene in Trinkwasser-Installationen – Betrieb und Instandhaltung, Beuth Verlag, Berlin, 05/2020.

All relevant planning documents, operating parameters and tests over the life cycle of the potable-water installation are fully documented in the asset ledger. As part of the asset ledger, the logbook is the place where all relevant documents concerning work on the potable-water installation, including analysis results of potable-water examinations and maintenance measures, are filed. The logbook is based on the maintenance or hygiene plan (see “Commissioning” chapter on page 122).

Draw-off points that are rarely used due to their position or use have a further negative impact. Whether or not such draw-off points are actually required must be verified as early as the planning stage, since the probability of contamination increases with every draw-off point. If a draw-off point is deemed necessary, measures should be set out in the hygiene plan or flushing schedule in order to prevent unwanted stagnation. In the case of a sink basin in the basement area, for example, the simplest way is regular manual flushing of the draw-off point. The question of how realistic it is for such a draw-off point to be properly flushed in actual operation should be considered.

Another way of safeguarding such draw-off points up to the wall plate is to integrate them into a service area bordering a series or ring system. If water is tapped in the other service areas because they are highly frequented, the pipeline volume ahead of the wall plate of the rarely used draw-off point concerned has to be exchanged. Ring systems for cold potable water are recommended for installations that are frequently used by several users concurrently. A ring system installation has a greater pressure reserve than a series installation of the same nominal diameter, for example. Moreover, the problem of stagnation zones between two draw-off points does not necessarily exist, since the draw-off points tend to be used at the same time rather than individually.

Pipes in series are the ideal solution for service units or installations in which draw-off points tend to be used sequentially rather than at the same time. On the one hand, the piping has to have larger dimensions than for a ring system installation, due to possible simultaneous use of the draw-off points, but the length of the piping carrying water and hence the volume at risk of stagnation is reduced.

Maintenance

The term 'maintenance' essentially refers to all technical and administrative activities that serve to maintain or restore the functional state and hence the required function of the component. This includes activities by the management, which must generally plan and coordinate work to ensure that all components of an installation are checked on a regular basis. The concept of maintenance[1] is generally divided into four areas:

1. MaintenanceMaintenance is a preventive activity which is designed to prevent damage before it occurs As such, it is carried out at regular intervals before functional impairments occur. From a hygienic point of view, a hygienically adequate target condition is maintained.
2. **InspectionDuring**the inspection, the component is examined for its essential characteristics through measurement, observation and function tests. The aim of the inspection is to check the component's essential function and establish whether repairs are needed or not. The actual hygienic condition is determined and assessed.
3. RepairsRepairs involve restoring the function of a defective component so that it can do its original job once again. As a result, the hygienically flawless target condition is restored.
4. ImprovementThe purpose of an improvement is to increase the reliability, maintainability or safety of a system and, in turn, to increase the value of an system. This increases the safety of a hygienically adequate potable-water installation.

The general aim of maintenance is to preserve or even improve the condition of a system, in this case the potable-water installation. All measures have one thing in common – active components and those with a control function in particular have to be included in the regular maintenance routines. These are most critical components to a potable-water installation, because any moving part may malfunction due to wear or dirt or limescale buildup.

As part of their legal duty to maintain safety, the entrepreneur or owner of a potable-water installation is obliged to provide the users of their installation with potable water of adequate quality. To ensure this on an ongoing basis, the potable-water installation must be maintained with a particular focus on accessibility. It is not without good reason that VDI 6023-3 / 3810-2 stipulates that accessibility to maintenance measures has to be considered as early as the layout planning phase. Even if manufacturers advertise their components as maintenance-free, it is always a good idea to question if they contain parts that could be affected by a malfunction. Contrary to the manufacturer's specifications, it might be necessary to maintain the components on a regular basis and to include ways to access them or enough clearance around them during the planning phase.

The operator of a potable-water installation is responsible for its maintenance, which is why they should have an interest in checking whether measures are necessary. They are also responsible for making improvements to

[1] DIN 31051 Basics of maintenance

the existing system to eliminate vulnerabilities that are known or have been discovered. This includes, for example, the hydraulic balancing of circulation pipes in order to restore compliance with the temperatures specified in DVGW Worksheet W 551.

Another aspect of maintenance that receives too little attention is that of inspection. Contrary to the widespread belief that an inspection involves nothing more than a visual examination of the component for damage or changes, it also includes checking the component for proper function. Here especially, not only is accessibility to the product a key factor, the inspection options also play a crucial role. In addition to the manual control of thermostatic circulation valves, an electronic circulation valve can also carry out function checks independently as well as measure the temperature. If these issues, among others, are taken into account during the planning of a potable-water installation, maintenance work will be much easier during subsequent operation (precautionary principle).

Potable water in first aid facilities

First aid facilities are technical aids that are used for rescue operations to prevent risk to the life and health of individuals. The designation originates from the German law on workplace safety and in also used in the autonomous law applied by the the accident insurers.

Emergency showers are a first aid facility and used primarily in laboratories and production operations.

Although unable to prevent an accident, emergency showers have to function in case of emergency if eyes, hands or the entire body are exposed to aggressive or harmful substances. A distinction is drawn between body showers, eyewashes and emergency face showers.

Legal and normative principles
In occupational safety law, in the Ordinance on Hazardous Substances, in the German workplace ordinance, in accident prevention regulations and in laboratory directives, emergency showers are indicated as an essential first aid facility. A hazard assessment can be used to establish whether an emergency shower is required and if so, where. The internet portal of the Federal Agency for Industrial Health and Safety (BAuA) is available for this purpose.

The Potable Water Ordinance (TrinkwV) should be taken into consideration for the selection and installation of emergency showers and eyewashes. It serves as the German implementation of the EU Drinking Water Directive 2020/2184, which is implemented in all EU countries.

For example, emergency and eye showers must be labelled with statutory signs in accordance with the Workplace Ordinance in Germany. The technical rule for workplaces ASR A1.3 specifies the requirements of the ordinance.

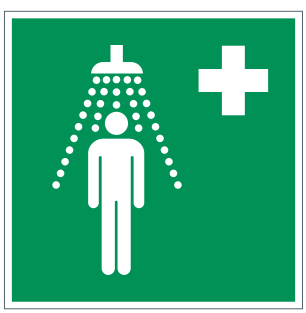


Fig. 78: E012 Emergency shower

Fig. 79: E011 Eyewash

The technical requirements for emergency showers and eyewashes are described in the following standards:

In Germany:
DIN EN 15154-1
Emergency safety showers – body showers with water connection for laboratories
DIN EN 15154-2
Emergency safety showers – eyewashes with water connection
DIN EN 15154-3
Emergency safety showers – body showers without water connection
DIN EN 15154-4
Emergency safety showers – eyewashes without water connection
DIN EN 15154-5
Overhead body showers with water for locations other than laboratories

In the USA:
ANSI Z358.1: Emergency Eyewash and Shower Standard

DIN EN and ANSI are often consulted in other parts of the world. An eyewash supplied with potable water must be installed in laboratories.

Planning information

General information

An emergency shower must be freely accessible. It should be erected no more than 15 m from the source of danger and be reachable within 10 s, in laboratories even within 5 s. In the case of highly hazardous substances, the emergency shower should be positioned at the source of danger directly and the water collected in a pan.

Normative specifications for operating parameters

EN 15154 describes the specified volumetric flows and/or water temperatures for body showers and eyewashes with a permanent water connection.

Body showers with water connection for locations other than laboratories:

Standard	DIN EN 15154-5	ANSI Z358.1
Body shower [l/min]	Class I: 30–60	75,6
	Class II: > 60–100	
	Class III: > 100	
Temperature [°C]	15–37 (ideally 20–25)	16–38

Tab. 28: Operating parameters for body showers with water connection for locations other than laboratories

For body showers with water connection for laboratories, DIN EN 15154-1 recommends a volumetric flow of 60 l/min or more. According to DGUV Information Document 213-850, the minimum volumetric flow in Germany is 30 l/min.

Eyewashes with water connection

Standard	DIN EN 15154-2	ANSI Z358.1
Eyewash [l/min]	6	11,5
Temperature [°C]	15–37	16–38

Tab. 29: Operating parameters for eyewashes with water connection

The water must run for at least 15 minutes.
Observe any existing national regulations on installation and use of emergency safety showers.

Fig. 80: Combination of body shower and eyewash

Both heated and unheated versions of emergency safety showers are available. However, they can be connected to a hot water supply. The advantage here is that a person who has already been injured is protected from the additional shock of excessively cold water.

The flushing of an emergency shower can be initiated in various ways, including a step grid, foot lever, pull bar, pressure plate or an openable cover on an eyewash.

Minimum pipe cross-sections are specified for the supply lines to emergency showers:

Emergency shower	Minimum pipe cross-section
Body showers	28 mm/1 inch
Eyewashes	15 mm/½ inch
Combined eyewash and body shower	35 mm/1 ¼ inch

Tab. 30: Minimum pipe cross-sections for supply lines for emergency showers

Commissioning, operation and maintenance
Emergency showers with DVGW approval can be connected directly to the potable water network.

Flush all piping thoroughly before commissioning emergency showers and eyewashes. Check all pipelines and any electrical loads and external sensors.

Briefing vulnerable people is extremely important. The emergency shower's location and mode of operation must be communicated to the employees in such a way that, even in an emergency with impaired vision, they are able to reach and operate the emergency shower.

Check emergency showers for functional safety on a regular basis. The precise intervals are indicated by the emergency shower manufacturers. According to DGUV Information Document 213-850, emergency showers in laboratories, for instance, have to be maintained at regular intervals (usually at least once per month). Adequate water exchange in the supply line can be provided by a suitable piping installation with a series or ring arrangement by actuating the emergency shower or other appropriate flushing devices (e.g. Viega universal flush valve). In the single supply line from the supply to the draw-off point, the water exchange must be carried out by actuating the emergency shower. If this is done manually, it may need to be organised and documented by means of a formalised flushing plan.

Automatic flush valves allow flushing at the times best suited to the working conditions and patterns. This reduces the danger that stagnant water ahead of the draw-off point can present. Thoroughly clean eyewash atomisers and shower nozzles every six months. Use a water baffle and a bucket to make a visual inspection for signs of corrosion.

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

For use of Viega products for potable water in first-aid facilities, refer to the planning information for potable-water installations.

Emergency showers and eyewashes can be connected to the potable water network using the following Viega piping systems:
- Sanpress
- Sanpress LF
- Sanpress Inox
- Sanpress Inox LF
- Profipress
- Raxofix

When potable water is used in first aid facilities, usage interruptions can usually be expected. To guarantee the required level of hygiene, Viega offers the universal PWH/PWC flushing valve for example. You can find further information in chapter „Products“ on page 278.

Process water

Industrial systems and product manufacturing equipment call for water that meets increased quality standards and has specific properties. This process water is free of any constituents that may cause damage to systems and products. Suitable treatment methods are applied to achieve the required process water quality, depending on the raw water available.

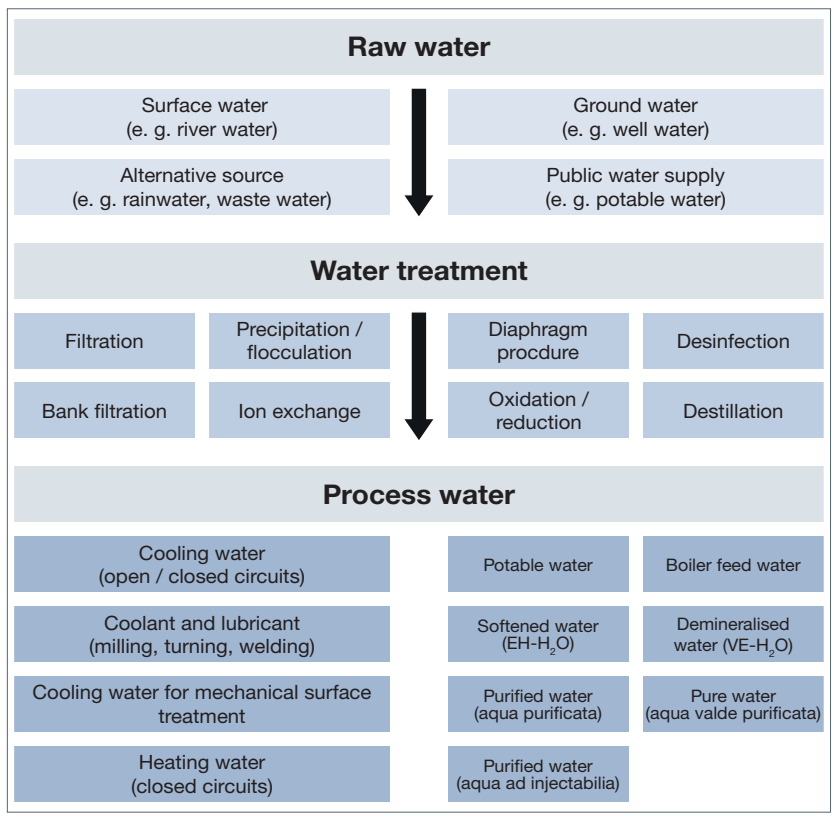


Fig. 81: Industrial process water supply

The treatment of the available raw water involves processes to remove constituents from the water (e.g. cleaning, sterilisation, deferrisation, softening and desalination). The treatment also includes setting parameters such as pH value, electrical conductivity and corrosion properties.
The industrial water treatment process does not refer to the potable water treatment carried out by the water supply companies, where the Potable Water Ordinance (TrinkwV), for example, plays a crucial role.

Water treatment

Raw water

A very high proportion of process water is obtained from raw water.
In the chemical industry, approx. 80% of the total water requirement is taken from rivers and used to cool systems. The remaining 20% is obtained from potable water and used in production, for instance.
Raw water includes ground water, rainwater and surface water (e.g. river water). It contains dissolved salts, bacteria, pathogens and pollutants and must therefore be treated before further use.

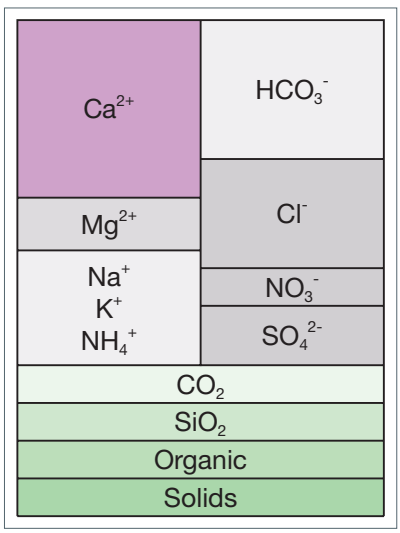


Fig. 82: Constituents dissolved in raw water

Cations
- Calcium [Ca^{2+}]
- Magnesium [Mg^{2+}]
- Sodium [Na^+]
- Potassium [K^+]
- Ammonium [NH_4^+]

Anions
- Hydrogen carbonate [HCO_3^-]
- Chloride [Cl^-]
- Nitrate [NO_3^-]
- Sulphate [SO42-]

Gases/solids
- Carbon dioxide [CO_2]
- Silicate [SiO_2]

Water softening

Water hardness is an important factor in many industrial processes. Alkaline earth cations as well as calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}) that dissolve in water cause damaging boiler scale deposits in piping, machines and devices. Low water hardness is very important, especially for water used in cooling circuits and to supply boilers (steam boilers).

High calcium concentrations also negatively impact
- the service life of machines,
- current consumption,
- the need for cleaning agents to remove calcium residues and
- the taste of food and beverages.

High water hardness is especially problematic in
- the textile industry,
- laundries, bleaching plants, dyeing mills,
- breweries and
- spirit and liqueur production.

Water hardness is an indicator of the proportion of calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}) in the water. In simple terms, it suggests the amount of "limescale" in the water. In Germany, water hardness is expressed in dH (degree of German hardness). It has its origins in the Detergents and Cleaning Products Act. A distinction is drawn between the following hardness ranges:

Hardness range	Calcium carbonate [mmol/l]	Hardness [°dH]
Soft	< 1,5	< 8,4
Medium	1.5–2.5	8.4–14
Hard	> 2,5	> 14

Tab. 31: Hardness range according to the Detergents and Cleaning Products Act (WRMG)

The purpose of water softening is to reduce a high concentration of calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}). A detailed description on the softening of potable water can be found in “Viega Planungswissen – System solutions and services, digital – connected – innovative” in the chapter on potable-water treatment and conditioning.

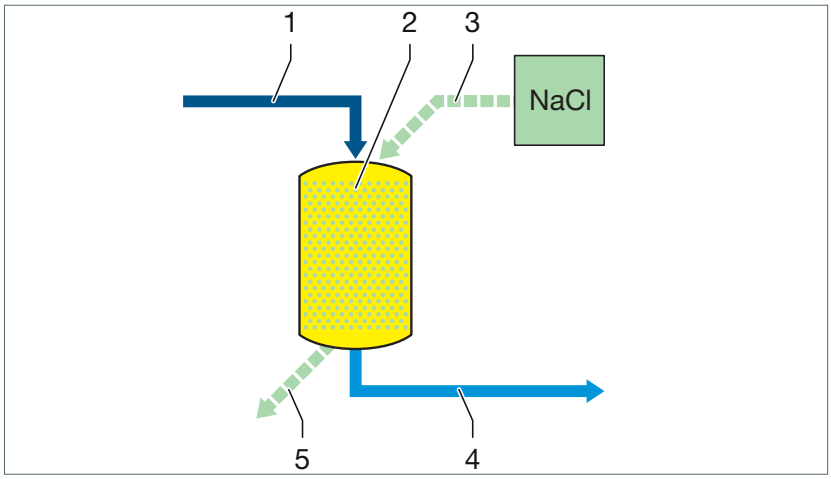


Fig. 83: Softening of raw water using cation exchange resin

1 Raw water
2 Cation exchange resin
3 Regeneration
4 Softened water
5 Wastewater

Demineralisation

Demineralised water, also referred to as deionised water or fully deionised water (demin water) is water without the salts that naturally occur in spring water and potable water. These salts, dissolved as anions and cations, determine the electrical conductivity of water, which is measured in microsiemens per centimetre (µS/cm). This value is considered an indicator of water quality. Significantly elevated conductivity is an indication of contaminated water. The more contaminated the water, the more efficiently it conducts. According to the German Potable Water Ordinance (TrinkwV, Annex 3 to Sections 7 and 14), the limit value for potable water is 2790 µS/cm at a water temperature of 25 °C and 2500 µS/cm at 20 °C.

Demineralised water can either be partially deionised or fully deionised. Partial deionisation involves removing hydrogen carbonate salts from the calcium and the magnesium. With full deionisation, all other dissolved salts are removed.

Limit values and degrees of purity for demineralised water
DIN ISO 3696 distinguishes between three degrees of water purity for analytical purposes:

Parameter	Quality 1	Quality 2	Quality 3
pH value at 25°C	Not applicable [1)]	Not applicable [1)]	5.0–7.5
Conductivity [µS/cm] at 25°C, maximum	0,1 [2)]	1,0 [2)]	5,0
Oxidisable constituents as oxygen content in mg/l, maximum	Not applicable [3)]	0,08	0,4
Extinction at 254 nm and 1 cm optical wavelength, maximum	0,001	0,01	Not specified
Residue after evaporation and drying at 110°C, in mg/kg, maximum	Not applicable [3)]	1	2
Concentration of active silica (SiO_2) in mg/l, maximum	0,01	0,02	Not specified

[1)] Given the difficulties measuring pH in ultrapure water and the questionable significance of the value obtained, no limits for the pH value of water in qualities 1 and 2 have been specified.
2) The values for the conductivity of water in qualities 1 and 2 refer to freshly prepared water. During periods of storage, impurities such as carbon dioxide from the air and alkali metal oxide that dissolves from glass receptacles can cause the electrical conductivity to change.
[3)] Limit values for oxidisable substances and for the evaporation residue are not specified for quality 1 because of the difficulty in checking compliance with a requirement for this degree of purity. The quality of this water, however, is ensured as a result of the production process if the other requirements are met.

Tab. 32: Requirements concerning water for analytical purposes in accordance with DIN ISO 3696

ASTM D1193-06 describes four types – I to IV – of analysis water, each sub-divided into Grades A, B and C

Type	I	II	III	IV
pH value at 25°C	Not applicable [1]	Not applicable [1]	Not applicable [1]	5.0–8.0
Conductivity [µS/cm] at 25°C, maximum	0,0555	1,0	0,25	5,0
TOC [2] [µg/l], at most	50	50	200	–
Resistance [MΩ*cm] at 25°C, minimum	18	1,0	4,0	0,2
HBC [3] [CFU/ml] [4], maximum	Values based on Grades A, B and C [5]			
Endotoxin [EU/ml] [6], maximum	Values based on Grades A, B and C [5]			
Sodium [µg/l], maximum	1	5	10	50
Chloride [µg/l], maximum	1	5	10	50
Silica [µg/l], maximum	3	3	500	–

1) Given the difficulties measuring pH in ultrapure water and the questionable significance of the measurement obtained, no limits for the pH value of water of types I, II and III have been specified.
2) Total organic carbon
3) Heterotrophic bacteria
4) Colony forming units
5) For details, see ASTM D1193-06
6) Endotoxin in endotoxin units per ml

Tab. 33: Extract from the requirements concerning water for analytical purposes in accordance with ASTM D1193-06

Demineralised water is used for the following industrial and scientific purposes:

- Laboratory applications and tests
- Carwashes
- Wash water for computer chip manufacture
- Boiler feed
- Laser cutting
- Fuel cell optimisation
- Pharmaceutical production

The semiconductor and pharmaceutical industries require highly pure water. Purified water (Aqua purificata) is required to manufacture pharmaceutical products that are not required to be sterile or pyrogen-free. A distinction is drawn between "purified water in bulk" and "purified water placed in containers".

Pure water (Aqua valde purificata) is required to manufacture pharmaceutical products for which water of a high biological quality is required.
Ultrapure water (WFI, Aqua ad injectabilia) is water for injection purposes which is intended for the manufacture of pharmaceutical products for parenteral application and the solvent of which is water. A distinction is drawn between "water for injection purposes in bulk" and "sterilised water for injection purposes". This water is placed in receptacles and sterilised.

Viega piping systems with press connectors cannot be used for the water intended for the manufacture of pharmaceutical products (Aqua valde purificata) or for injection purposes (Aqua ad iniectabilia).

There are various methods for producing demineralised water:

Ion exchange process
When water is demineralised by the exchange of ions, all dissolved ions are removed from the water. The water flows through a cation resin with H^+ for the exchange of all cations and through an anion resin with OH^- for the exchange of all anions. During this process, H^+ and OH^- form pure water.

Electro-deionisation
Electrodeionisation (EDI) is an electrochemical process that removes ions and ionisable substances from the water to the greatest possible extent. The process is a combination of ion exchange and electrodialysis using a semi-permeable membrane. The key component of a water treatment plant performing this process is the EDI module in which electrodeionisation takes place.

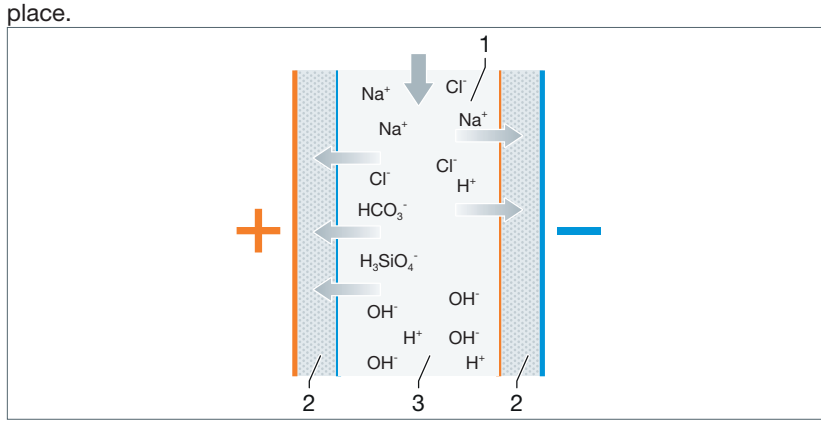
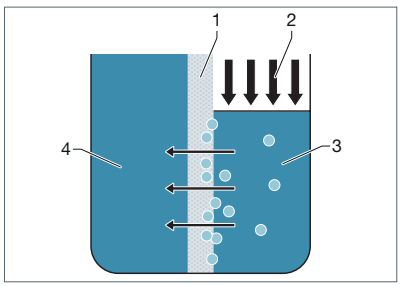


Fig. 84: Principle of electrodeionization in the mixed bed cell

1 Resin in the mixed bed
2 Concentrate
3 Diluate

Reverse osmosis

Reverse osmosis is the process by which the water to be treated is passed through a semi-permeable membrane under pressure. Because the membrane is largely impermeable to dissolved salts, the water can be demineralised to up to 99% depending on membrane, water composition and temperature.



1 Semi-permeable membrane
2 Pressure
3 Salt water
4 Ultrapure water

Fig. 85: Reverse osmosis principle

Distillation

Distilled water is obtained by distilling (evaporating and then condensing) normal potable water or from pre-cleaned water. It is largely free of salts, organic substances and microorganisms. Distilled water may, however, still contain small amounts of volatile compounds. If highly pure water is required, one-step distillation is not sufficient to achieve the desired degree of purity and clarity. Therefore, there is double distilled (bi-distilled) water (aqua bidestillata, aqua bidest for short or Bidestillatus) and triple distilled water aqua tridestillata).

Small traces of silica dissolve from glass receptacles and contaminate the water during and after the distillation process. Therefore, water that is repeatedly distilled is stored in quartz or platinum receptacles after the second process.

Use of process water

Cooling or recooling water in open and closed circuits

Cooling water can be divided into three categories:
Through-flow systems, closed cooling systems and open cooling systems.

Through-flow systems are cost-efficient and simple. After a mechanical clean, the water drawn from a river or canal is routed through a heat exchanger. The water is then returned, either with or without cooling (cooling tower), to the river or canal. As a rule, usage is limited by the maximum permissible heating of the river water to 25°C.

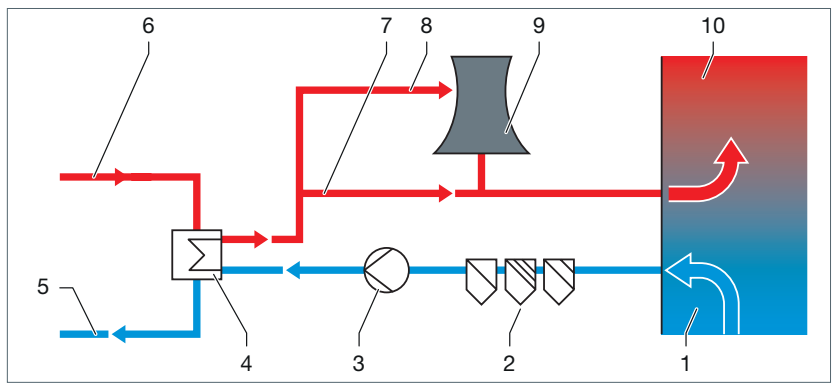


Fig. 86: Through-cooling

1 River water
2 Mechanical cleaning
3 Circulation pump
4 Heat exchanger
5 Cooled process medium
6 Process medium to be cooled
7 Heated cooling water without outlet cooling
8 Heated cooling water with outlet cooling
9 Cooling tower
10 Returned (heated) river water

Open cooling circuits with circulation cooling are commonplace. If damage in the cooling system is to be avoided, requirements concerning water quality, construction and the materials used must be met. Treating water reduces the risk of calcification, deposits, corrosion, fouling and biological growth. Water losses caused by vaporisation must be compensated by adding mechanically or chemically treated make-up water.

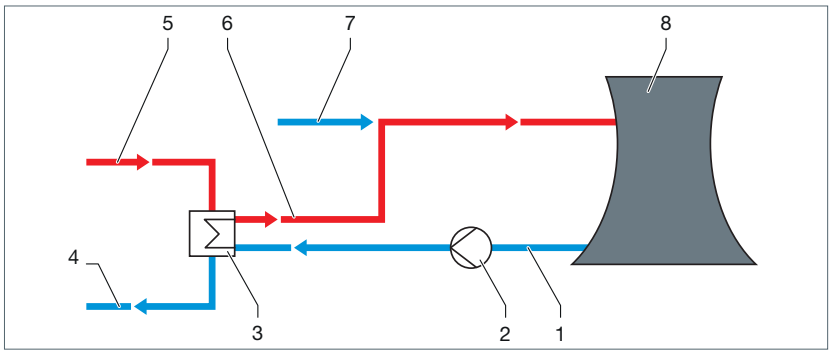


Fig. 87: Open cooling circuit with circulation cooling

1 Cooling water
2 Circulation pump
3 Heat exchanger
4 Cooled process medium
5 Process medium to be cooled
6 Heated cooling water
7 Make-up water feed
8 Cooling tower

Requirements for the quality of water in open cooling circuits
The problem of corrosion and deposits can be resolved by having water treated in a professional manner. The requirements for water quality are partly dictated by the materials used. The following parameters are important:

- Total hardness (sum total of calcium and magnesium salts)
- Carbon hardness
- Total salt content and conductivity
- Chloride concentration
- Sulphate content
- Iron and manganese content

The iron and manganese content is significant particularly if no potable water is available. A detailed chemical raw water analysis must essentially be conducted for the dimensioning of the water treatment process. The concentrations of matter dissolved in water in a cooling system change constantly due to the special conditions. This change in concentration can be attributed to the thickening caused by the evaporation in the cooling tower. Salts accumulate in the residual water. Therefore, constant monitoring of the water quality is recommended in order to minimise the operating costs.

Closed cooling systems require the least maintenance. They are used to cool transformer oil, diesel and petrol engines, and also for the cold water in air conditioning systems. The cooling water is cooled by a heat exchanger and does not come into contact with the atmospheric air. Since the cooling water is used several times over, a one-time mechanical and/or chemical treatment is required. Water/glycol mixtures with a glycol content of up to 50% are used for numerous industrial cooling processes.

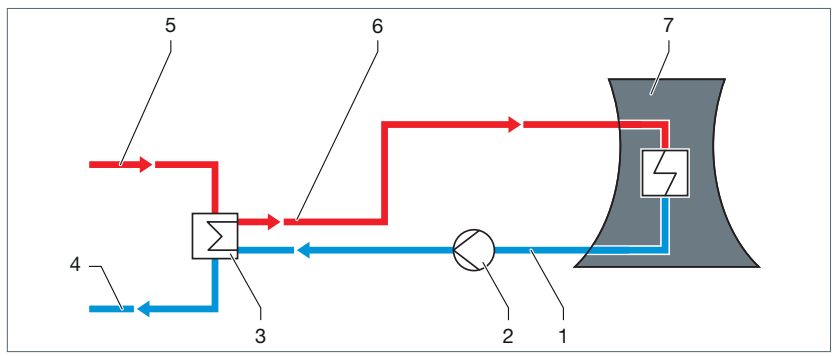


Fig. 88: Closed cooling circuit with circulation cooling

1 Cooling water
2 Circulation pump
3 Heat exchanger
4 Cooled process medium
5 Process medium to be cooled
6 Heated cooling water
7 Cooling tower

Boiler feed water

Boiler feed water is treated water that is used to power a steam turbine, for heating purposes or for engineering processes. The requirements for the purity of the water depend largely on the amount of feed water needed and the dimensioning of the heating circuit. The boiler manufacturer provides information on the permissible concentrations of pollutants. The water used contains harmful constituents in the form of alkaline earth salts which, at elevated temperatures, precipitate on the heating surfaces, form an insulating layer and hence impede the emission of heat. This leads to overheating and, as a result, thermal stress cracks. Moreover, the boiler scale can deposit and cause safety-relevant equipment parts to fail. The O_2 and CO_2 gases dissolved in the water cause corrosion.
Depending on the purpose for which the steam is used, a larger or smaller amount can be reused as feed water in the form of condensate. In a steam power plant, the losses caused by desalination and thermal degasification have to be compensated by make-up water. In processing plants, some of the steam is used for direct heating, and therefore no condensate is available for reuse.
In the case of once-through boilers, all the feed water is evaporated. With this type of boiler, therefore, all dissolved raw water constituents must be removed from the feed water. Therefore, only deionate (= purified water without constituents) may be used.

The requirements for the boiler feed water are described in the following regulations:

- Harmonised European standards:
  - EN 12952-12/Water-tube boilers and auxiliary installations – requirements for boiler feedwater and boiler water quality
  - EN 12953-10/Shell boilers – requirements for the feed water and boiler water quality
- Other regulations published by federations and associations:
  - VGB-S-010-T-00/Feed water, boiler water and steam quality for power plants/Industrial power plants (previously VGB-R 450 L)
  - VGB-M 410 N/Quality requirements for district heating water
  - VdTÜV MB TECH 1466 or AGFW FW 510/Requirements for the circulation water of industrial and district heat systems including information on their operation
- Operation manuals and warranty conditions for boiler and component manufacturers

Solvents, reaction medium, cleaning agent

Water is the best-known solvent. It is used in the chemical, pharmaceutical, food and beverage industry and also for the manufacture of paints and varnishes. Water is able to dilute or dissolve gases, liquids and solids without causing a chemical reaction between the dissolved substance and the dissolving substance. Water as a solvent is often purified or ultrapure water produced from potable water.
Water is also an important reactant in chemical, biological and engineering processes. The extraordinary properties of water can be explained by its bonding and structural conditions.

Water can be used as a reactant in a broad range of processes:

- Hydration
- Protolysis
- Hydrolysis
- Redox reactions with water
- Complex formation
- Hydration

The medium conveyed in piping, devices and machines often leads to scaling, which adversely affects surfaces and the emission of heat. Sterility or the absence of foreign bodies is required especially in the food and pharmaceutical industries, as well as in medical technology. Treated water is used as a flushing medium, for example.

Process water is also used for cleaning products. Water-soluble flux residues on PCBs, for instance, can be cleaned using water.

Cooling lubricants

In manufacturing technology, cooling lubricants, also referred to as drilling fluid, are used on machine tools during cutting and forming processes to dissipate heat, reduce friction between tool and workpiece and transport away the chips.

Fig. 89: Cooling lubricants in manufacturing technology

DIN 51385 describes two distinctly different types of cooling lubricant:

- Water-miscible and water-mixed cooling lubricants
- Non-water-miscible cooling lubricants (for cutting oils, see “Oils and diesel fuels” on page „Oils and diesel fuels“ on page 252)

Cooling water for mechanical surface treatment

The surface machining and cleaning of workpieces has become an indispensable part of industrial production processes. With vibratory finishing, mainly metals are ground or hardened using a mixture of plastic or ceramic to which a water compound is added. Compounds are aqueous solutions and ensure clean, bright and corrosion-free workpieces during the machining process.

Typical processes are:

- Deburring
- Descaling
- Shining and polishing
- Edge-rounding
- Grinding/rough-grinding
- Dulling
- Degreasing and deoiling

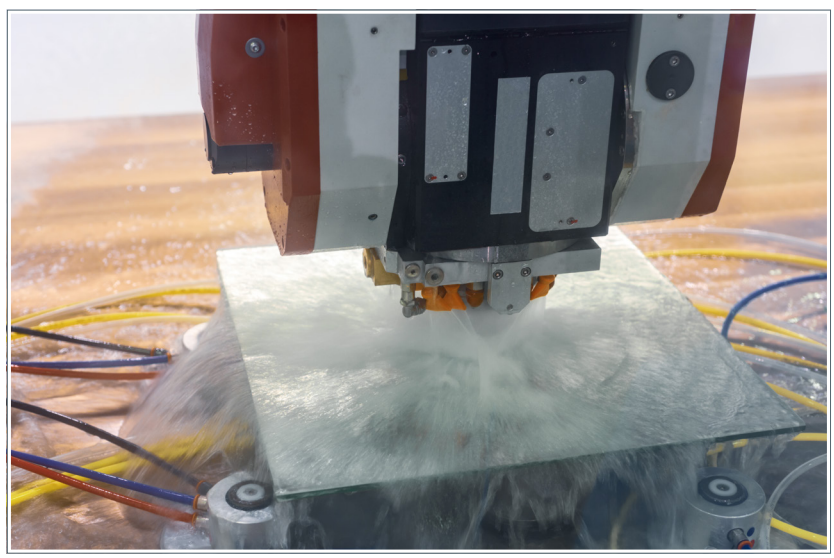


Fig. 90: Glass polishing

Process water as a production aid

Process water is required in industrial plants to manufacture products. Special requirements are placed on water quality, gas content, pH value and water hardness, depending on usage. Typical examples are the food and beverage industry and the paper industry:

Food and beverage industry

As a constituent of food, process water has to meet special requirements in terms of chemical purity, mineralisation and hygiene. Generally, the water from the public potable water supply or wells is treated by special processes to meet the specific requirements of the food industry. Carbonate that has not been removed, for example, can neutralise flavour carriers such as vinegar and fruit acids, and this leads to changes in the flavour of the food.

The food and beverage industry makes use of water in various ways:

- as an ingredient or part of an ingredient
- for processing (e.g. heating, deep-freezing)
- for cleaning

Fig. 91: Cleaning in the food industry

Paper industry
It takes around 100 litres of water to produce one kilogramme of paper. Treated process water is used here too. Soft water with the smallest possible amount of dissolved substances such as salts of iron, ammonium, calcium and magnesium minimises the risk of deposits on pumps, fittings, cylinders and piping and is absolutely essential to paper quality.

Fig. 92: Paper production

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

The chemical composition of the raw or process water is a crucial factor in selecting a suitable piping system. Operating conditions and requirements for the system must be taken into account. Process water is chemically more aggressive than potable water. The high dissolving power of the water must be taken into consideration in selecting the material for piping, fittings and seals.
Therefore, selecting the optimum piping system often requires a water analysis and knowledge of possible additives such as corrosion inhibitors.

Raw water/cooling water in open systems
The following Viega piping systems can be used for raw water and cooling water applications:
- Profipress
- Sanpress Inox
- Sanpress

Fig. 93: Viega piping system Sanpress XL in a water treatment plant

NOTE!
Risk of property damage!
Viega press connector systems are not suitable for transporting refrigerants.
Installations with Profipress or for drilling and cooling lubricants must be agreed with the Viega Service Center on a case-by-case basis.

Cooling water in closed systems/water-glycol mixtures
The following Viega piping systems can be used in closed cooling circuits:
- Profipress
- Sanpress Inox
- Sanpress
- Temponox
- Prestabo
- Megapress
- Seapress

Special water purity
Water purity has a special significance for softened, fully deionised, partially deionised or distilled water, as well as water used as a means of production and purified water.
The following Viega piping system has proved especially successful here:
- Sanpress Inox

Viega piping systems in applications where special requirements apply to organic constituents require subsequent cleaning at the draw-off point. Viega piping systems with press connectors cannot be employed for any water used in the production of pharmaceuticals (Aqua valde purificata) or for injection purposes (Aqua ad iniectabilia).

Water for heat transmission

Viega press connector system have proven to be a high-performance solution in building services engineering. Beyond that, they are an excellent solution for pipeline networks in local and district heat systems, and also for supplying technical processes and applications involving process heat.

Process heat

Cogeneration

Process heat is the heat required for certain technical processes, particularly in industry. It is mainly generated by burning fossil fuels by means of solar thermal collectors, or as a by-product from cogeneration plants. Process heat at temperatures of up to 90°C is also obtained from the power generated in district heating plants.

Modern high-temperature fuel cells for power generation make the use of heat particularly effective. When pure hydrogen is used as the fuel, extremely hot vapour is emitted. This can be used not only to supply residential blocks with hot water, but also to provide process heat at up to 400°C for industrial applications.

Fig. 94: Cogeneration

Solar heat

Process heat is required in industry and production for numerous processes. In around a third of these processes, the temperature is below 100°C. These temperatures can be reached without a problem using flat collectors. Vacuum tube collectors are used at temperatures of 100 to around 150°C, the levels required in breweries. Process heat is required mainly during the day and the demand is easier to plan than that of private dwellings. Which is why solar heat is able to play an important role in the transition to renewable energies.

Process heat applications

Process heat can be divided into the following temperature ranges:

Temperature range [°C]	Process
< 100	Heat transport mainly with warm/hot water
100–300	Heat transport using overheated vapour or thermal oils
> 400	Furnaces (no water or vapour usage)

Tab. 34: Typical temperature ranges for the use of process heat

The typical processes in which water is used as a heat transfer medium include

- Manufacturing processes in the chemical industry
- Drying
- Refining
- Liquefying
- Forging
- Cleaning (e.g. bottles in bottling plants or washing processes in industrial laundries)
- Heating of potable water and swimming pool water
- Heating support

Fig. 95: Water heated by process heat for cleaning bottles

Local and district heat

The heat transmitted through a local network between buildings for heating purposes is defined as local heat. Unlike district heat, local heat is transmitted over relatively short distances. The transition from local heat to district heat is fluent and defined by the amount of heat and the length of the line. District heat networks are often supplied with heat from heating plants and district heating plants that are operated as cogeneration plants. The heat sources are often fossil fuels, biomass or waste. There is a clear trend towards sustainable district heat systems with a higher proportion of renewable energies. Geothermal energy, solar energy and large-scale heat pumps are being used with increasing frequency.

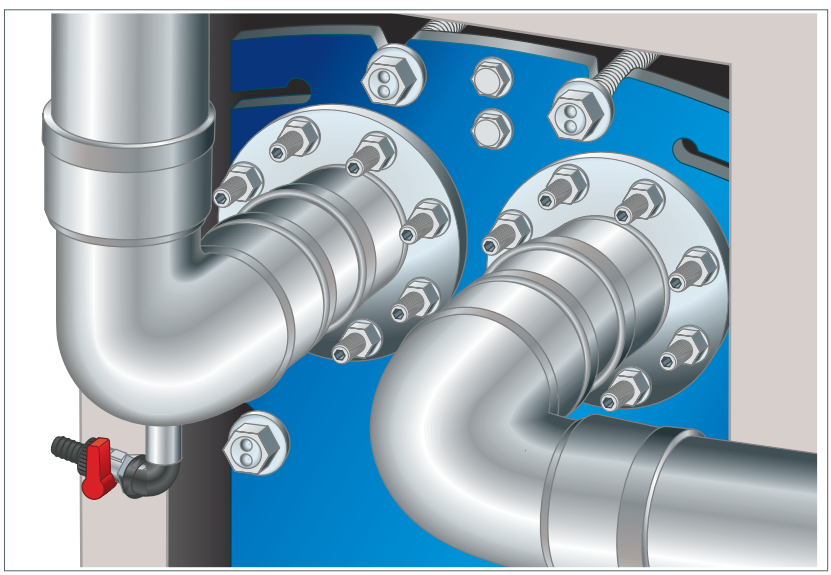


Fig. 96: Secondary connection to a heat exchanger in a district heat transfer station

Local heat networks consist of a central heat generation system, a pipeline network, which is generally shorter than 1 km, and multiple house transfer stations. The heat output is usually less than 1 MW. Typically, the maximum temperatures in the local and district heat networks (primary heating circuit) are 100 to 140°C and in the heat distribution system (secondary heating circuit), a maximum of 100°C. As a rule, the nominal pressure of local and district heat networks is PN16 or PN25.

Requirements for heating water
The circulation water of district heat systems has to meet specific requirements. Basic information is provided by Worksheet AGFW[1] FW 510, as well as VDI Directive 2035.

Worksheet AGFW FW 510 deals with the quality of heating water and provides information for the operation of industrial and district heat supply systems.
VDI Directive 2035, Sheet 1, addresses the the issue of calcification in potable water heating systems and hot water heating systems. VDI Directive 2035, Sheet 2, deals with corrosion on the hot-water side.

Water treatment
The insoluble and soluble solids, as well as gases, contained in the raw water, can lead to problems in district heat supply systems. Therefore, they must be removed through water treatment processes or their impact limited.

Insoluble solids can lead to deposits and clogging and therefore need to be removed by means of a suitable filter technology (e.g. candle filter, bag filter or precoat candle filter).

Water-soluble substances include
- Alkaline earths
- Chlorides and sulphates
- Hydrogen carbonate
- Organic substances
- Oils and greases

In heating installations, these substances lead to limescale and corrosion as well as to microbiological reactions in the circulation water.

As a rule, dissolved salts are removed by ion exchange processes or by reverse osmosis. Degassing processes such as thermal or vacuum degassing remove the gases dissolved in the water.

Process engineering
In district heating practice, there are essentially two distinctly different water-chemical methods of operation:
- low-salt operation
- salty operation

The characteristic guide values in accordance with VDI Directive 2035 are shown in Tab. 35.

[1] AGFW: Energieeffizienzverband für Wärme, Kälte und KWK e.V. (German Energy Efficiency Association for Heating, Cooling and CHP) (formerly working group for heat and heat and power industry/working group for district heat)

	Low-salt	Salty
Electrical conductivity at 25 °C [µS/cm]	> 10 to ≤ 100	> 100 to ≤ 1500
Appearance	Clear, free from sedimenting substances	
pH value at 25 °C (with aluminium alloys)	8.2–9	
pH value at 25 °C (without aluminium alloys)	8.2–10	
Oxygen [mg/l]	< 0,1	

Tab. 35: Requirements for heating water in accordance with VDI 2035, Sheet 1

Monitoring the condition of heating and make-up water is extremely important to preventing corrosion and calcification in heating installations. VDI 2035, Sheet 1, defines the requirements concerning pH, water hardness and oxygen content. If the vales from the table in the VDI sheet (Tab. 36) are exceeded, suitable measures (demineralisation, pH adjustment) are required. It is advisable to examine the applicable regulations and request a water analysis from the water supply company as early as the planning phase.

Total heat output [kW]	Total alkaline earths [mol/m³]	Total hardness [°dH]
≤ 50	No requirements[1)]	
> 50 to ≤ 200	≤ 2.00	≤ 11.20
> 200 to ≤ 600	≤ 1.50	≤ 8.40
> 600	< 0,05	< 0,3

1) In the case of systems with circulation water heaters and systems with electrical heating elements, the guide value for total alkali earths is ≤ 3.0 mol/m³, equivalent to 16.8°dH.

Tab. 36: Requirements for the hardness of heating water in accordance with VDI 2035, Sheet 1, for a system volume of up to 20 litres per kW of heating output

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Pipe connector systems from Viega are an effective solution for the provision of process heat, as well as local and district heat. These systems are equipped with temperature resistant sealing elements and are available for temperatures of up to 140°C, nominal pressures of up to PN16 and nominal widths of up to DN100.
Press connectors for heating water at a maximum operating temperature of 105°C are equipped with the EPDM sealing element. FKM is used up to a maximum operating temperature of 140°C.

Local and district heat systems

With Megapress S (dimensions ⅜ to 2 inches), it is possible to press thick-walled steel pipes in local and district heat systems in accordance with AGFW FW 524. The Megapress S press connectors can be used from the point of entry to the building for primary and secondary heating circuits with indirect connections, as well as for systems with direct connections.
The Megapress S press connectors up to 2 inch satisfy the high requirements of AGFW Worksheet FW 524. Numerous tests by independent laboratories as well as a test report from the Material Testing Institute (MPA) in Dortmund confirm the suitability of Megapress S press connectors for district heat systems in accordance with AGFW FW 524.

Fig. 97: District heat transfer station connected on the primary side using Megapress S

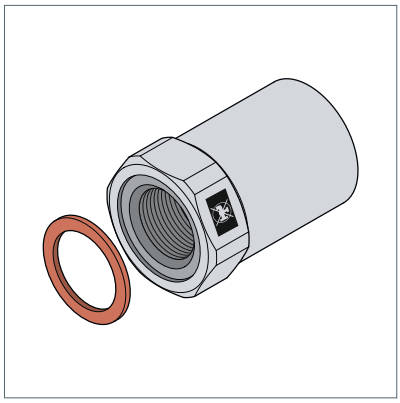


Fig. 98: Megapress S plug-in piece model 4312.7

The Megapress S plug-in piece model 4312.7 can be used to easily connect thermometers and pressure gauges, for example. Use of the copper gasket means assembly can be completed without any additional sealants, which are not permitted in many cases.

After consultation with the supply company, Profipress S or Profipress can also be used in district heat systems, depending on the maximum temperature, provided that EPDM is replaced with FKM for the Profipress (cf. „Sealing elements“ on page 12).

Always consult with the supply company before installing press connector systems. This ensures that the system is installed in accordance with the utility company's specifications.

Solar heat

Press connectors of the Profipress S piping system can be used in all solar installations. The permissible anti-freeze agents and their maximum permissible concentration must be observed and can be found in the “Areas of application for metal piping systems”.
Press connectors from the piping systems Profipress and Temponox can be used in all solar installations with flat collectors. If Profipress and Temponox press connectors are used for installations involving vacuum tube collectors, the factory-fitted EPDM sealing elements must be replaced with FKM sealing elements.

Extinguishing water

Water is often the extinguishing agent of choice for fighting fires. This resource is affordable, readily available and its evaporation temperature of 100°C is lower than the ignition temperature of many combustible substances. Its high evaporation heat permits effective heat dissipation, displacing the oxygen required for the combustion process at the same time. In extinguishing water systems, it is used to save people's lives and protect buildings.

Fig. 99: Viega Megapress in a sprinkler unit

A general distinction is drawn between stationary and mobile extinguishing water systems. There are different types of stationary extinguishing water systems – non-automatic systems, automatic systems and fire-fighting aids. Tab. 37 provides an overview of stationary extinguishing water systems.

Extinguishing water systems		
Non-automatic extinguishing water systems	**Automatic extinguishing water systems**	**Fire fighting aids**
Wall hydrant type "S" (self-help)	Wet, dry water extinguishing systems with open pipeline network	-
Wall hydrant type "F" (fire service), wet, wet/dry	Gas extinguishing system	
Extinguishing water system dry (dry riser pipes)	Powder extinguishing systems	

Tab. 37: Classification of stationary extinguishing water systems

Planning extinguishing water and potable-water concepts
In the fire protection concept the planner describes which piping system is to be used to provide extinguishing water to the individual extinguishing water connections. In order to create a consistent fire safety concept, the should not only be familiar with the local extinguishing water supply but also needs detailed knowledge of the properties and capabilities of the potable-water supply. For example, he must not assume that the supply company also provides a sufficient amount of extinguishing water in addition to a sufficient supply of potable water.
As connected extinguishing and potable-water installations may also cause hygiene problems due to stagnation (contamination of potable water), the fire safety concept should always involve close co-operation between planners from these specialist areas.

Non-automatic extinguishing water systems

Overview
Non-automatic extinguishing water systems are extinguishing water pipes and draw-off points (e.g. wall hydrants) which, in the event of a fire, allow extinguishing devices to be connected.
A distinction is drawn between "wet" extinguishing water pipes, which are always ready for use and constantly pressurised, and "dry" systems that have to be filled with water before they can be used in case of fire.

Classification
- Wet:
  Extinguishing water pipes with extinguishing water draw-off points which are constantly connected to the potable water supply and hence ready for use at all times. Use by the fire service and lay people, with the exception of wall hydrants with flat hoses.
- Wet/dry:
  Extinguishing water pipes with extinguishing water draw-off points, which are connected to the potable water supply by means of quick-opening fittings only in case of fire. Use by the fire service and lay people, with the exception of wall hydrants with flat hoses.
- Dry:
  Non-potable-water pipelines with extinguishing water draw-off points and no direct connection to the potable-water installation, which are filled by the fire brigade only in case of fire. With these systems, the time-consuming laying of hoses is not required. Use only by the fire service.

Potable-water installation with type-S wall hydrants

Potable-water installations with directly connected type-S wall hydrants in accordance with DIN 14461-1 and an integrated safety arrangement (backflow preventer and type-HD aerator in accordance with DIN EN 1717) are designed for initial firefighting efforts by laypersons. It is not intended for use by the fire brigade, as it does not permit the connection of fire hoses. The main distinguishing feature between wall hydrants of type S and type F is the hose connection valve.

- Type S: DN25, with pipe aerator design HD
- Type F: DN50

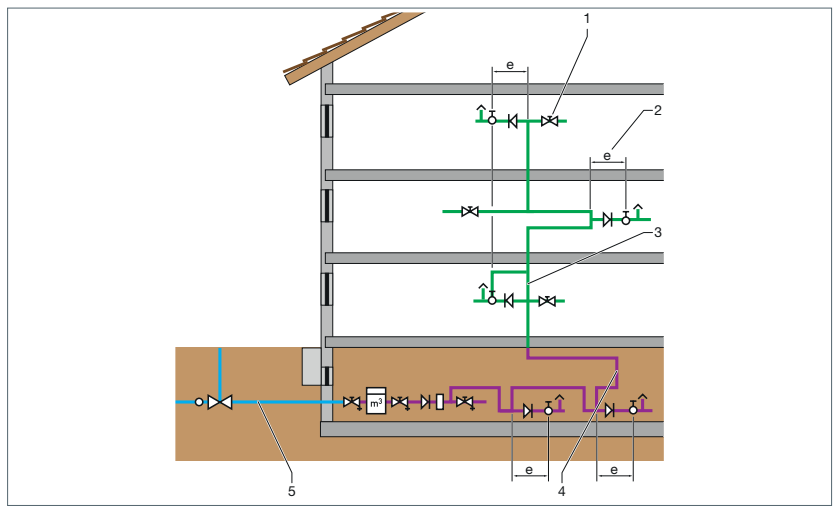


Fig. 100: Potable-water installation with type-S wall hydrants

1 The volumetric flow of potable water must be greater than the demand for extinguishing water, whilst taking simultaneous use into account. The consumer fittings must be designed as fail-safe.
2 $e \leq 10 \times d$ maximum distance between the potable-water pipeline with a sufficient volumetric flow and the shut-off valve of the type-S wall hydrant.
3 Non-combustible (A) and combustible (B1/B2) installation pipes are permitted. The installation pipes must be laid behind the non-combustible wall coverings of installation walls or be enclosed in fire-resistant material. Combustible pipes must not be laid exposed. In case of fire, an adequate supply of extinguishing water must be guaranteed.
4 Non-combustible potable-water pipelines should be used to supply initial-response facilities if the pipeline is exposed in the protected areas of initial-response facilities. Central supply lines that are at an increased risk of fire in the protected areas must be non-combustible. Any deviation from that provision must be agreed with the fire protection expert responsible, the authorities and, if applicable, the test expert, and it must be included in the fire safety concept.
5 Supply line

Potable-water installations with wall hydrants must be built in accordance with DIN 1988 or EN 806, with the potable-water pipeline being used as the extinguishing water pipeline up to the final extinguishing water draw-off point.
Where potable-water installations are designed with wall hydrants, the pressure losses and the nominal pipe diameters must be calculated and determined as per DIN 1988-300 or EN 806-3.
Take the following planning data into consideration:

Volumetric flow of draw-off	24 l/min
Minimum flow pressure	0.2 MPa
Max. flow pressure at the draw-off point with simultaneous draw-off at the two least favourable extinguishing water draw-off points	0.8 MPa
Max. stagnation pressure at the hydraulically most favourable hydrants – nominal pressure PN 12 in accordance with DIN 14461-1	1.2 MP
Hose connection valve with integrated safety combination	DN25

Tab. 38: Planning data

DIN 1988 and DIN 14462 permit the use of combustible materials such as plastic pipes. They should only be used as extinguishing water pipelines if laid underground or used in service connection rooms without fire loads.

Protective goal of potable water quality
Extinguishing water systems are supplied with either potable water or water that does not comply with the Potable-Water Ordinance. Where connected to the potable-water supply directly, extinguishing water systems have to meet certain hygienic requirements (see DIN 1988-600). Extinguishing water is generally assigned to Class V in accordance with DIN EN 1717 and DIN 1988.

In order to rule out the possibility of potable-water quality being impacted by stagnation, only type-S wall hydrants may be connected to the potable-water installation directly. Incorrectly planned and executed extinguishing water systems may present major problems in terms of a building's potable-water hygiene, resulting in health hazards. Risk factors exist for the following reasons:
- physical – due to temperature increase
- chemical – due to metal ion concentration
- microbiological – due to stagnation

Standards and their implementation are designed to maintain potable water quality. This protection goal can be achieved by:
- Separation of the extinguishing water and the potable water supply
- Avoidance of direct extinguishing water connections to the potable water supply
- Safe separation of the systems via a free outlet of type AA or AB in accordance with DIN EN 1717

- Avoidance of stagnation in potable water pipelines
- Increase in potable water flow

Because extinguishing water systems are rarely in operation, the following planning approach applies to new systems in conjunction with potable-water installations:
To prevent hygiene issues being caused by germ formation, it is necessary to ensure, during the planning, construction and operating phase of the system, that there is no water stagnation or that it is impossible for stagnated water to enter the potable-water installations.

Stagnant water can be prevented by:
- Arrangement of points of consumption according to user behaviour
  Arranging frequently used draw-off points in series installations at the end of the installation.
- Guaranteeing regular potable water draw-off
- Precise dimensioning of the piping
- Supplying extinguishing water and potable water pipelines for a site via a joint connection line
- Connecting the potable water pipeline directly upstream of the extinguishing water transfer point
- Flushing the supply lines to extinguishing water connections once per week with 1.5 times the volume of the line content with 20 to 50% of the design volumetric flow
- Securing extinguishing water and fire protection systems so as not to interfere with potable-water installations in accordance with DIN EN 1717

Potable-water installation with type-F wall hydrant

Wet and wet/dry extinguishing water systems must be installed in accordance with DIN 14462.
The potable water pipeline is used as an extinguishing water pipeline up to the extinguishing water transfer point.

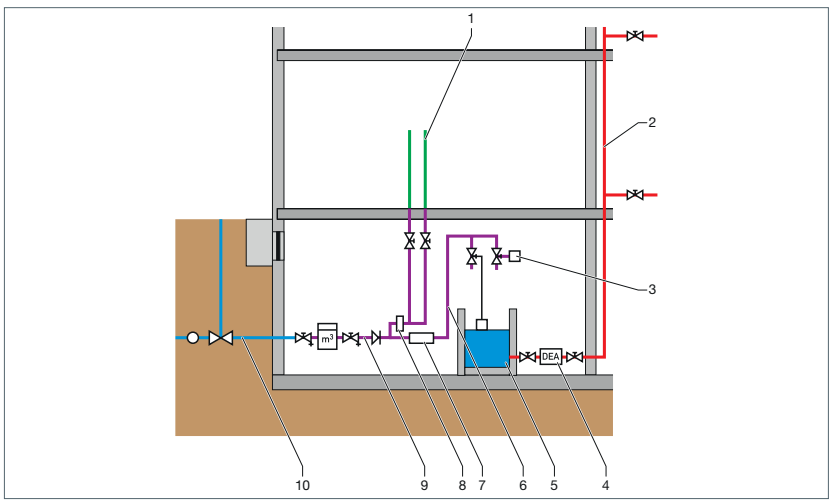


Fig. 101: Extinguishing water transfer point with indirect connection to the potable-water installation

1 Non-combustible (A) and combustible (B1/B2) installation pipes (potable-water installation) are permitted. These must be laid behind non-combustible coverings of installation walls. Combustible pipes must not be laid exposed. In case of fire, there must be no risk of the extinguishing water supply being inadequate.
2 Non-combustible wet or dry extinguishing water pipes in accordance with DIN 14462
3 Flushing system
4 Pressure boosting station in accordance with DIN 14462
5 Intermediate container with free outlet type AA or AB
6 Non-combustible potable water and extinguishing water pipes in accordance with DIN 1988-600 for feeding into the intermediate container
7 Stone trap
8 Filter/domestic water station
9 Potable-water installation according to DIN 1988-600 with additional requirements as per DIN 14462
10 Supply line

During the design of the wet and wet/dry extinguishing water systems, pressure losses must be calculated and the required nominal pipe diameters must be determined. The possible calculation methods are described in DIN 1988-300/EN 806-3.

Take the following planning data into consideration:

- Draw-off volume of 100 or 200 l/min, according to the fire protection concept
- Minimum flow pressure of 0.3 or 0.45 MPa
- Flow pressure of max. 0.8 MPa at the draw-off point with simultaneous draw-off at the three least favourable extinguishing water draw-off points
- Stagnation pressure of max. 1.2 MPa at the hydraulically most favourable hydrant (nominal pressure PN 12) in accordance with DIN 14461-1 and DIN 14461-6
- Hose connection valve DN50

For wet/dry extinguishing water systems, the time required to fill the empty piping network must be calculated and proof of this must be furnished for the approval process. According to DIN 14462, extinguishing water must be available at the draw-off point which is furthest away from the extinguishing water transfer point after 60 seconds. This requires the volumetric flow of the pump systems to be dimensioned according to the filling volumetric flow, or the reservoir has to be adequately dimensioned for this filling quantity.

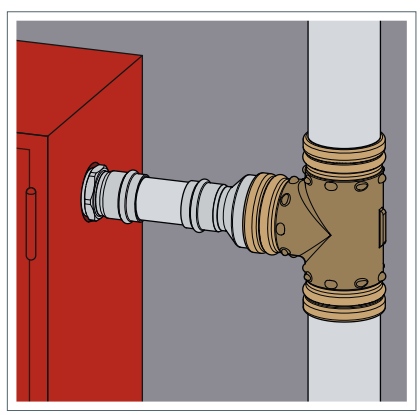


Fig. 102: Wall hydrant connection with Sanpress XL T-piece DN80 (model 2218XL)

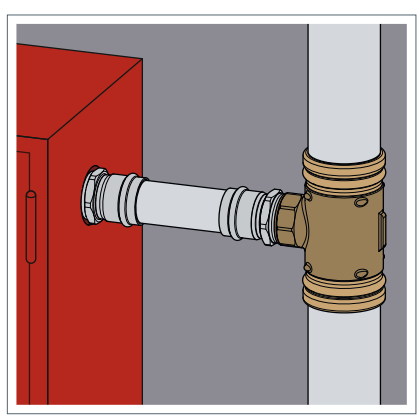


Fig. 103: Wall hydrant connection with Sanpress XL T-piece DN80 x Rp2 x DN80 (model 2217.2XL)

Category	Minimum flow rate at minimum flow pressure	Simultaneity	Minimum flow pressure	Max. flow pressure[1)]	Max. at-rest pressure
Type-S wall hydrant	24 l/min	2	0.20 MPa	1.2 MPa	1.2 MPa
Wall hydrant with extinguishing agent additive	See DIN 14462, Section 4.4.2, Simultaneity in the fire safety concept				
Type-F wall hydrant or wall hydrant with lay-flat hose and hose connection valves	100 l/min	3	0.30 MPa	0.8 MPa	
	200 l/min	3	0.45 MPa		
Above-ground hydrant DN 80	800 l/min	According to the fire safety concept	0.15 MPa		
Above-ground hydrant DN 100	1600 l/min				
Underground hydrant DN 80	800 l/min				
Dry extinguishing water extraction	It must be ensured that, with a feed pressure of 0.8 MPa and 3 draw-off points in simultaneous use, each at 200 l/min, the flow pressure will not fall below 0.45 MPa at any point. The pressure difference between the extinguishing water supply and the most unfavourably located draw-off point must not exceed 0.1 MPa + the pressure loss from the geodetic height difference.				

[1)] For flow rates lower than the specified minimum, e.g. with a type-F wall hydrant in initial-response mode, the flow pressure may increase up to the specified value for maximum at-rest pressure.

Tab. 39: Required minimum flow rates and pressures according to the extinguishing water hose connection device

Extinguishing water system dry

Dry extinguishing water systems, „Fig. 104: Extinguishing water system dry“ on page 168, built in accordance with DIN 14462. For supply fittings, refer to DIN 14461-4, and, for extraction fittings, refer to DIN 14461-5.
The extinguishing water pipe must have a dimension of DN 80, while individual supply lines branching off to draw-off points may have a dimension DN 50 up to a length of 10 m. For total lengths > 100 m, sufficient dimensioning must be verified by calculation and the maximum permissible filling time of the system must be agreed with the fire brigade or the authority responsible for fire safety. It must be ensured that, at a feed pressure of 0.8 MPa and 3 draw-off points in simultaneous use, each at 200 l/min, the flow pressure will not fall below 0.45 MPa at any point. The pressure difference between the extinguishing water supply and the most unfavourably located draw-off point must not exceed 0.1 MPa + the pressure loss from the geodetic height difference.
Calculations can be carried out in accordance with DIN 1988-300/EN 806-3.

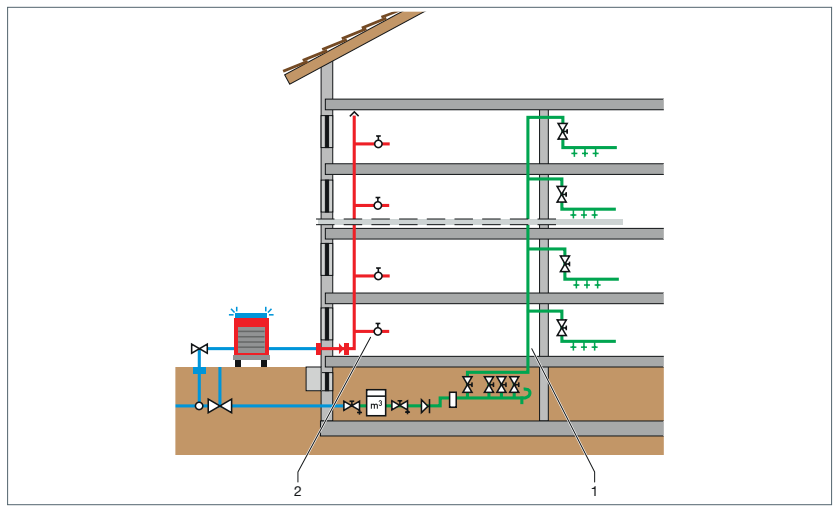


Fig. 104: Extinguishing water system dry

1 Non-combustible dry extinguishing water pipe according to DIN 14462
2 Non-combustible (A) and combustible (B1/B2) installation pipes (potable-water installation) are permitted.

Maintenance

Maintain extinguishing water systems in accordance with the specifications of DIN 14462, DIN EN 671-3 and the recognised rules of engineering. They must be maintained regularly and after each use and the work must be documented in an inspection log. The maintenance intervals are specified by the manufacturer. However, they must not exceed two years for dry extinguishing water systems and one year for wall-mounted hydrants.

Automatic extinguishing water systems (sprinkler units)

Function and operating mode

Sprinkler systems are permanently installed devices for automatic fire fighting. They can delay or prevent a fire spreading as soon as it breaks out by targeted use of the extinguishing water. Sprinklers installed on storey floors are triggered by the change in temperature in case of fire and thus reduce risks to humans and damage to property.
The advantages of a sprinkler unit lie in the localised and effective use of extinguishing agents at an early stage in the course of the fire.
Preferred areas of application:

- Office and administration buildings
- Hospitals and retirement homes
- Hotels
- Schools and universities
- Underground garages and car parks
- Industrial units

Alongside glass bulb sprinklers, fusible link sprinklers are also common for special applications. The various types cover all possible on-site situations and requirements, both in terms of their positioning on ceilings, wall and floors and also with respect to the spraying properties and extinguishing performance in litres per minute.
The design must be handled by experts in accordance with hydraulic and fire-fighting criteria.

Glass bulb sprinklers
Sprinkler heads with glass bulbs are usually installed with a defined spacing on the storey floor and are integrated into the extinguishing water and fire protection installation. The sprinklers' nozzles are sealed with glass bulbs, which will burst in a fire due to thermal stress and release the pressurised extinguishing agent. The activation temperature for the sprinkler heads should be approx. 30 °C above the maximum expected room temperature and can be set at a precise value between 57 °C and 182 °C by using different types of glass bulbs, which are colour-coded.

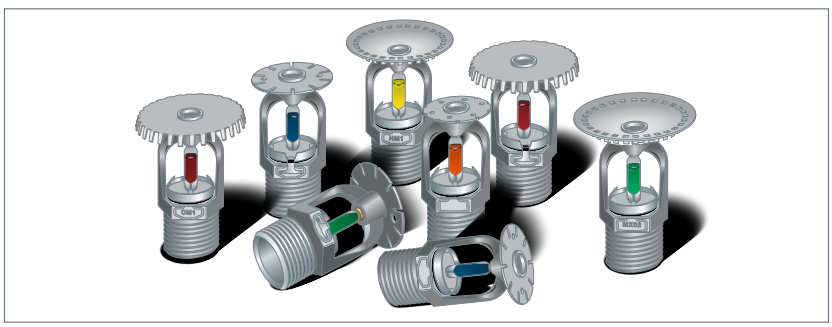


Fig. 105: Colour-coded sprinklers with glass ampoules

Trigger temperature [°C]	Marking	Use
57	Orange	Standard
68	Red	
79	Yellow	Special
93	Green	
141	Blue	
182	light violet	

Tab. 40: Opening temperature classification

Water performance – K factor
Due to the various areas of application, sprinklers with a range of water capacities are required. The water evaporation capacity is calculated using the following formula:

$$Q = K \cdot \sqrt{p}$$

Q = Water volume in l/min
K = Outflow factor of the sprinkler at 0.1 MPa
P = Sprinkler pressure in bar
The minimum pressure is 0.05 MPa, the maximum permitted pressure is 0.5 MPa.

K factor	Thread [R]	Use	Min. performance at 0.05 MPa [l/min]
57	⅜	Low fire load	40,0
80	½	Standard	57,0
115	¾		81,3
160–202	¾	Large drip sprinkler 0.31 MPa	281.7–355.7

Tab. 41: K factors for sprinklers in line with the installation situation

Example
A sprinkler R½ with K = 80 achieves at 0.1 MPa (1 bar)
$Q = 80^{*}\sqrt{1} = 80$ l/min
At 0.2 MPa (2 bar) the same sprinkler achieves
$Q = 80^{*}\sqrt{2} = 113$ l/min

Nominal K factors are influenced by the sprinkler angle used. The influences upon the K factor must be taken into consideration in the hydraulic calculation and in the system layout.

Nominal K factor	Total K factor including sprinkler angle
K-80	K-69
K-57	K-53

Tab. 42: Sprinkler use

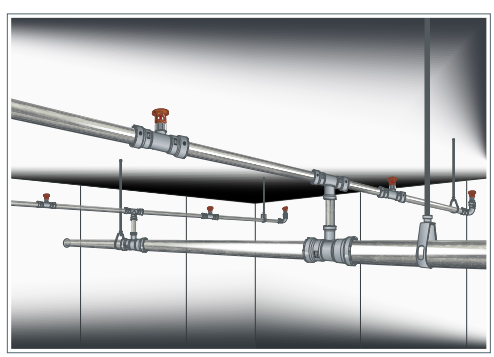


Fig. 106: Sprinkler unit with Viega Megapress and galvanised steel pipe

Legal and normative principles

Classification – integration in the regulations

The building regulations for the various federal states define the general requirements for structural systems to prevent and fight fires.
The requirements for extinguishing water systems are derived from the individual state's building regulations and the associated ordinances, guidelines and recognised rules of engineering.
The special building regulations issued by the states provide requirements for the various types of extinguishing water systems depending on the size of the building and its use.

	Non-automatic	Automatic
Garage regulations	x	X
Assembly Area Ordinance / Guideline	x	X
Sales Premises Ordinance / Guideline	x	X
Building Code for Hospitals	x	
High-rise building guidelines	x	x
Industrial building guidelines	x	X

Tab. 43: Extinguishing water systems as described in special building regulations

Supervisory authorities for the construction sector may specify further requirements with due regard to the principle of proportionality.
The fire safety concept or fire safety certificate, in which the requirements for extinguishing water systems are defined, is an essential part of the building permit procedure for special buildings.
Existing buildings often deviate from the building regulations, for example by exceeding the fire compartment areas, exceeding the permissible escape route length or not upgrading the stud frame. This must be compensated for by technological means, e.g. extinguishing water systems. These serve to save lives, protect individuals and fight fires. For this reason, special requirements are placed on the planning, installation and operation of these systems.
Extinguishing water systems can fulfil their protective function reliably only if the principal or building owner employs a suitable concept from as early as the planning phase.
The fire safety concept encompasses planning, execution and operation. They include:

- The essential requirements for the behaviour of building materials and components during a fire, including the permitted use of construction products, types of construction with verification and proof of applicability
- Assigning the planning process to authorised expert planners
- Involving experts for extinguishing water systems who are recognised by the building authorities

- Assigning installation, repair and maintenance work on the systems to authorised specialist companies
- Providing a back-up concept in case the extinguishing water system is decommissioned
- Drawing up an understandable description of the fire protection concept, taking any necessary deviations, e.g. for adjacent buildings, into account

The importance of the fire protection concept is clearly shown by the current sample high-rise building regulations (MHHR). In contrast to the previous directives, the MHHR assumes that the fire service will fight the fire from inside the building. Even with building heights of up to 22 m, in terms of planning fire fighting efforts from the outside are the exception to the rule. That is why MHHR section 6.3 stipulates that, in addition to automatic extinguishing systems, wet riser pipes must be installed with wall hydrants in all the necessary stairwells (incl. safety stairwells) on each floor.
Dry riser pipes are not permitted here as any impairment can go unnoticed and, in case of fire, their functionality first has to be restored by the deployed fire service.
Depending on the building floor area and the fire hazard class, with sufficient planning of the wall hydrants, up to a third fewer fire extinguishers may be kept.
In the industrial sector wall hydrants with flat hoses are used to in order to be able to provide large amounts of water to fight fires. Given the special features of these systems, their usage must be practiced regularly and they must only be deployed by trained personnel.

Standards and regulations
Extinguishing water and fire protection systems must be planned and implemented by specialised companies. In addition to the legal building regulations and technical construction provisions, the following standards and regulations must be observed:

- Potable Water Ordinance (TrinkwV)
- Model directive on technical requirements for fire protection with respect to piping systems (MLAR)
- DIN 4102-4: Fire behaviour of building materials and building components: Synopsis and application of classified building materials, components and special components
- DIN 1988-200 Codes of practice for drinking water installations – Part 200: Installation Type A (closed system) – Planning, components, apparatus, materials; DVGW code of practice
- DIN EN 1717: Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow; German version EN 1717; code of practices of the DVGW
- DIN 1988-500: Codes of practice for potable water installations - Part 500: Pressure boosting stations with RPM-regulated pumps; DVGW code of practice
- DIN 1988-600: Codes of practice for potable water installations – Part 600: Extinguishing water installations in connection with fire-fighting and fire protection installations; DVGW code of practice

- DIN EN 806-1: Specifications for installations inside buildings conveying water for human consumption, Part 1: General, German version EN 806-1:2001 and A1:2001
- DIN EN 806-2: Specifications for installations inside buildings conveying water for human consumption, Part 2: Design, German version EN 806-2
- DIN EN 806-3: Specifications for installations inside buildings conveying water for human consumption, Part 3 – Pipe sizing – Simplified method; German version EN 806-3
- DIN EN 806-4: Specifications for installations inside buildings conveying water for human consumption, Part 4: Installation; German version EN 806-4
- DIN EN 806-5: Specifications for installations inside buildings conveying water for human consumption, Part 5: Operation and maintenance; German version EN 806-5
- DIN 14461-1: Delivery valve installations for firefighting purposes – Part 1: Wall hydrants with semi-rigid hose
- DIN 14461-2: Delivery valve installations – Part 2: Filling station and output system connected with "dry" water conduit for fire extinguishing
- DIN 14461-3: Delivery valve installations for firefighting purposes – Part 3: Fire hose valves for nominal pressure PN 16
- DIN 14461-4: Delivery valve installations for firefighting purposes – Part 4: Filling valves PN 16 connected with firefighting pipes
- DIN 14461-5: Delivery valve installations for firefighting purposes – Part 5: Tap PN 16 connected with firefighting pipes
- DIN 14461-6: Delivery valve installations for firefighting purposes – Part 6: Wall hydrants with flat hose for trained personnel according to DIN EN 671-2
- DIN 14462: Water conduit for fire extinguishing – Planning, installation, operation and maintenance of fire hose systems and pillar fire hydrant and underground fire systems
- DIN 14463-1: Water systems for fire extinguishing – Filling and draining devices operated by remote control - Part 1: For hose reel systems
- DIN 14463-2: Filling and draining devices operated by remote control – Part 2: For water extinguishing systems with empty and non-pressure pipeline network; Requirements and testing
- DIN 14463-3: Water systems for fire extinguishing – Filling and draining devices operated by remote control – Part 3: Valves for ventilation PN 16 of fire extinguishing pipe systems
- DIN 14464: Assembly with direct connection for sprinkler systems and extinguishing systems with open nozzles – Requirements and testing
- VDI/DVGW 6023: Hygiene in Trinkwasserinstallationen – Anforderung an Planung, Ausführung, Betrieb und Instandhaltung
- Association for Sanitation, Heating and Air Conditioning (ZVSHK) potable water hygiene; T88/1: specialist information – technical measures for compliance with potable water hygiene

Piping Systems

General notes

System approvals
Plastic pipes may only be used as extinguishing water lines if placed underground or used in house connection rooms without fire loads.

NOTE!
Risk of property damage!
Installation systems with press connectors in extinguishing water systems (dry and wet/dry) may only be used if they have been approved for the specific area of application.

Piping systems for non-automatic extinguishing water systems
DIN 14462 is the most important standard for the installation, operation and maintenance of extinguishing water systems. Tab. 44 specifies the permissible materials for extinguishing water systems.

Pipeline material	Pipe regulations	Standard connection technologies	Connector regulations	Pipe connection regulations
Galvanised ferrous materials	DIN EN 10255 Series M and H in conjunction with DIN EN 10240 DIN EN 10305-3	Threaded connection	DIN EN 10241 DIN EN 10242	DIN EN 10226-1
		Clamp connection Press connection Flange connection	DVGW W 534 DIN 2459 DIN EN 1092-1	DVGW W 534
Stainless steel	DVGW GW 541	Press connection Clamp connection	DIN 2459 DVGW W 534	DVGW W 534
Copper and internally tin-plated copper	DIN EN 1057 DVGW GW 392	Brazed connection[1)]	DIN EN 1254-1 DIN EN 1254-4 DIN EN 1254-5	DVGW GW 2
		Welded connection / flange connection[1)]	DIN 2607 DIN EN 1092-3 DIN EN ISO 24373	
		Press connection	DVGW W 534 DIN 2459 DIN EN 1254-7	
		Clamp connection, metal-to-metal sealing	DVGW W 534 DIN EN 1254-2 DIN EN 1254-4	
		Plug connection	DVGW W 534	

[1)] Brazed and welded connections are not permitted for internally tin-plated copper.

Tab. 44: Permissible pipe materials for extinguishing water systems according to DIN 14462

Press, clamp and plug connectors in dry and wet/dry extinguishing systems are permitted only if they are fit for this purpose and have been tested for use in dry sprinkler systems (min. PN16) in conjunction with the pipes used.

Fixing technology

Note the following for the execution and fixing of extinguishing water pipelines and supply lines to extinguishing water transfer points:

- Planning of connection line lengths according to DIN 1988-600
- Extinguishing water pipes are allowed to be laid in pipe routes
- The use of plastic dowels is not permitted
- Installation based on DIN 4102-4 in conjunction with DIN V 4102-21
- Ensure the stability of the fixing points in accordance with the expected duration of use – 2 hours in accordance with DIN 14462
- Design fixing points and fixing structures (crossbeams, crane arms, etc.) according to the expected duration of use and, if relevant, apply a fire protection wall coating

Special requirements may be specified in the course of the construction approval process whilst taking the principle of proportionality into account. These requirements are specified in the fire protection concept or the construction regulations.

Fixations are to be made of steel without flexible connecting links and must be dimensioned so that the mathematical stresses do not exceed the limit values indicated in Tab. 45. Suspension components must be at least 1.5 mm thick.

Load	Fire resistance class according to DIN 4102-4	
	L30 or L60	L90 or L120
Tensile stress σ in vertical parts [N/mm²]	9	6
Shear stress τ in screws of the strength class 4.6 according to DIN EN ISO 898-1 [N/mm²]	15	10

Tab. 45: The approved stresses in suspensions correspond to the fire resistance class

Horizontal extinguishing water lines may only be fixed to beams or ceilings with the same fire resistance duration. The use of plastic dowels in fire protection systems is not permitted.

If dowels are used for fixation, the various requirements for dowels with and without fire protection proof of suitability must be met.

According to DIN 14462, brackets must generally be at a distance of max. 4 m with galvanised ferrous materials and stainless steel with a wall thickness of >2.6 mm.

With copper pipelines and pipelines made of galvanised ferrous materials and stainless steels of a wall thickness of <2.6 mm, the fixation spacing is 2 m.

The various specifications of the fixation technique given in the regulations apply for sprinkler systems.

Fixing points
Fire extinguishing pipes may expand linearly when exposed to fire. The resultant forces must not destroy fire stops. For this reason, fire extinguishing pipes must be fixed in place at a sufficient number of points in order to divert these forces in a controlled manner via expansion compensators (L or U pipe) or other compensators.
Additional fixing points must be provided in wet/dry and dry extinguishing water lines in order to compensate for the reaction forces of the extinguishing water pipe during the filling process. These additional fixing points must be located on the connection of pressure booster systems on the pressure side and on remote-controlled filling and emptying stations (wet/dry stations) according to DIN 14463. Standard structures made of non-flammable building materials have proved to be effective for the fixing points, e.g.,pipe bows.

Use dowels
In terms of the quality and execution of fixations with dowels **without** fire protection proof of suitability the following applies
- Steel material
- Minimum size M8
- Installation depth = at least twice the dowel length
- Max. mathematical tensile load = 500 N

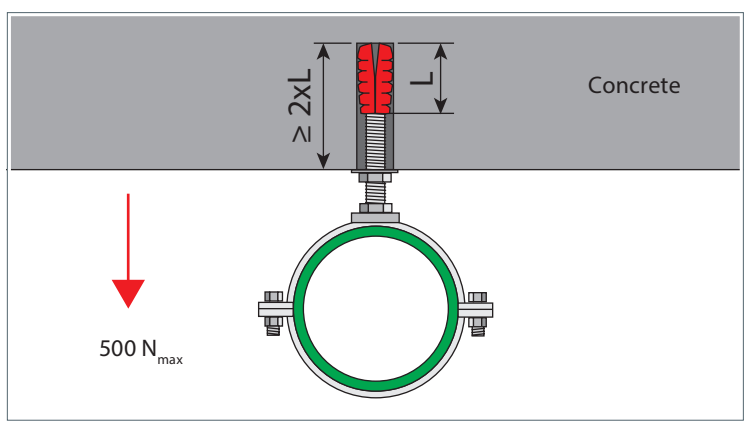


Fig. 107: Steel dowel without fire protection proof of suitability

The maximum load and installation type for dowels **with** fire protection proof of suitability are defined in the proof of suitability documentation.

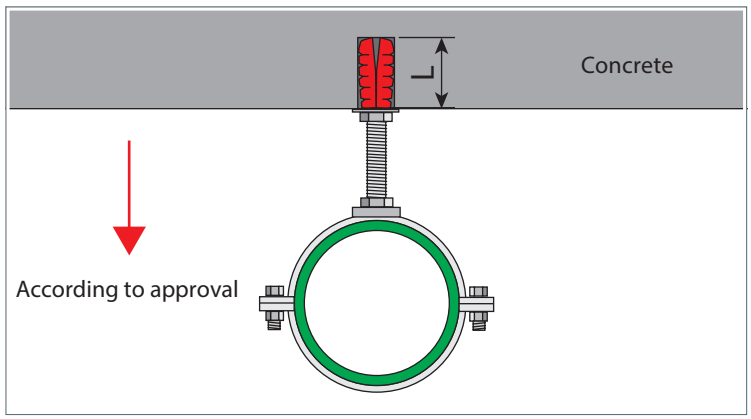


Fig. 108: Steel dowels with fire protection proof of suitability

In both cases, the permitted fixing distances according to the manufacturer's information must be observed.
When fastening extinguishing water piping to steel components with fire protection cladding, use force-fit fixing elements instead of dowels. The specified limit for mathematical tension must be respected. Extend the fire protection cladding of the steel components to a length of at least 300 mm on the suspension. This prevents the fire resistance duration of the steel components being impaired by connection of the suspending brackets.
The length of the suspension (distance between the bottom edge of the extinguishing water line and the bottom edge of the ceiling) must not exceed 1.5 m with unprotected hanging brackets.

Fire protection cladding for pipework
Extinguishing water pipes and the supply line to the extinguishing water transfer point must be built as to be adequate to the expected duration of use.
Extinguishing water pipes and supports must be dimensioned and protected in such a way that the system continues to function in the event of a fire. There are already fire protection jackets on the market that are based on a critical temperature of 500 °C. It is recommended that the installation of such solutions is agreed in advance with the fire safety expert and that cladding providing effective fire protection should be used should take into account the weakest component in the pipeline system, the sealing element.

For dry riser pipes, a cladding thickness according to the calculation values of DIN 14462:2023-07 can be used as an alternative.

Installation site	Measures
In fire load-free stairways, lock systems and escape routes	None
In areas with automatic extinguishing systems (e.g. sprinkler systems)	Coordination with the creator of the fire safety concept or the local authorities and the fire protection department
In areas with fire loads	Cladding of the pipeline according to DIN 4102-4 or equivalent

Tab. 46: Fire protection measures for extinguishing water pipes

The following can be used for fire protection cladding for extinguishing water pipes:
- Exposed and metal-concealed fire protection pipe casing
- Mineral fibre wool in accordance with DIN 4102-4
- Approved fire protection systems made from other building materials

The cladding thickness must be selected separately for each component in line with the general building supervisory approval for piping systems. If, on the basis of the calculated loads, the brackets have tensile loads well in excess of 6 N/mm², the suspension brackets must also be cladded to comply with the basic rules outlined in DIN 4102-4.

Commissioning of non-automatic extinguishing water systems

Pressure test report

In line with the requirements of DIN 14462, extinguishing water pipes, including their fittings, must be subjected to strength and leakage tests before commissioning.

The latest pressure test record for extinguishing water systems can be downloaded from the Viega homepage by entering "Druckprobenprotokoll" (Pressure test record) as the search term.

System control book

Furthermore, a reference book containing the following data must be created for the extinguishing water system:
- Installation site/address
- Owner's address
- Operator's address
- Installation company's address
- Competent water supply company
- Constructional requirements and planning fundamentals
- Technical documents for the components used
- System diagram with wall hydrants, feed-in and extraction fittings as well as other key components
- Pipeline dimensions
- Flooding time calculation for dry or wet/dry extinguishing water systems
- Record: Pressure/leakage test
- Record: Rinsing

- Record: Instructing of the operator by the installation company
- Installation company's declaration of compliance
- Acceptance test
- Records on servicing work
- Records on maintenance performed
- Records on malfunctions and their causes

Piping systems for automatic extinguishing water systems (sprinkler units)
During the planning, installation and commissioning of sprinkler systems, the following points, amongst others, should be taken into consideration:

- Applicable and agreed regulations as well as the recognised rules of engineering
- Deviating country-specific requirements and regulations
- Product information provided by the manufacturer

The pipeline network must be executed in such a way that every section can be drained completely and at any time. Any reverse incline in the piping must not mean that water can remain in the system after draining.

If offsets are required, e.g. at a concrete lintel, a suitable draining facility must be provided at the lowest point. According to VdS CEA 4001 section 13.6, flushing connections via which the pipeline network can be flushed and aerated must be placed at the end of all secondary distribution pipes. Depending on the installation design, it may be necessary to fit further pipeline sections with bleeder valves.

Commissioning of automatic extinguishing water systems (sprinkler units)
A pressure test must be carried out before commissioning the system.
The pipeline network must be easily and fully accessible for the pressure test and must not be concealed.
If the system is not put into operation immediately after the pressure test, carry out a pressure test with oil-free compressed air or inert gases.

Procedure for a pressure test:

- Visual inspection of the complete system for obvious defects – thorough flushing of the entire piping network required
- Completely fill the system with the test medium, such as inert gases/oil-free compressed air/filtered potable water in accordance with the PWO
- Carry out a pressure test in accordance with the generally recognised rules of engineering (e.g. VdS CEA 4001, Chapter 17)
- Document the results of the pressure test in a log.
- Have an authorized expert sign the record and hand it to the customer

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the specific operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website viega.de by entering "material durability" as the search term.

	Sanpress	Sanpress Inox
Area of application	Extinguishing water systems dry wet/dry	Extinguishing water systems dry wet/dry
Pipe	Stainless steel 1.4401 or 1.4521	Stainless steel 1.4401 or 1.4521
Nominal diameter	DN80 88.9 x 2 mm	DN20 22 x 1.2 mm DN25 28 x 1.2 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm DN65 76.1 x 2 mm
Press connectors	Gunmetal	Stainless steel
Sealing element Fire extinguishing systems	Dry system: EPDM Wet/dry systems: EPDM	Dry system: FKM Wet/dry systems: FKM
Pressure range	1.6 MPa	1.6 MPa
Standard, Certificate, Proof of suitability	MPA test report No. 122000852-PB	VdS: G 4070017
Note	For dimensions < DN80 (88.9 mm), use Sanpress Inox.* For details, see Sanpress XL instructions for use.	Replacing the sealing elements with FKM. For the dimension DN80 (88.9 mm), use Sanpress XL.*

* For an installation example, see Fig. 102 or Fig. 103

Tab. 47: Application area of the Viega piping systems in **dry** and **wet/dry** extinguishing water systems , according to DIN 14462

	Profipress	Sanpress Inox	Sanpress	Prestabo hot dip galvanised	Megapress / Megapress S
Area of application	Exclusively Fire extinguishing systems wet	Exclusively Fire extinguishing systems wet	Exclusively Fire extinguishing systems wet	Exclusively Fire extinguishing systems wet	Exclusively Fire extinguishing systems wet
Pipe	Copper according to DIN EN 1057	Stainless steel 1.4401 or 1.4521	Stainless steel 1.4401 or 1.4521	Internally and externally galvanised steel pipe	Steel pipes, galvanised, in accordance with DIN EN 10255, galvanising in accordance with DIN EN 10240
Nominal diameter	DN10 12 x 1.0 mm DN12 15 x 1.0 mm DN15 18 x 1.0 mm DN20 22 x 1.0 mm DN25 28 x 1.5 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 2.0 mm 64.0 x 2 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108.0 x 2 mm	– – DN15 18 x 1.2 mm DN20 22 x 1.2 mm DN25 28 x 1.2 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm 64.0 x 2 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108.0 x 2 mm	– – DN15 18 x 1.2 mm DN20 22 x 1.2 mm DN25 28 x 1.2 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm 64.0 x 2 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108 x 2 mm	– – – DN20 22 x 1.5 mm DN25 28 x 1.5 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm 64.0 x 2 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108.0 x 2 mm	– – – 3/4 (DN 20) Wall thickness 2.6 to 3.3 mm 1 (DN 25) Wall thickness 2.6 to 3.3 mm 1 1/4 (DN 32) Wall thickness 2.6 to 3.3 mm 1 1/2 (DN 40) Wall thickness 2.6 to 3.3 mm 2 (DN 50) Wall thickness 2.6 to 3.3 mm 2 1/2 (DN 65) Wall thickness 2.6 to 4.5 mm 3 (DN 80) Wall thickness 2.9 to 5.0 mm 4 (DN 100) Wall thickness 3.2 to 5.4 mm
Press connector	Copper and Gunmetal/silicon bronze	Stainless steel	Gunmetal/silicon bronze	Galvanised steel	Non-alloyed steel
Sealing element	EPDM	EPDM	EPDM	EPDM	≤ DN50 EPDM / FKM ≥ DN65 FKM
Pressure range	1.6 MPa	1.6 MPa	1.6 MPa	1.6 MPa	1.6 MPa
Standard, Certificate, Proof of suitability	DIN 1988-600; DVGW certificate	DIN 1988-600; DVGW certificate	DIN 1988-600; DVGW certificate		
Note				Do not connect to potable water installations. Testing intervals according to DIN 14462-7.4 (maintenance) are permissible	

Tab. 48: Area of application of Viega piping systems in wet extinguishing water systems in accordance with DIN 14462

Tab. 49: Sprinkler unit in accordance with DvS Directives

	Profipress	Sanpress Inox	Prestabo hot dip galvanised	Megapress / Megapress S
Area of application	Sprinkler systems wet	Sprinkler systems wet wet/dry dry	Sprinkler systems wet	Sprinkler systems wet wet/dry dry
Pipe	Copper, according to DIN EN 1057 R 290 (hard)	Stainless steel 1.4401 or 1.4521	Internally and externally galvanised steel pipe	Black steel pipes, galvanised, industrially painted or powder-coated in accordance with DIN EN 10255, DIN EN 10216-1, DIN EN 10217-1 or DIN EN 10220 (galvanising in accordance with DIN EN 10240)
Nominal diameter	DN20 22 x 1 mm DN25 28 x 1.5 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 2 mm	DN20 22 x 1.2 mm DN25 28 x 1.2 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108 x 2 mm	DN20 22 x 1.5 mm DN25 28 x 1.5 mm DN32 35 x 1.5 mm DN40 42 x 1.5 mm DN50 54 x 1.5 mm 64 x 2 mm DN65 76.1 x 2 mm DN80 88.9 x 2 mm DN100 108 x 2 mm	¾ (DN20) Wall thickness 2.6–3.3 mm 1 (DN25) Wall thickness 2.6–3.3 mm 1¼ (DN32) Wall thickness 2.6–3.3 mm 1½ (DN40) Wall thickness 2.6–3.3 mm 2 (DN50) Wall thickness 2.6–3.3 mm 2½ (DN65) Wall thickness 2.6–4.5 mm 3 (DN80) Wall thickness 2.9–5.0 mm 4 (DN100) Wall thickness 3.2–5.4 mm
Press connectors	Copper and gunmetal	Stainless steel	Galvanised steel	Non-alloyed steel
Sealing element	EPDM	Wet fire extinguishing system: EPDM Wet/dry systems: FKM Dry system: FKM	EPDM	≤ DN50 EPDM / FKM ≥ DN65 FKM
Pressure range	1.6 MPa	DN20–DN65: 1.6 MPa DN80–DN100: 1.25 MPa	DN20–DN65: 1.6 MPa DN80: 1.25 MPa DN100: 1.0 MPa	DN20–DN65: 1.6 MPa DN80: 1.25 MPa DN100: 1.0 MPa
Certificate	VdS: G 4980009	VdS: G 4070017	VdS: G 4090017	VdS: G414021
Fire hazard classes according to VdS CEA 4001	LH, OH1 - OH3, OH4 restricted to exhibition halls, cinemas, theatres, concert halls	LH, OH1 - OH3, OH4 restricted to exhibition halls, cinemas, theatres, concert halls	LH, OH1 - OH3, OH4 restricted to exhibition halls, cinemas, theatres, concert halls	LH, OH1 - OH4, HHP1 - HHP4 and HHS1 - HHS4
Note		No certification for pipe size 64.0 mm		

PWIS conformity

The introduction of water-soluble paints into the automotive industry brought with it the toughest requirements for the systems and accessories used in the painting processes. Impurities, such as lubricants or softeners from sealing materials, on the components to be painted lead to coating defects known as pitting. To avoid this, the industry demands products that are free from paint **wetting** impairment substances, or **PWIS** for short. The interaction between substances and the coating system was initially observed with silicones, but also occurs with release agents, oils, greases and other substances. For this reason, the expression “PWIS conformity”, commonly known as “PWIS-free”, defines a requirement relevant to any substances.

Fig. 109: Impeccable painted surfaces

Freedom from PWIS refers not only to components involved in painting applications, it also includes all substances, lubricants and packaging materials used in paint shops.

Sources of PWIS
During painting processes, microscopic impurities can lead to surface tension defects. As a result, the paint is unable to wet the surface uniformly.

Contamination by paint-wetting impairment substances is typically introduced by two sources: operational processes and human beings.

Examples of operational sources are:
- Lubricants (for moving parts of appliances and systems)
- Release agents and softeners from plastic mounted parts in systems engineering or workpieces
- Residues of drawing agents and lubricants
- Hoses and sealants
- Impurities distributed through ventilation, process air systems or compressed-air systems
- Carryover from other areas of production
- Contaminated paint material, caused by improper storage, transport or unsuitable additives or solvents, for example

- Equipment and resources, such as cleaning agents, cleaning rags, abrasives, polishes, adhesive tapes or mounting units

Human sources include:
- Cosmetics, skin care products, shampoo, hairspray, hair gel, hair dyes, spectacle cleaners, deodorant, lipstick, aftershave, make-up, skin protection cream
- Clothing (e.g. impregnation), gloves, shoe care products
- Eating and drinking (fatty acid esters, e.g. butter or fats) as well as drinking cups (release agents in coffee machines)
- Plastic wrist bands or jewellery, fitness trackers, smartphone cases
- Natural skin oils

WFIS-compliant production
WFIS-compliant production requires suitable measures to be taken and constantly monitored along the entire production chain. This includes the use of PWIS-free production equipment and materials such as:
- Materials, elastomers in particular
- Additives and operating substances
- Materials
- Transport container
- Care products such as soap and skin protection cream
- Workwear and personal protective equipment

PWIS-free press connector installation systems from Viega are subject to special manufacturing criteria, from manufacturing process itself all the way to the packaging stage:
- Cleaning of the press connector after the production process (casting/deformation/machining)
- Mounting of special sealing elements using PWIS-free lubricants
- Marked with a blue dot on the press connection, Fig. 110
- Packaging with WFIS-free marking, Fig. 111

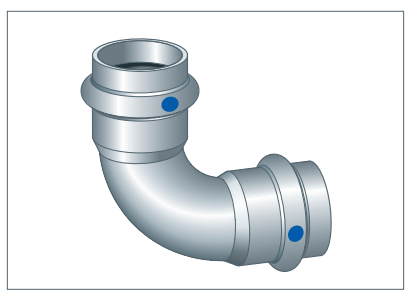


Fig. 110: Sanpress Inox LF

Fig. 111: Sanpress Inox WFIS-free, individually packed

Quality control
At Viega, the manufacture of PWIS-free press connectors is subject to strict internal testing. For quality assurance purposes, so-called pitting logs from all well-known German car manufacturers, who continually test Viega products, are available.

Viega solutions

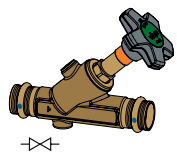
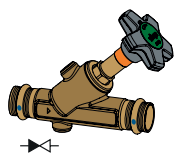
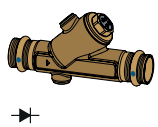
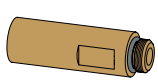
When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Currently, three PWIS-free press connector systems developed specifically for these requirements are available:
- Sanpress LF
- Sanpress Inox LF
- Prestabo LF

The product range is complemented by PWIS-free gunmetal and silicon bronze fittings from the Easytop series (Easytop LF). „Tab. 74: Test procedures for coating systems for non-alloy steel, hot-dip galvanised steel and steel with a thermally sprayed metal coating for atmospheric corrosivity categories (source: DIN EN ISO 12944-6)“ from page 275 provides an overview of the PWIS-free range of fittings.

All the Easytop fittings listed in this section are DVGW-approved and feature Viega press connections. Just like the press connectors, fittings free of paint-wetting impairment substances are marked with a blue dot on the press connection.

Figure	Model	Product name	Size d [mm]	Article number
	2237.5LF	Easytop slanted seat valve, free-flow valve	15 18 22 28 35 42 54	757 120 757 137 757 144 757 151 757 168 757 175 757 182
	2238.5LF	Easytop CRV slanted seat valve, free-flow with backflow preventer	15 18 22 28 35 42 54	757 458 757 465 757 472 757 489 757 496 757 502 757 519
	2239.4LF	Easytop backflow preventer	15 18 22 28 35 42 54	757 786 757 793 757 809 757 816 757 823 757 830 757 847
	2234LF	Easytop drainage valve	G ¼	565 312
	2234.5LF	Easytop drainage valve extension	G x L ¼ x 50	565 329

Tab. 50: Overview of PWIS-free Easytop shut-off valves and ball valves

Compressed air

Compressed air is used in various industrial applications. It is used as part of a process (process air), to clean machines and workpieces (blast air), to operate control systems (control air) and to generate a vacuum.

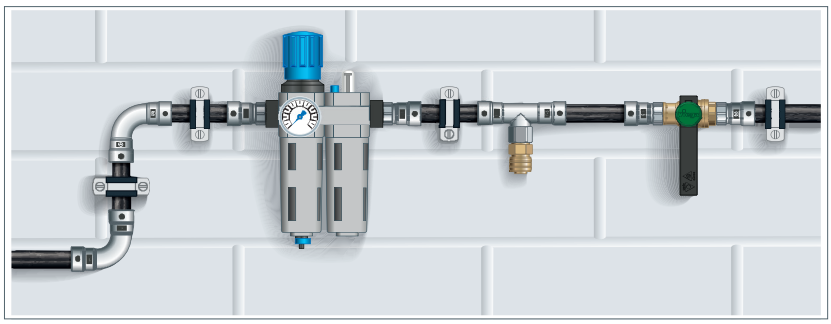


Fig. 112: Compressed air installation with Viega Megapress

Process air

Compressed air is defined as process air if it is physically or chemically involved as a medium in a machining or processing operation or if it is used to convey products. It always comes into direct contact with the product.

Typical applications for process air include:

- Transport of bulk material
- Aeration and drying processes
- Injection moulding

Fig. 113: Process air for propelling shuttles in weaving machines back and forth

Blast air
Blast air is compressed air that is used to clean machines and workpieces. Like process air, blast air comes into direct contact with the product during a machining or processing operation.

Fig. 114: Blast air during sandblasting

Control air
Control air is compressed air that is used to operate controls, linear and rotary compressed-air motors and instrumentation. It is also known as instrument air or service air and does not come into contact with the product during the process.

Typical applications of control air include:
- Driving machines
- Instrument air
- Pneumatic door openers

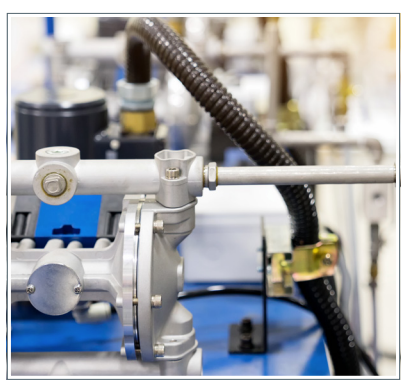


Fig. 115: Compressed air diaphragm pump

Vacuum

The use of compressed air to generate vacuum eliminates the need for decentralised equipment at the point of use.

Typical applications are:

- Packing
- Drying
- Lifting
- Positioning
- Exhausting

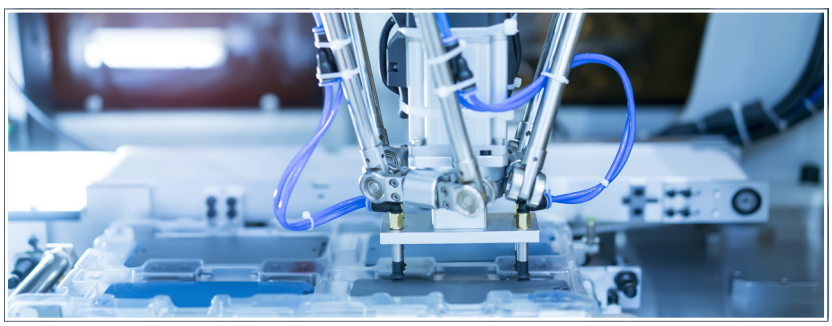


Fig. 116: "Pick and place" application using compressed air

Basics

Definition of compressed air

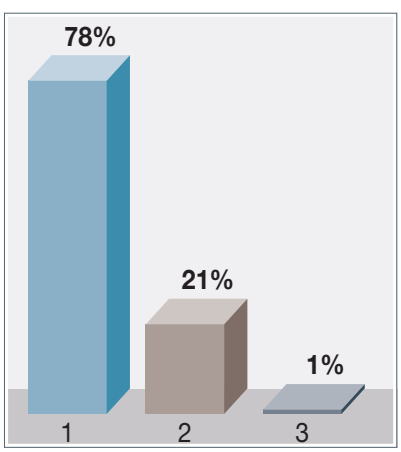


Fig. 117: Composition of air

Compressed air is air kept under a pressure that is greater than atmospheric pressure. Its composition is as follows: 78% nitrogen, 21% oxygen and 1% other gases. The compression process turns this air into an energy store. The energy released when the air expands can be used as service air for various technical applications.

1 Nitrogen
2 Oxygen
3 Other gases

The thermal parameters of temperature, volume and pressure determine the state of the compressed air. The volume and pressure of the gas are inversely proportional (ideal gas law):

$$\frac{p \cdot V}{T} = \text{constant}$$

Physical principles

The Boyle-Mariotte law can be used to describe the following compression processes.

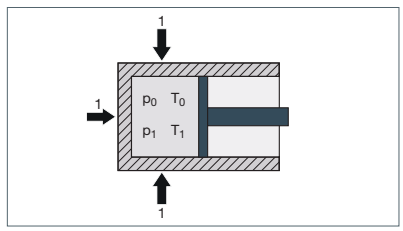


Fig. 118: Isochoric compression

Isochoric compression
at constant volume

1 Warmth

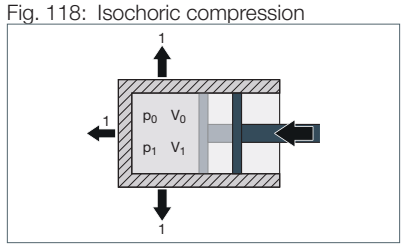


Fig. 119: Isothermal compression

Isothermal compression
at constant temperature

1 Warmth

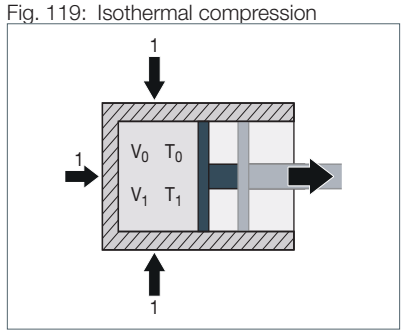


Fig. 120: Isobaric compression

Isobaric compression
at constant pressure

1 Warmth

Kinetic compressed air

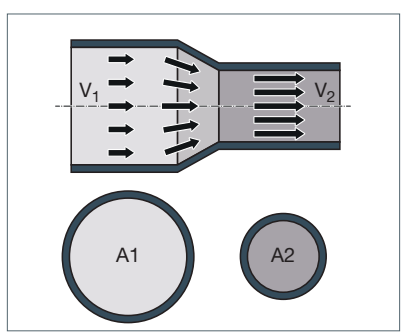


Fig. 121: Flow behaviour in case of changes to the cross section

Consideration should be given to the laws of kinetic compressed air in the dimensioning of compressed air installations. The volumetric flow is calculated from the cross-sectional area of the pipeline and the flow velocity:

$$\dot{V} = A1 \cdot V1 = A2 \cdot V2$$

The flow velocity is inversely proportional to the pipeline diameter. The flow velocity in compressed air installations is 2 to 3 m/s and should never exceed 20 m/s. Higher velocities transform the laminar flow into a turbulent flow. The consequences of this are flow noises, a bigger pressure drop and heat losses.

Compressed air quality

Untreated compressed air

On average, one cubic metre of untreated air contains

- 180 millions of dirt particles measuring 0.01–100 µm,
- 5–40 g of water,
- 0.01–0.03 mg of oil in the form of aerosols and non-combustible hydrocarbons and
- traces of heavy metals.

Compressing atmospheric air at 0.1 MPa to form compressed air at 1 MPa increases the concentration of the constituents by a factor of 11. High compressed air quality is therefore crucial to a system's economic efficiency and production safety.

Advantages of correct compressed air conditioning

The impurities contained in atmospheric air can negatively impact the compressed air installation and the consumers. Ultimately, the quality of products can suffer.

Conditioning compressed air in the proper manner has the following advantages:

- The service life of downstream compressed-air loads is extended
- Product quality is better and more consistent
- The compressed air lines remain free of condensate and corrosion
- There are fewer malfunctions
- Condensate collectors are no longer required
- Maintenance effort is scaled down
- The pressure losses caused by leaks and flow resistance are reduced
- The less severe pressure losses cut energy consumption

Compressed air qualities according to ISO 8573-1

To ensure smooth-running manufacturing processes, there must always be sufficient amounts of compressed air of consistent quality and at adequate pressure. The trouble-free operation of a compressed air system hinges on maintenance tailored to operational requirements.
ISO 8573 defines compressed air qualities in various classes:

Class	Maximum particle count pro m^3/ Mass concentration C_p [mg/m^3]			Pressure dew point [°C] / residual moisture content C_W [g/m^3]	Oil content [mg/m^3]
	0.1–0.5 µm	0.5–1 µm	1–5 µm		
0	Specified by the device user or supplier, more stringent than Class 1				
1	≤ 20 000	≤ 400	≤ 10	≤ -70°C	≤ 0.01 mg/m^3
2	≤ 400 000	≤ 6 000	≤ 100	≤ -40°C	≤ 0.1 mg/m^3
3	Not specified	≤ 90 000	≤ 1 000	≤ -20°C	≤ 1 mg/m^3
4		Not specified	≤ 10 000	≤ 3°C	≤ 5 mg/m^3
5			≤ 100 000	≤ 7°C	
6	≤ 5 mg/m^3*			≤ 10°C	
7	5–10 mg/m^3			≤ 0.5 g/m^3	
8				0.5–5 g/m^3	
9				5–10 g/m^3	
x	> 10 mg/m^3			> 10 g/m^3	> 5 mg/m^3

* If any particles larger than 5 µm have been detected, classes 0–5 cannot be applied.

Tab. 51: Compressed air purity classes according to ISO 8573-1

Typical compressed air purities for various areas of application

The typical purities indicated below are taken from VDMA Unit sheets 15390-1, 15390-2, as well as 15390-3, and are empirical values from industrial applications and subject to change. They are intended as a reference point for users of compressed air if the machine/appliance manufacturer has not provided any data for the required purity of the compressed air.

Use	Purity classes			
	Particles	Moisture (vapour)		Total oil content
		Ambient temperature		
		> + 10°C	≤ + 10°C	
	A	B_1	B_2	C
Mining				
Control air (working equipment and shaft installations)	7	4	2–3	4
Petrochemical				
Control air for refineries	5	4	2–3	2
Control air for drilling sites (gas/oil)	7	4	2–3	4
Food industry				
Control air in the production area Indirect contact with packaging material or product	2	4*	2–3	1
Process air Direct contact with the material of non-sterile packaging	2	4*	2–3	1
Tobacco processing				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	1
Textile sector				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	2
Paper industry				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	2
Publishing and printing sector				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	1
Chemical industry				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	1
Pharmaceutical industry				
Control air in production facilities (indirect contact with the packaging material and/or product)	2	4*	2–3	1
Process air (direct contact with the material used for non-sterile packaging)	2	4*	2–3	1
Rubber and plastics industry				
Control air	3	4	2–3	2
Process air (conveying air)	2–3	4	-	1
Blast air	2–3	4	-	2
Glass and ceramics industry				
Control air	3	4	2–3	2
Process air (conveying air)	3	4	2–3	2–3

Use	Purity classes			
	Particles	Moisture (vapour)		Total oil content
		Ambient temperature		
		> + 10°C	≤ + 10°C	
	A	B_1	B_2	C
Metal production and metalworking				
Control air	3–4	4	2–3	3
Process air (blowing out moulds)	4	4	2–3	3
Casting shops				
Control air	3–4	4	2–3	3
Process air (core shooting)	4	4	2–3	2–3
Surface finishing				
Control air, general	2	4	2–3	2
Process air (powder coating)	1	4	-	1
Control air	2	4	2–3	2
Control air not coming into direct contact with the paint, solvent or substrates to be painted	2	4	2–3	1
Blast and/or conveying air (spraying air) coming into direct contact with the paint (paint guns/nozzles)	1	2-4	2–3	1
Machine and plant engineering				
Control air (drive air)	3	4	2–3	3
Blast air	3–4	4	2–3	3
Electrotechnology, electronics				
Control air	2	4	2–3	2
Cable production	3	4	-	3
Energy supply				
Control air	3	4	2–3	3
Process air (decentralised conveyance of pulverised coal)	-	4	2–3	-
Measuring and testing systems				
3D measurement technology	2	3–4	-	1
Measuring and test air	2	3–4	3–4	1

* Higher compressed air purities may be required, depending on the compressed air system (see VDMA 15390-2, 4.1 to 4.5) and/or the applications, as well as and in particular the hazard assessment of critical control points under the HACCP concept

Tab. 52: Typical purity classes and their applications (selection from VDMA Unit sheets 15390-1, 15390-2 and 15390-3)

The itemised points, tables or lists are merely isolated examples from a number of methods and representations. The table is not intended to be exhaustive, nor does it claim to have precisely interpreted the existing legal regulations. The special features of the products concerned and their various potential uses must be taken into account.

Compressed air systems

Advantages of compressed air

Compressed air offers numerous advantages in industrial applications:

- **Central provision and distribution**
  The compressed air generated by the centrally installed compressors can be distributed via a pipeline network.
- **Storability in tanks**
  Compressed air can be delivered in tanks of all sizes – mobile and stationary – even to exposed sites.
- **Low weight of drives**
  Drives operated by compressed air are lighter than electrical ones. This is an advantage especially with hand-held tools.
- **Cleanliness**
  Residue-free use with advantages for the food, textile, paper and packaging industries.
- **Operational safety**
  Compressed-air devices are spark-free and can therefore also be used in areas at risk of fire and explosion.
- **Quick cycles**
  High flow speeds of >20 m/s ensure quick switching times for valves and high working speeds for machines. At 0.6 MPa, the valve cycle time is approx. 50 ms. The piston speed in pneumatic cylinders is approx. 15 m/s.
- **Adjustability**
  The forces, torques and speeds of drive and control elements can easily be adapted to the requirements using pressure and flow rate controllers.

Compressed air reprocessing

Multi-stage compressors based on the piston compressor principle have proven to be effective for the central supply of industrial compressed-air installations with a high compressed-air demand. It should be noted that the operating pressures used are mostly below 1.0 MPa.
Compressors suction in air from the surroundings and compress this to the required operating pressure. Depending on where they are set up, the air can contain pollution such as soot, dust, machine emissions and humidity which has to be removed before the air is fed into the compressed air installation. Impurities increase proportionately to the level of compression. When compressed air is produced at 1.0 MPa, the concentration of impurities increases 11-fold.
The aim of compressed air conditioning is, in addition to the removal of oil and dirt, to reduce air moisture. Energy-saving cold drying is used mostly for financial reasons.
Reprocessing is based on the specified requirements. According to ISO 8573-1, compressed air is divided into purity classes with corresponding requirements. The required purity classes for particles, water content and oil content can be completely different.
For example, the size and number of particles according to Class 2, the residual water content according to Class 3 and the residual oil content according to Class 1 can be set as requirements for the operator. As such, reprocessing must be planned and executed on a case by case basis. According to ISO 8573-1, compressed air of this nature carries the designation “ISO 8573-1 [2:3:1]”.
Compressed air installations in areas at risk of frost are fitted with an absorption dryer instead of a cold dryer. Absorption dryers achieve a lower residual moisture content (pressure dew point), which prevents the system from freezing in very low ambient temperatures.

Air pollution – condensation

In the industrial sector in particular, the quality of the outside air used to generate compressed air depends on the site concerned. Particles and aggressive components must be filtered out – either before being suctioned in by the compressor or, at the latest, during compressed air conditioning before being fed into the system. If this is not achieved or not done adequately, this has a negative impact on the compressed air installation and the functioning of the connected fittings, machines and devices. Also, any contaminated compressed air that leaks out can also be harmful to health and impair production quality. It is therefore advisable to provide pre-filters for the suctioned air and adapt the extent of compressed air conditioning to the conditions concerned.

Impact of unclean compressed air on system parts and human beings:
- **Condensate formation from solid particles and oils**
  Premature machine wear from abrasion and corrosion
- **Transport of germs/aggressive chemicals**
  Damage to health from the inhalation of leaking compressed air
- **Oil deposits**
  Cross-section constriction caused by resinification leads to loss of power and energy, which reduces the system's efficiency
- **Water accumulation**
  Leaks are rendered more likely due to electrochemical corrosion; impairment of lubrication systems in connected devices and machines; frost damage

Mixtures of water, oil, grease and other impurities resulting from the compression of air are referred to as condensates.
A mixture of a great variety of substances, compressed-air condensate is a very harmful stress factor for the environment. In Germany, for example, the correct procedure for disposing of condensate is laid down in the Federal Water Act. § 7a specifies that water containing hazardous substances must be processed in line with the generally recognised rules of engineering. Wherever condensate accumulates (pressure vessels, filters, dryers), it must be automatically drained away and collected to prevent it from being re-introduced into the compressed air flow.

System components

Requirements of compressed air systems
Compressed air systems can be divided into three parts:
- Compressed air generation – compressor with heat recovery
- Compressed air conditioning – storage, cleaning
- The piping system – distribution

The system components are selected based on the system requirements. They concern:
- the nature of compressed air generation – compressor type
- provision – centralised or decentralised
- the nature of heat usage or recovery
- the nature of storage – storage type
- the nature of compressed air processing – system type
- the piping system – material and execution

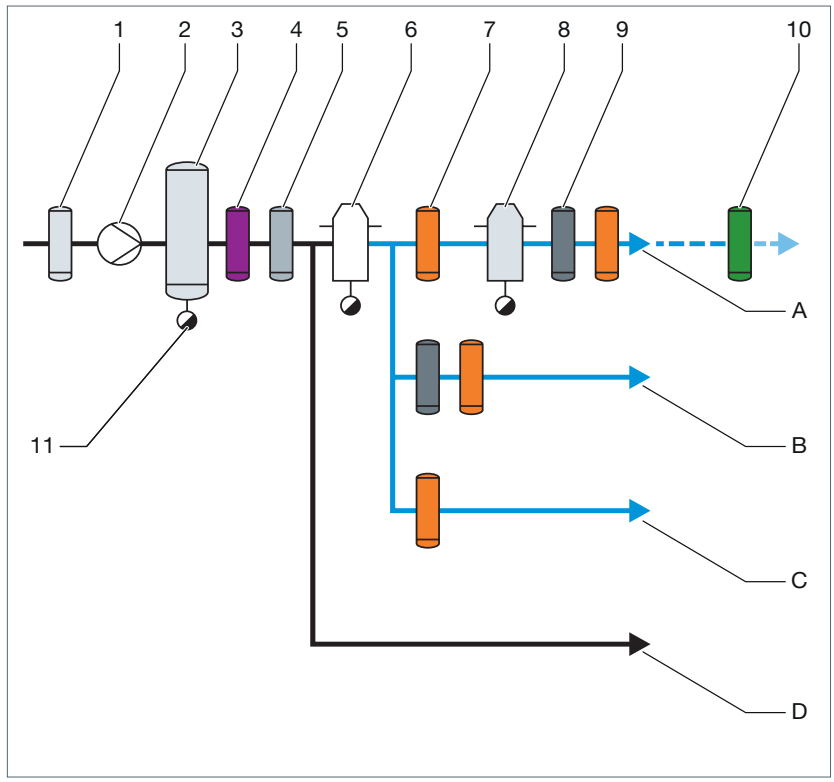


Fig. 122: Principle of a compressed air system

1 Suction filter
2 Compressor with heat recovery
3 Store
4 Cyclone separator
5 Pre-filter (sieve)
6 Cold dryer
7 Microfilter (volume filtration)
8 Absorption dryer
9 Microfilter (activated carbon)
10 Microfilter (sterile filter)
11 Condensate trap

A Top quality
B Better quality
C Normal quality
D Low quality

Compressed air generation
The following are required to dimension the compressor type:
- the sum of the required compressed air amounts
- the necessary reserve air amounts
- the necessary operating pressure
- the details on the planned future requirement

Depending on the quantity of compressed air and pressure levels required, different types of machines are used to produce compressed air.

- **Ventilator**
  For large quantities of air at low pressure.
  Rotating propeller blades create an air flow, mainly in the work area itself.
  Use: for cooling

- **Radial compressor**
  For low quantities of air at medium pressure.
  Air is routed to the centre of a rotating rotor and propelled to the periphery by the centrifugal force. The pressure increase is achieved by routing the accelerated air through a diffuser before it reaches the next rotor. As a result, the kinetic energy is converted into static pressure.
  Use: turbo charger in cars

- **Axial compressor**
  For large quantities of air at medium pressure
  The air alternatively flows through a series of rotating and stationary blades. The air is initially accelerated and then compressed. The blade channels form diffuser-like expanded channels in which the kinetic energy created via circulation stalls the air and converts it into pressure energy.
  Use: Aircraft turbines

- **Compressor**
  For medium and large quantities of air at high pressures.
  Compression of suctioned in air using pistons, often over several stages during intermediate storage, until the required operating pressure is achieved – designed as plunger or screw compressors.
  Use: Feeding large quantities of air into small stores (e.g. (scuba tanks) or central compressed air provision with long transport routes

- **Fire protection**
  In special buildings, rooms at particular risk of fire, such as spaces where compressors operate, are partitioned off for fire safety purposes, even if they are located in the same unit. These specifications can be found in the fire safety concept or the building permit.

Requirements for fire-resistant operating rooms

- Walls, ceilings, floor structures and doors must be specified to be at least fire-retardant.
- No flammable liquids may be stored.
- The floor structure around the compressor must be made of non-flammable material.
- Leaking oil must be prevented from spreading over the floor.
- There must be no flammable materials within a three metre radius of the compressor.
- There must be no flammable system parts above the compressor (cable trays, plastic pipes etc.).

Compressed air storage

Pressure vessels are a core component of any compressed air system. The required vessel size depends on the compressed air requirements and the type of compressor.

Pressure vessels have to perform the following tasks:

- Buffer for consumption peaks
- Pulsation damper when using piston compressors
- Condensate separation

Compressed air distribution

piping systems

Compressed air-driven tools, devices, machines and systems are supplied with compressed air via a piping system. The basis for efficient and economic operation is the differentiated dimensioning of the pipeline diameters during the planning and professional execution of the installation. Compressed air systems are required to achieve high levels of performance:

- Sufficient amounts of compressed air of consistent quality and pressure must be available to each consumer at any time.
- The piping system must be leak-free.
- The piping system must be divided into blockable sections. Expansions, maintenance and repairs must not lead to failure of the system as a whole.
- The system must be executed in line with the applicable safety regulations.

A piping system is divided into the sections

- Supply line
- Manifold
- Connection line

It is important to calculate the pressure losses in the individual piping sections. The total pipe length, also referred to as fluidic pipe length, includes the equivalent pipe length of moulded pieces and fittings. With the equivalent length method, the pressure loss through elbows, fittings and other pipeline components is described by means of tables as the pressure loss along the length of a straight pipe.
If the piping route is not known during planning, the fluidic pipe can be estimated by multiplying the straight pipe length by 1.6.
The nominal widths of the individual pipeline sections are determined using a layout diagram, with due consideration for the air quantity assigned to the pipeline section and the pressure loss to be respected, as well as pressure at which the system is operated.

Supply line

The compressor station with compressed air conditioning and the compressed air tanks are connected via the supply line. According to VDMA 15391-1, the pressure drop Δp in the supply line should not exceed 30 hPa. From the supply line, the compressed air is routed through a header. In the header (ring system or single connection pipeline), the pressure drop should not exceed Δp 30 hPa.

Ring system as manifold
A ring system is a closed distribution ring. Areas of the piping can be shut-off individually for maintenance purposes. This ensures the supply to most of the other consumers at all times. Ring systems typically have short distances, low pressure losses and small nominal pipeline widths.

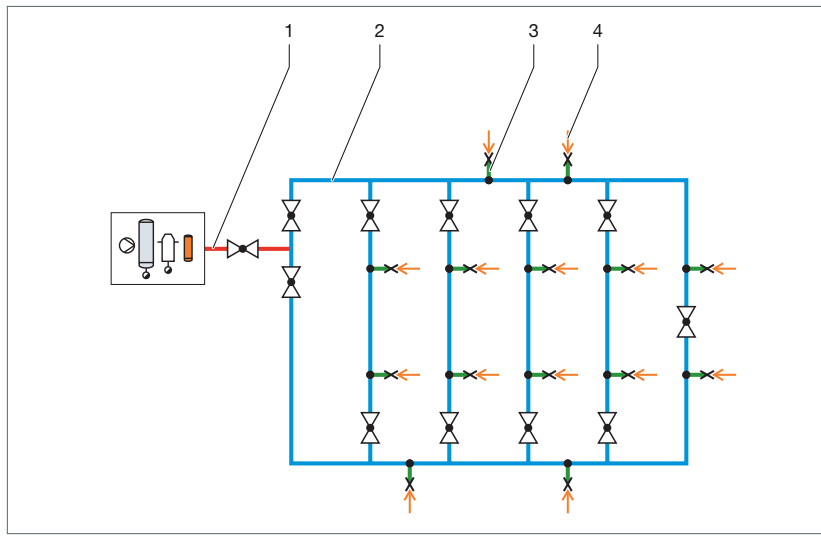


Fig. 123: Compressed air supply with ring system

1 Supply line
2 Ring system
3 Connection line
4 Connection point

Advantages:
- Sections possible
- Section-by-section maintenance
- Short distances to the connection points
- Low pressure losses
- Smaller pipeline nominal widths

Disadvantages:
- More material required than in a installation with a single supply line

Single connection pipeline as manifold
A single connection pipeline branches from the supply line as an individual distribution leg and leads to the connection lines, which in turn lead to the consumer. Although less material is required, single connection pipelines must be dimensioned larger to prevent higher pressure losses. Single connection pipelines should be equipped with a shut-off valve for maintenance purposes.

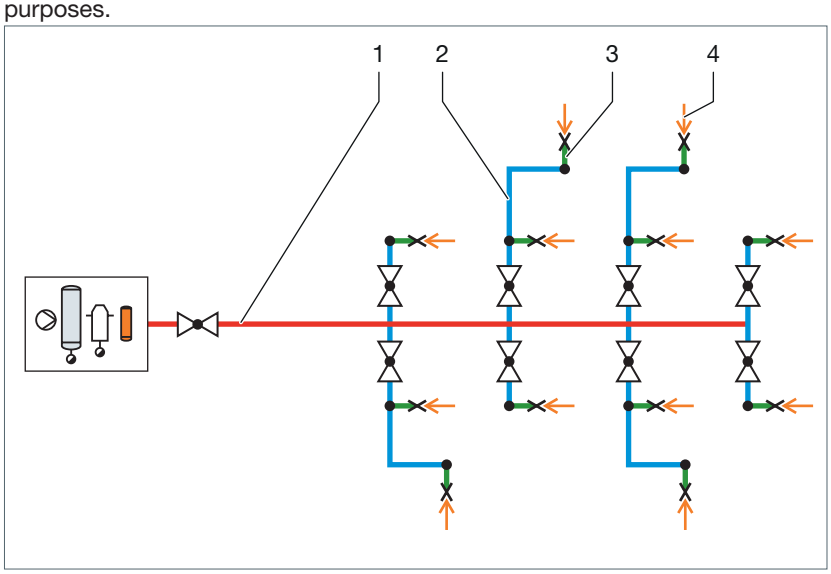


Fig. 124: Compressed air supply with single supply line

1 Supply line
2 Single connection pipeline
3 Connection line
4 Connection point

Advantages
- Less material required than for a ring system

Disadvantages
- Frequently occurring high pressure losses
- Large pipeline nominal widths

Connection line
The consumers are supplied with compressed air through the connection line. If the consumers are operated at different pressures, a maintenance unit with pressure regulating valve, via which the supply pressure is reduced to the operating pressure of the consumer, has to be installed in front of the consumer. Maintenance units – consisting of filter, separator, controller and oiler – are not required for treated compressed air. The pressure drop Δp in the connection lines should not exceed 40 hPa. Connection lines with a nominal diameter of DN25 are recommended in industry for a compressed air requirement of 1800 l/min and a pipe length of 10 m.

Total pressure loss for the compressed air system

The total pressure loss for a compressed air system should not exceed 0.1 MPa for economic and ecological reasons.

With a pressure loss of 0.1 MPa (1 000 hPa), the system parts can be assigned the following pressure losses on a pro rata basis:

- 100 hPa Pipeline network with supply line, manifold and connection line
- 700 hPa Provision with drying, cleaning, storing, supply line connection
- 200 hPa Reserves, tool or device connection

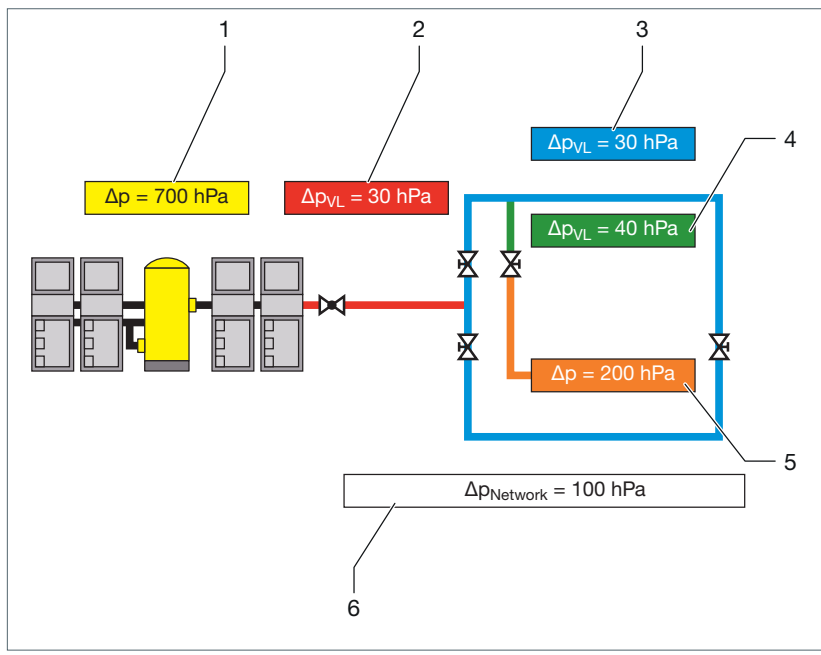


Fig. 125: Pressure losses from a compressed air system

1 Provision
2 Supply line
3 Manifold
4 Connection line
5 Tool or machine connection
6 Pressure loss in the pipeline network (2 + 3 + 4)

Piping calculations

Compliance with the pressure losses recommended on an economical basis calls for accurate dimensioning of the piping system. Pipe strength is determined by the maximum pressure. Pipe dimensioning is based on the maximum volumetric flow with the lowest possible pressure loss. A uniform flow pressure must be maintained at every draw-off point. The flow velocity of the compressed air in piping is generally 2 to 3 m/s and, to prevent flow noises and turbulence, should not exceed 20 m/s. The flow velocity of compressed air containing condensate should be no higher than 3–4 m/s.

This is to ensure that the condensate is not entrained. Higher flow velocities may be required for process-related reasons, in machines with fast production cycles for example. The pressure loss from the piping system as a whole should not exceed 0.01 MPa.
The VDI Heat Atlas can be used to assist with the pressure loss calculation. The nomograph from VDMA 15391-1 provides a practical aid to calculating the clear nominal pipe diameter.

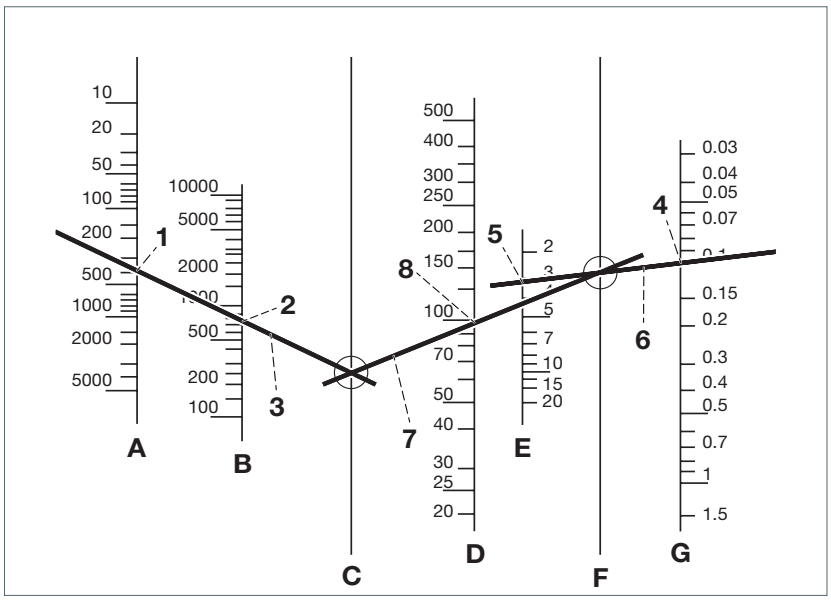


Fig. 126: Nomograph for calculating the clear nominal pipe diameter

A Pipe length [m]
B Suction volume [m^3/h]
C Auxiliary axis 1
D Clear nominal pipe diameter [mm]
E System pressure [bar]
F Auxiliary axis 2
G Pressure loss [bar]

Determine the nominal pipe diameter as follows:
1. Axis A: mark equivalent pipe length.
2. Axis B: mark suction volume.
3. Connect points 1 and 2 with a straight line and intersect Axis C.
4. Axis G: mark pressure loss.
5. Axis E: mark system pressure.
6. Connect points 4 and 5 with a straight line and intersect Axis F.
7. Connect Axes C and F intersection points with a straight line.
8. Axis D: read off pipe nominal width.

Additional planning notes

- Lay compressed-air lines as straight as possible
- Use elbows or Y-sections for changes of direction
- If possible, do not use T- or knee pieces
- Avoid abrupt cross-sectional changes

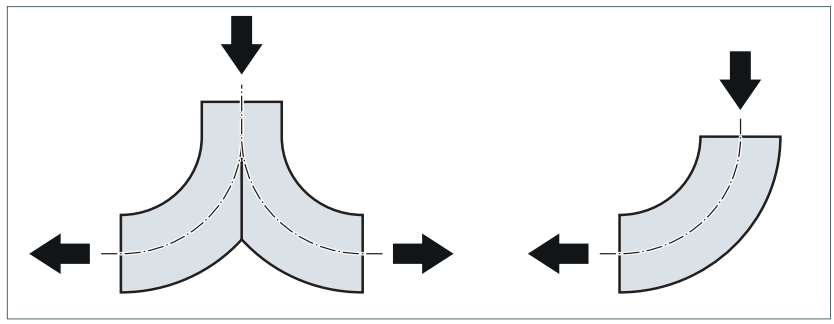


Fig. 127: Y-section and elbow

Pipeline networks without compressed air drying

If the drying stage is omitted from compressed air conditioning, condensate can form throughout the pipeline network. The following measures should be taken to prevent damage to compressed air consumers:

- Do not allow compressed air to cool down in the process
- Lay piping sloping (gradient of 1.5–2‰)
- Lay the supply line vertically downstream of the compressor
- Install condensate drainers at the lowest points of the compressed air installation
- Branch connection lines upwards in the direction of flow
- Install maintenance units with filter, water trap and pressure reducer

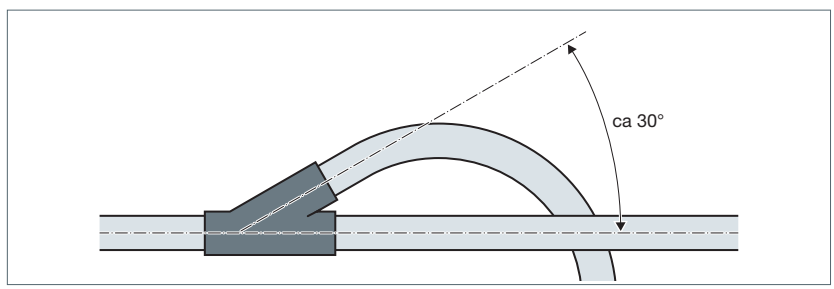


Fig. 128: Laying the connection line

Pipeline networks with compressed air drying
A number of measures can be omitted in pipeline networks with compressed air drying:
- Piping can be laid horizontally
- Condensate drainers installed only at filters, containers and dryers
- Connection lines can be laid facing downwards
- Pressure reducers can be provided without water separator

Material selection and connecting technology for piping systems

Compressed air installations should be maintenance-free if possible and dimensioned to suit requirements. Within the scope of planning and material selection for the pipeline installation, it is important to take the individual, mechanical and chemical factors into account.
In order to determine the material suitable for use in compressed air systems, the advantages and disadvantages of the materials normally used must be weighed up on a case-by-case basis:
- Comparison of the pipe materials' mechanical and chemical properties
- Influence of pipe material on compressed air quality
- Mounting and fixing requirements for piping
- Synergy from the use of certain pipe materials, e.g. lower energy consumption due to reduced pressure loss from pipe friction, expanding the use of press connector systems to other areas (potable water, technical gases etc.)

The same criteria apply to selecting a suitable pipe connecting technology as to selecting the material. More importance is attached to the use of resources for mounting.
Important criteria for pipe connection technology:
- Components – manageable amount, simple to handle
- Properties – high tensile strength, pressure-proof
- Personnel qualifications – no special qualifications required
- Mounting – quick, with only few tools and personnel

Approval of compressed-air systems

A compressed-air system requires monitoring. This system is bound by acceptance regulations in accordance with the latest German Pressure Equipment Directive (DGRL) and Industrial Safety Regulations (BetrSichV). Pressure systems are therefore required to be tested prior to initial commissioning, after any modifications that have to be inspected and also after periodic tests. The obligation to test compressed-air systems is a requirement specified in EU Directive 2014/68/EU (Official Journal of the European Union). Data Sheet T 039/BGI 619 of April 2012 from the Employer's Liability Insurance Association for Raw Materials and Industry describes the test procedure. In the EU, these tests must be performed by certified inspection bodies, e.g. DEKRA and TÜV in Germany.

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

The compressed air quality can be influenced by various factors. Such factors include the compressed air compressor, the piping systems employed and the transport, storage and installation of the components used.
During operation of the compressed air system, the possibility of particle abrasion and the condensing of atmospheric moisture also play an important role. To prevent atmospheric moisture from condensing in the piping, it must be ensured during the planning phase that the temperature does not drop below the dew point.
Tab. 53 provides an overview of the Viega piping systems and their potential applications in accordance with ISO 8573-1. To achieve the required purity classes, suitable measures must be taken to protect the components from contamination during transport, storage, installation and commissioning.
The use of FKM or HNBR sealing elements make the Viega piping systems suitable for oil-containing compressed air also.
The purity classes for compressed air in accordance with DIN ISO 8573-1 are among the determining factors for the ability to use products from Viega for compressed-air applications.

Considering the requirements of DIN ISO 8573-1, Viega piping systems are a good choice for compressed air.

The following systems can be used:
- Profipress, Profipress S, Profipress G
- Sanpress
- Sanpress Inox, Sanpress Inox G
- Sanpress Inox LF
- Temponox
- Prestabo
- Prestabo LF
- Megapress, Megapress S, Megapress G
- Seapress

Tab. 53: Area of application of Viega piping systems by purity class as per ISO 8573-1, Part 1 of 2 (2023-11, V39)

system name	pipe material	Sealing element[12]	p_{max} [MPa]	T_{max} [°C]	Solid particles[13] class									Residual moisture content class										Oil content class					
					0	1	2	3	4	5	6	7	X	0	1	2	3	4	5	6	7	8	9	X	0	1	2	3	4	X
Profipress	Copper pipe acc. to DIN EN 1057	EPDM	1,6	60	O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
Profipress S		FKM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
Profipress G		HNBR			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
Sanpress	1.4401 model 2203/2203XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
	1.4521 model 2205/2205XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
	1.4520 model 2204/2204XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
Sanpress Inox	1.4401 model 2203/2203XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
	1.4521 model 2205/2205XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
	1.4520 model 2204/2204XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✗
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
Sanpress Inox G	1.4401 model 2203/2203XL	HNBR			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓
Sanpress Inox LF	1.4401 model 2203/2203XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✗
	1.4521 model 2205/2205XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✗
	1.4520 model 2204/2204XL	EPDM			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✗

[12] EPDM sealing element for oil concentrations < 25 mg/m³

[13] Recommendation for classes 1 to 3: Flush the line before commissioning

[15] The EPDM factory-fitted sealing element can be exchanged for a FKM sealing element on-site

✓ = For use

✗ = Not for use

O = Conditional use, consultation with the Service Center required

Tab. 54: Area of application of Viega piping systems by purity class as per ISO 8573-1, Part 2 of 2 (2023-11, V39)

system name	pipe material	Sealing element[12]	p_{max} [MPa]	T_{max} [°C]	Solid particles[13] class									Residual moisture content class												Oil content class					
					0	1	2	3	4	5	6	7	X	0	1	2	3	4	5	6	7	8	9	X	0	1	2	3	4	X
Seapress	Copper nickel wrought alloy to DIN 86019 WL 2.1972.11 or WL 2.1972.22	EPDM	1.6	60	O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	X
		FKM[15]			O	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓
Prestabo	Externally galvanised model 1103/1103XL	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	X
		FKM[15]			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓
	PP coated model 1104	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	X
		FKM[15]			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓
	Externally and internally galvanised model 1106/1106XL	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	X
		FKM[15]			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓
Prestabo LF	Externally galvanised model 1103/1103XL	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	X
	PP coated model 1104	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	X
	Externally and internally galvanised model 1106/1106XL	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	X
Megapress	Steel pipes according to DIN EN 10255 DIN EN 10220 DIN EN 10216-1 DIN EN 10217-1	EPDM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	X
Megapress S		FKM			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓
Megapress G		HNBR			X	X	X	X	✓	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	✓

[12] EPDM sealing element for oil concentrations < 25 mg/m³

[13] Recommendation for classes 1 to 3: Flush the line before commissioning

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Technical gases

Technical gases are gases that are produced by a technical process and have to achieve a specified purity. They are used primarily in trade and industry. They often have a high degree of purity, which can usually be achieved only through specific treatment techniques. Conceptually, they are differentiated from industrial gases, which do not involve a specified purity of substances. Technical gases are pure gases consisting of one element or mixtures of pure gases.

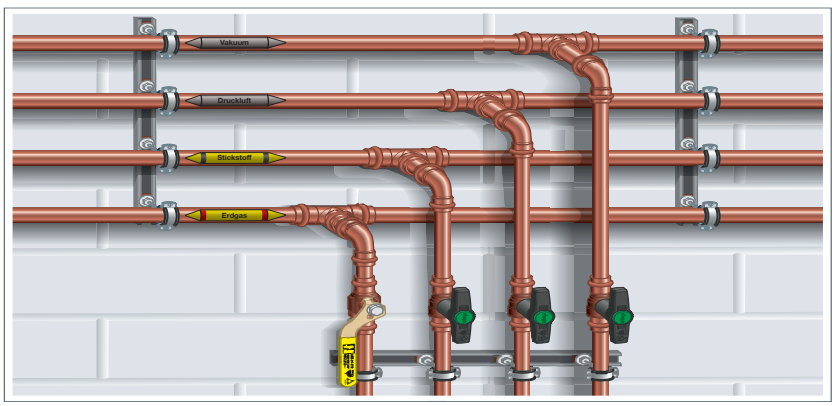


Fig. 129: Piping system for technical gases with Viega Profipress

Nowadays, technical gases are used in almost every sector of industry. Employed as control, protective and carrier gases, they transmit energy and have a reactive, reductive, oxidising, neutralising, cryogenic or thermal effect. Sectors in which technical gases are typically used include:

- Food industry
- Automotive industry
- Chemical industry
- Pharmaceutical industry
- Petrochemical industry
- Metal processing industry

The chemical and physical properties of technical gases determine their areas of application. They are used mainly as:

- Protective gas during welding and hardening processes
- Inert gas
- Fuel gas
- Respiratory gas (among other applications in medical technology)
- Gas for leakage tests
- Means of transport (pneumatic conveyance of explosive and combustible bulk materials)
- Packaging gas

The examples below illustrate the broad range of potential applications.

Welding technology
Various gases are used, depending on the welding process:
- Acetylene/oxygen:
  Autogenous welding
- Argon/helium mixture:
  Metal Inert Gas welding (MIG), Tungsten Inert Gas welding (TIG)
- Argon/carbo dioxide/oxygen mixture (e.g. Corgon®):
  Metal Active Gas welding (MAG)

The protective gas displaces the air to prevent an explosive air/gas mixture from forming. During gas metal arc welding processes, it prevents combustion and corrosion because the metal is unable to react with oxygen. In the case of high-alloy steels containing aluminium and titanium, high-grade protective gas eliminates the risk of tarnishing. DIN EN ISO 14175 specifies the purities of various technical gases used specifically for welding.

Fig. 130: Gas metal arc welding

Hardening technology
In hardening technology, nitrogen and hydrogen prevent the unwanted effect of the steel to be hardened being altered by oxygen. Once hardened, steel components for example have a polished surface that is free of any residue.

Fig. 131: Protective gas furnace for hardening gearwheels

Food technology

Oxygen accelerates the oxidation of food and the growth of aerobic microorganisms. Nitrogen and carbon dioxide, on the other hand, prevent this effect and are therefore used as protective gases in packaging technology. Conversely, oxygen is widely used in meat and vegetable processing. It acts as a stabiliser for the red colour of the meat and keeps vegetables fresh for longer.

As well as its role in packaging technology and for carbonating beverages, carbon dioxide can also be used as dry ice.

Fig. 132: Carbon dioxide for carbonating beverages

Leakage tests

Helium is used as a medium for carrying out leakage tests on technical systems in numerous sectors of industry:

Leakage tests	
Automotive	Airbag detonators, shock absorbers, sensors
Semiconductor industry	Integrated circuits
Aviation	Hydraulic components, engines
Vacuum systems	Gas-carrying pipes
Plant engineering	Leakage testing of piping
General information	Packaging, drums, timers

Medical technology

Oxygen, carbon dioxide, nitrous oxide, helium and nitrogen are used in medical technology. Applications such as respiratory support and anaesthesia, as well as for calibrating medical devices. Medical gases are required to have a specific purity. Therefore, in Germany for example, the provisions from the Pharmaceuticals Act must be taken into account.

Basics

Overview Technical gases vary in terms of their physical, chemical and physiological properties and are classified as follows:

- Inert gas
- Combustible and self-igniting gases
- Oxidising gases
- Corrosive gases
- Toxic gases
- Testing and calibration gases

Certain technical gases are recovered from the atmosphere by means of air separation units. These include:

- Oxygen
- Argon
- Nitrogen
- Xenon
- Neon

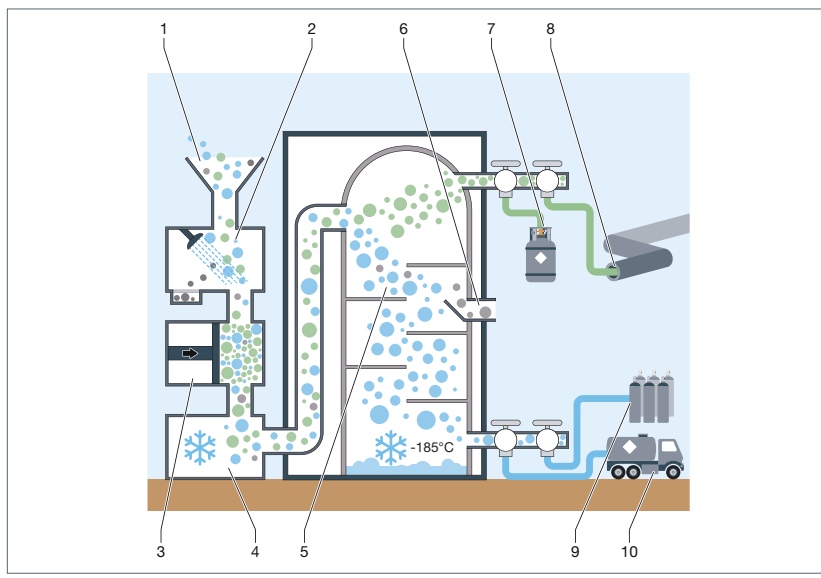


Fig. 133: Principle of an air separation unit

1 Intake of air
2 Pre-cleaning
3 Compression
4 Pre-cooling
5 Separation
6 Raw argon removal
7–10 Bottling

Other technical gases are obtained by different methods. Carbon dioxide, for example, is recovered from the waste air discharged by industrial operations. Hydrogen and acetylene are produced by chemical processes.

Examples of technical gases

Important properties, safety precautions, material compatibilities and relevant regulations for relevant technical gases are listed below.

An overview of suitable Viega piping systems can be found in the “Areas of application for metal piping systems” data sheet on the Viega website *viega.de*.

Ethyne (C_2H_2), also called acetylene

Properties:	Colourless, mildly odorous, flammable, lighter than air
Application:	Extremely important to industrial processes. Used as a starting compound in the large-scale production of important base chemicals. Other applications: autogenous welding and cutting processes.
Safety:	Non-toxic, flammable gas. Forms explosive mixtures in the presence of air (ignition range: 1.5–83 volume percent). Under unfavourable circumstances without the involvement of oxygen, the high-energy acetylene molecule can decompose and release energy. This self-disintegration can be initiated by an acetylene cylinder in a hot environment, or is caused by a flashback into the cylinder. The start of disintegration is signalled by heat development inside the cylinder. Countermeasures: Clear the danger zone. Cool down the cylinder with copious amounts of water from a safe distance.
Pipe material:	Stainless steel Copper is forbidden as a pipe material for acetylene, since acetylene reacts with copper to form copper acetylide. In its dry state, this compound is extremely sensitive and can be caused to explode simply through friction. Fittings made of copper alloys must not contain more than 70% copper.
Regulations:	Code of Practice Acetylene, BetrSichV

Argon (Ar)

Properties:	Colourless, odourless, inert
Application:	Serves as an inert gas in metallurgy and for arc welding. Used in numerous different mixtures for welding technology, argon usually being the primary component and hence dominating the properties. Used as a food additive (E938) and as a protective gas in food packaging processes.
Safety:	A non-toxic, inert gas that forms practically no chemical compounds. Just like nitrogen, argon is capable of displacing the oxygen required for respiration. Because argon is heavier than air, it accumulates in case of leaks, particularly at ground level and in recesses. Check the O2 content! Prevent liquid argon from coming into direct contact with the skin. Wear protective gloves and safety goggles!
Pipe material:	Copper and stainless steel For argon and noble gases such as helium, crypton, xenon, radon Steel For argon
Regulations:	UVV gases (BGV No. B6)

Oxygen (O_2)

Properties:	Colourless, odourless
Application:	Used to intensify combustion processes, e.g. in the steel industry and for autogenous welding and cutting operations. Also supports biological processes, including breaking down pollutants in purification plants. In its purest form, it is used as medical oxygen for respiration.
Safety:	A non-toxic gas and does not burn, it does however promote combustion. A slight increase in the oxygen content of air can significantly speed up combustion processes. In the presence of pure oxygen, even supposedly incombustible materials such as steel can burn. Under atmospheric conditions, the temperature of liquid oxygen is approx. -183°C. Liquid oxygen should therefore be prevented from coming into direct contact with the skin. Wear protective gloves and safety goggles!
Pipe material:	Copper, stainless steel and standard steel All parts coming into contact with oxygen must be free from oil, grease, glycerine or other carbon-containing lubricants due to the risk of explosion.

Regulations:	UVV Oxygen (BGV No. B7) UVV Welding and cutting (BGV No. D1) BG Information on handling oxygen (BGI No. 617) BG Information on the risks presented by oxygen (BGI No. 644)

Nitrogen (N_2)

Properties:	Colourless, odourless, inert
Application:	Used as an inert gas for the safe storage of combustible liquid and dusts, and also as a protective gas for annealing metals. In its cryogenic, liquefied state, acts as a refrigerant in the food sector and for industrial production processes, for example.
Safety:	Non-toxic, inert gas. When handling nitrogen, remember that it can thin or displace the atmospheric oxygen required for respiration. When evaporated, 1 litre of liquid nitrogen expands to form around 700 litres of nitrogen gas. As a result, evaporating liquid nitrogen can appreciably reduce the oxygen content of closed rooms. Eliminate this risk by aerating or exhausting. Prevent liquid nitrogen from coming into direct contact with the skin. Wear protective gloves and safety goggles!
Pipe material:	copper, stainless steel and standard steel

Hydrogen (H_2)

Properties:	colourless, odourless, combustible
Application:	Used as a protective gas in the heat treatment of metals and for hydrating processes in the chemical industry. In the electronics industry and food technology sector, it is used as a process gas. In addition, hydrogen is used in drive technology.
Safety:	Forms explosive mixtures in the presence of air (ignition range 4-75 volume percent). Is much lighter than air and rises quickly in case of leaks. Therefore, the risk of explosion usually exists only for a short time if hydrogen is released (in contrast to liquid gas). Combusts with air in an almost colourless, practically invisible flame.
Pipe material:	Copper and stainless steel
Regulation:	BG-Information Wasserstoff (BGI-Nr. 612)

Carbon dioxide (CO_2)

Properties:	Colourless, odourless, inert, readily soluble in water
Application:	Used as a protective gas for packing food and for carbonating beverages. Also used as an inert gas for covering and conveying explosive and combustible silo solids. Other applications include the preservation of fruit, vegetables and crops, as well as use as a fire extinguishing agent. It is used for cooling purposes in the form of dry ice.
Safety:	Very mildly toxic, almost inert gas. Carbon dioxide is capable of displacing the oxygen required for respiration. It is 1.5 times heavier than air. In case of major gas leaks, therefore, it can lead to dangerous concentrations at ground level, in recesses and in basements. Prevent dry ice (temperature of -78°C from coming into direct contact with the skin. Wear protective gloves and safety goggles!
Pipe material:	Piping must be executed in cold-resistant materials (e.g. stainless steel). To prevent chemical reactions with the pipe material, the carbon dioxide must be technically dry and moisture must be prevented from penetrating the piping system.
Regulation:	UVV gases (BGV No. B6)

Corgon® (mixture of CO_2 and Ar)

Properties:	Colourless, odourless, inert
Application:	Used as a protective gas for MAG welding.
Safety:	Non-flammable. Can cause suffocation in high concentrations. Heavier than air. In case of major gas leaks, therefore, it can lead to dangerous concentrations at ground level, in recesses and in basements.
Pipe material:	Copper, stainless steel and standard steel

Medical gases
(e.g. oxygen, carbon dioxide, nitrous oxide, helium, nitrogen)

Properties:	In Germany, for example, they are regulated by the Pharmaceuticals Act and therefore have to meet high quality standards. Consequently, only extremely pure technical gases may be used for medical purposes.
Application:	Used for respiratory support and anaesthesia, as well as for calibrating medical devices.
Safety:	Used as pharmaceutical or medical products and are therefore in direct contact with living bodies.
Pipe material:	The technical regulation DIN EN ISO 7396 specifies the use of corrosion-resistant materials for medical gases. Currently, the hard soldering and welding processes are carried out under protective gas.
Regulation:	DIN EN ISO 7396 Must have a specific degree of purity. Therefore, in Germany for example, the requirements specified by the Pharmaceuticals Act must be taken into account.

Purity classes of technical gases

The purity of a substance is defined as the amount of the substance itself compared to the total amount of the mixture. Chemical substances are assigned purities of "raw" all the way through to "for analysis". In the case of technical gases, on the other hand, the method of point notation has become an established standard. The substance amounts are expressed in volume percent. A substance without any impurities at all has a purity of 1 or 100%.

- The digit before the point indicates the number of "nines" in the value for the percentage of the pure gas.
- The digit after the point indicates the first decimal point to deviate from the digit "nine".

Point notation	Percentage of substance amount
2.0	99 %
2.5	99.5 %
3.0	99.9 %
5.0	99.999 %
5.7	99.9997 %
6.0	99.9999 %

Tab. 55: Examples of purity classes

The following gas purities can be distinguished:

Gas types	Gas quality	Purity [%]	Residual grease content [mg/dm²]	Leakage rate [mbar·l/s]
Technical gases	< 4.5	99,995	0.2–0.4	≤ 10^{-4}
Pure gas	4.5–5.0	99.995–99.999	≤ 0.2	≤ 10^{-5}
High-purity gas	> 5.0–6.0	99.999–99.9999	≤ 0.1	≤ 10^{-8}
Ultra-pure gas	> 6.0	> 99.9999	< 0.1	≤ 10^{-9}

Tab. 56: Overview of gas types and degrees of purity

Technical gases contain residual impurities, such as moisture, hydrocarbons and other gases. These are specified by the manufacturers in a non-uniform manner and can be as follows:

Argon 5.0 (99.999%)	
O_2	≤ 2 ppm
N_2	≤ 4 ppm
C_nH_m	≤ 0.3 ppm
H_2O	≤ 3 ppm

Tab. 57: Example of the residual constituents of Argon 5.0

Gas purities for various areas of application

Technical gases must have a purity class appropriate for the application. Tab. 58 shows examples of purity classes depending on the application.

Use	Gas	Purity level	Standard
MIG welding gas	Argon	4.8	ISO 14175 Group I1
Laser welding	Helium	4.6	ISO 14175 Group I2
Metalworking	Carbon dioxide	4.5	ISO 14175 Group C1
Gas chromatography, measurement technology	Nitrogen	5.0	ISO 14175 Group N1
Dry ice (food quality E290)	Carbon dioxide	3.0	EU Ordinance 231/2012

Tab. 58: Typical purities of technical gases

The purity requirements of EU Ordinance no. 231/2012 must be fulfilled when using technical gases in the food industry. In practice, the purity requirements are often exceeded.

Legal and normative principles

Piping for technical gases must be laid in compliance with the relevant regulations. These include Code of Practice for Acetylene, AD 2000, TRBS, DVS Data Sheet.
In Germany, the safety regulations of the government and the Employer's Liability Insurance Association must be observed for the handling of gases. The Ordinance on Hazardous Substances (GefStoffV) defines most gases as hazardous substances. This ordinance states that employees have to be protected against the possible damaging effects of hazardous substances. It stipulates, among other things, that substance-specific operating instructions have to be drawn up for the handling of hazardous substances.

When handling technical gases, the following important regulations must be observed (valid as of the publication date of this document):

- Product Safety Act (ProdSG)
- Industrial Safety Regulations (BetrSichV)
- 14th Ordinance for the Product Safety Act (Pressure Equipment Ordinance – 14th GPSGV)
- German Social Accident Insurance (DGUV) Rule 113-001 Explosion Protection Regulations (EX-RL)
- Technical Rule for Hazardous Substances 510 (TRGS) “Storage of hazardous substances in non-stationary vessels”

Piping inspections

The Industrial Safety Regulations (BetrSichV) apply for the use of materials and aim to guarantee the health and safety of employees.
Their area of application encompasses pressurised equipment, including piping installations, e.g. for flammable or toxic gases.
The regulations specify tests prior to commissioning and before every restart after modifications subject to mandatory inspections. Periodic inspections for ensuring safe operation must be performed in due time.
Authorised inspection bodies, such as TÜV or DEKRA, are appointed by the Federal Institute for Occupational Health and Safety.

Emergency shut-off device

The Pressure Equipment Directive 2014/68/EU serves as the basis for classification, hazard analysis, testing and declaration of conformity for the manufacture of piping as a type of pressurised equipment. According to this directive, it must be possible to block off piping for combustible, oxidising or toxic gases that lead into closed buildings from a safe location.

piping systems

General notes

A distinction is drawn between decentralized and central gas supplies for supplying consumers with technical gases. A direct supply of gas to consumers is called a decentralised gas supply. With a central gas supply, the consumers of an operation are supplied from one central gas storage tank via a pipeline network.
Single cylinders, banks of cylinders, drums, banks of drums and tank systems can be used as storage facilities.

The advantages of a central gas supply are:
- Space saving
- Reduced accident risk
- Lower transport costs
- No interruption to operations
- Uniform drainage of the cylinders/tanks
- Easier monitoring of the inventory
- Smaller cylinder pool

The physical and chemical properties, as well as the physiological effects of the gas, have to be taken into consideration to ensure the correct choice of piping system. All these characteristics have a bearing on material selection, type of connection and flushing process.
An overview of suitable Viega piping systems can be found in the “Application areas for metal piping systems” data sheet on the Viega website *viega.de*.

Piping calculations

The calculation of pipe diameters must include the system's economic viability. The system costs are derived from the total of the investment and operating costs. Small nominal pipe diameters lead to low investment costs, but to higher operating costs as well due to the greater pressure losses. Using the recommended flow velocities to calculate the nominal pipe diameters achieves efficient pipe dimensions and optimises the overall costs. The dimension of piping for technical and medical gases is calculated based on a pressure loss within the piping of $0.1 * p_B$ (operating pressure).

The formula for calculating the clear pipe dimension d [m] of a gas supply line is as follows:

$$d = \sqrt{\frac{Q * 4}{\pi * v}}$$

Q = flow rate [m^3/s], v = flow velocity [m/s]

Material selection

Piping for the technical gases mentioned here must be made of metallic materials.

Copper or stainless steel pipes are normally used for lower purity gases. Copper with a residual grease content of ≤ 0.2 mg/dm^2 can be used for gases with a quality of up to 5.0.
Gases with a quality higher than 5.0 require copper or stainless steel piping systems with a residual grease content of ≤ 0.1 mg/dm^2.
Piping systems with gas purities of 6.0 and higher, such as those used in the microelectronics sector for example, usually consist of stainless steel and are often welded.

The material selection may be limited due to the properties of the gases. Copper must not be used for acetylene, for example (see also „Examples of technical gases“ on page 215).

Depending on the type of gas, suitable sealing materials must be used. This applies also to solvents carried along in the gas such as acetone (Propanon-2) and/or dimethylformamide (DMF) in acetylene lines or NO_X additives for welding protective gases.

Pipe connection technologies

Besides welding and other connection technologies, press connectors have proven to be the best solution for connecting pipes.
The advantages of press connection technology include:

- Huge time savings
- Less manpower
- Increased safety – no risk of fire (no fire precautions, no fire watch)
- Reduced assembly costs (shorter hire periods for working platforms, etc.)
- No X-ray costs
- Minimal system shutdowns

Pipe mount material

- In principle, non-ablative pipe mount material should be used to avert a fire risk
- To prevent contact corrosion, piping from austenitic stainless steel or copper must not be allowed to come into contact with ferritic mount materials
- Use pipe clamps with insulation/inlay
- Series and conduit clamps in conjunction with C-profile rails are considered the standard solution for installing pipes in gas systems

Pipeline installation

Ensure good accessibility when installing exposed pipes. With parallel routings and intersections, the pipe spacing must allow repair and maintenance work without endangering the pipelines. Protect the piping systems against vibrations and displacement. Gas-carrying pipes must be laid above water-carrying pipes. Pipes for lighter gases should be laid above those for heavier gases.

Observe the following instructions (extract from VDMA 4390-2):

- Lay pressurised gas lines horizontal or vertical wherever possible
- Lay pipe routes supported wherever possible
- Do not lay the piping through the components of other systems (e.g. ventilation ducts)
- Do not fix piping in concrete or masonry
- Bridge separation points to buildings (e.g. expansion joints) with expansion bends in the piping
- Pipe routes that are exposed to severe temperature fluctuations between day/night or summer/winter must be fitted with expansion bends.
- Exhaust pipes must not contain shut-off valves or loops as condensate can collect in them.
- If piping is laid parallel to low-voltage electrical lines of up to 1 000 V AC, a minimum distance of 50 mm must be observed. Convergence to less than 50 mm is permissible at intersections. However, the two systems must never be allowed to come into contact.

Piping with press connectors for technical gases should always be laid by trained personnel from a specialised company. Viega offers the relevant training, see
viega.de/de/service/Seminare.html
Mark the pipes in accordance with DIN 2403 for the gas being transported.

Fig. 134: Acetylene with hazard symbol

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Taking into account the required purity class, Viega piping systems are a good choice for technical gases.
The following systems can be used:

- Profipress, Profipress G
- Sanpress Inox, Sanpress Inox G
- Temponox
- Megapress, Megapress G

Tab. 59 provides an initial overview of Viega piping systems and their potential applications. Further information can be found in the media list on the Viega website *viega.de.*

	Profipress, Sanpress Inox	Profipress G, Sanpress Inox G	Temponox	Megapress	Megapress G
	Sealing element				
	EPDM	HNBR	EPDM	EPDM	HNBR
Compressed air	✓	✓	✓	✓	✓
Carbon dioxide dry	✓	✓	✓	✗	✗
Nitrogen	✓	✓	✓	✓	✓
Argon	✓	✓	✓	✗	✓
Corgon® protective gas	✓	✓	✓	✗	✓
Vacuum	✓	✓	✓	✓	✓
Oxygen	✓	✗	✗	✓	✗

Tab. 59: Viega piping systems for technical gases

Viega piping systems are suitable for the following gas purities, for example:

- N_2 4.8
- O_2 2.8
- Ar 4.0

Agree the suitability for higher gas purities and other gas types with the Viega Service Center.

Thanks to the good compressibility of the connectors, Viega piping systems have a high degree of leak tightness with leakage rates < 10^{-5} mbar l/s.

Fuel gases

Fuel gases are combustible gases that are used primarily as fuel. The most widely used fuel gas today is natural gas.

Fig. 135: Fuel gas

When fuel gases are liquefied by cooling or compression, they are referred to as liquid gases. In liquid form, they are very easy to transport and store in large quantities because their volume is less. At the moment of consumption, they are transformed back into the gaseous phase.

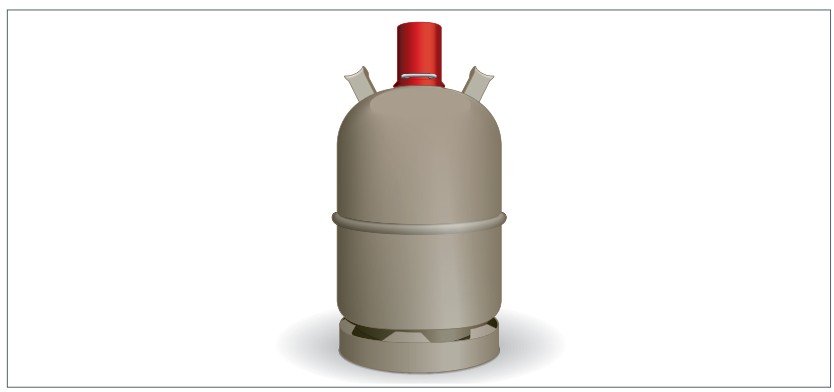


Fig. 136: Example of a liquid gas cylinder

Gas families

Different fuel gases with similar combustive and physical properties are grouped together in one gas family. This classification system is used primarily in domestic gas installations and is described in DVGW Worksheet G 260.

Gas family	Fuel gases	Comment
1	Town gases (coal gases)	These gases are produced in large quantities through the gasification of coal. They often contain large quantities of toxic carbon monoxide (CO). Town gases have declined in significance and have not been fed into public grids since around 1950.
2	Natural gases and oil gases	These gases are fossil fuels from natural deposits that evolved in the geological past from decomposition products of dead vegetation and animals.
	Natural gases	This regenerative fuel is obtained from biological materials, e.g. as manure gas, landfill gas or sewage gas.
3	Liquid gases	These gases, also referred to as refinery gases because of their origin, contain primarily propane and butane (sub-groups P and B).
4	Air/liquid gas mixtures	This gas, also called aerogenic gas, is a mixture of the vapour from benzine and air. In former times, before the advent of electrical lighting, it was used to light gas lanterns.
5	Hydrogen	Considered to be a low-emission fuel and a propellant and most often obtained by synthesis. At the time of printing, alternative production by electrolysis is not yet available on an industrial scale.
		Group A[1)] hydrogen content ≥ 98%
		Group B[1,2)] hydrogen content ≥ 99.97%

[1)] See ISO 14687
2) See DIN EN 17124

Tab. 60: Gas families in acc. with DVGW worksheet G 260

Regulations
Domestic technology and comparable installations for gas families 1, 2 and 4 up to an operating pressure of 0.1 MPa (1.0 bar) are covered by the "Technical Rule for Gas Installation TRGI 2018" (DVGW Worksheet G 600). Their scope of application starts behind the main shut-off device and ends at the point where the waste gas enters the atmosphere.
Commercial applications are regulated in DVGW Worksheet G 631 "Installation of industrial gas applications in systems for bakeries and confectioners, butchers, restaurants and catering establishments, smokehouses, ageing and drying facilities, as well as laundry services".
Industrial applications are covered by DVGW Worksheet G 614 "Exposed gas supply lines on factory premises behind the transfer point".
Installations in gas family 3 in accordance with DIN 51622 are regulated by the "Technical Rules for Liquid Gas (DVFG-TRF 2021)".

Pressure Equipment Directive 2014/68/EU must be observed for other fuel gas applications at a maximum permissible pressure exceeding 0.05 MPa (0.5 bar).

Specificities
For the technical use of fuel gases, other properties in addition to the calorific value are also important and have to be considered. These include the dew point, the flash point and the explosion limits.
Because fuel gases can usually form explosive mixtures in the presence of air, see Fig. 139 on page 233, the safety aspect of handling fuel gases is extremely important.

Higher thermal resistance (HTR)
The correct choice of material for piping systems is especially important due to the risk to the installation from fire or explosion. One criterion is the higher thermal resistance of the system used.
The criterion for higher thermal resistance (HTR) is based on the ignition temperature of natural gas in air (approx. 640°C). To prevent the formation of an explosive mixture, in case of fire, no dangerous quantity of gas must escape at any point in the building that is below the ignition temperature.
For gas installations in the domestic sector, only components labelled “higher thermal resistance (HTR)” may be used. Components that are not HTR-resistant must be separately secured by a thermal shut-off system (TSS). Viega gas fittings meet HTR criteria in accordance with DIN EN 331 if the product will resist fire for at least 30 minutes at an operating pressure of 0.1 MPa (1 bar) and an ambient temperature of 650 °C and remain functional. Leak tightness even at extreme ambient temperatures prevents the spread of fire due to gas escaping unchecked and buys time for closing the shut-off systems.
Products that meet the criteria in accordance with DIN 3537-1 at a required max. operating pressure of 0.1 MPa (1.0 bar) are provided with the "GT 1" marking.
Products that achieve the increased thermal capacity even at a higher maximum operating pressure are marked accordingly, e.g. with "GT 5" for the maximum operating pressure of 0.5 MPa (5.0 bar).

Natural gas

Basics

Natural gas is a fossil energy carrier that occurs naturally in underground deposits, see Fig. 137. It occurs most frequently with crude oil and coal because it evolved through similar processes.

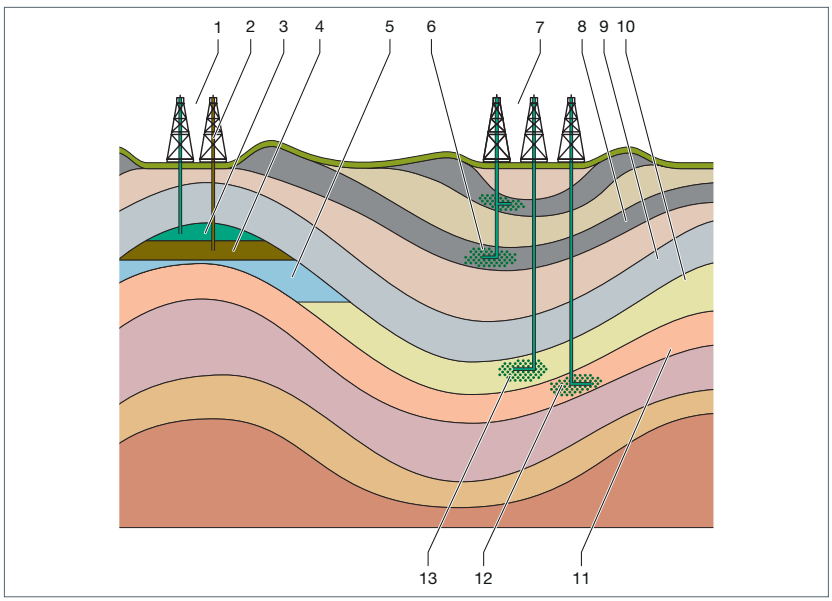


Fig. 137: Natural occurrence of natural gas

1 Conventional deposits
2 Oil source
3 Natural gas
4 Crude oil
5 Reservoir water
6 Coal gas deposit
7 Unconventional deposits
8 Hard coal
9 Impervious rock strata
10 Dense sandstone
11 Oil shale
12 Shale gas deposit
13 Gas deposit

Its main constituent is the highly combustible methane (CH_4), the simplest constituent hydrocarbon. Crude gas, which is obtained directly from its source, also contains ethane, propane, butane and pentane in various concentrations. Depending on the deposit, however, the composition can vary greatly. Therefore, natural gas has to be treated in refineries before being used for technical purposes. During this process, unwanted constituents are removed and the methane is enriched to the required concentration.

The additional constituents also lead to the expression "wet natural gas", which has two different meanings. First, it refers to raw gas with a higher content of ethane, propane, butane and pentane, which can be liquefied under slightly increased pressure and therefore also carry the English name of natural gas liquids (NGL), see Fig. 138. The other meaning is that of raw

gas with a relatively high water vapour content.
Dry natural gas, on the other hand, has a very low content of readily condensable gases.

DIN EN 16723 lays down the requirements for feeding natural gas into the natural gas network and for its use in transport.

For transport applications, natural gas is either compressed under high pressure (compressed natural gas (CNG)) of liquefied by cooling to reduce the transport volume (liquefied natural gas (LNG)), see Fig. 138.

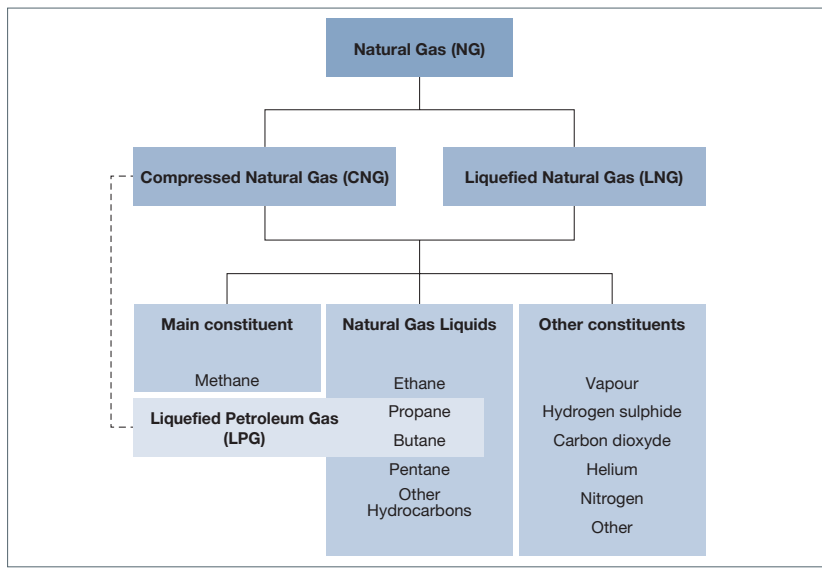


Fig. 138: Terms and abbreviations

Due to its high energy content, natural gas is used primarily for heating buildings and in thermal processes in trade and industry. It is also widely used in power generation and in the drive technology for motor vehicles and ships. It is also an important chemical raw material, e.g. for the fertiliser industry, steel production and for manufacturing hydrogen gas.

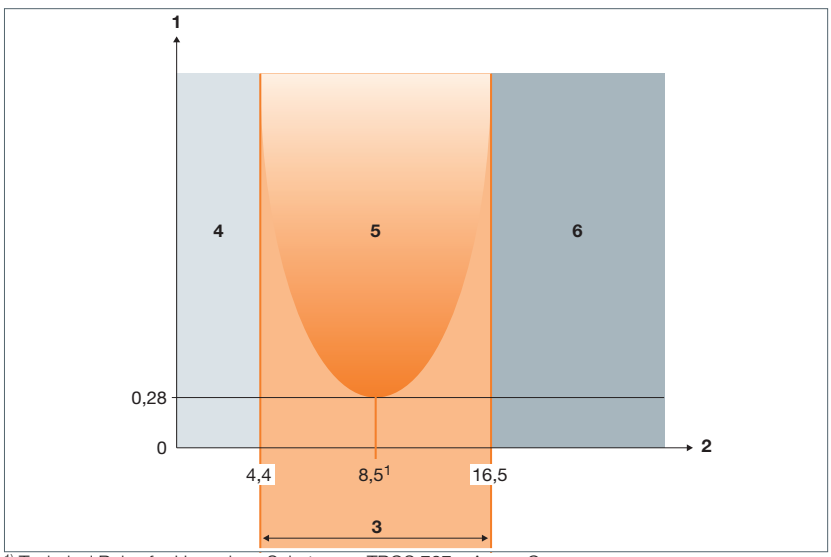
Properties

The methane in natural gas is colourless and odourless under atmospheric conditions. It is lighter than air and forms explosive mixtures in its presence, see Fig. 139. It burns with a bright bluish flame. It is barely soluble in water, but does dissolve in ethanol and diethyl ether.

Biological hazard

Although natural gas is non-toxic, it does have a narcotic effect because it displaces the oxygen in inhaled air and starves the brain of oxygen. Further down the line, it can lead to unconsciousness and, at higher concentrations, even respiratory arrest. For this reason, an odorant is added to the colourless and almost odourless gas so that a gas leak is perceptible at early stage.

Risk of fire and explosion
Natural gas is combustible and, in the presence of air, forms explosive mixtures (ignition range approx. 4.4-16.5 volume percent) which can be made to explode by even a small spark. The indicated ignition range and also the ignition temperature of approx. 640°C may vary depending on the composition of the gas. These values can be found in the safety data sheets issued by the manufacturer.



[1] Technical Rules for Hazardous Substances TRGS 727 – Annex G
Fig. 139: Explosion limits of methane at 20°C

1 Ignition energy [mJ]
2 Volume percent of methane [CH_4]
3 Explosive range
4 Too lean
5 Ignitable mixture CH_4/air
6 Too rich

Biogas
Biogas is a combustible gas that is produced during the microbial degradation of organic substances. The syllable "bio" refers to the biological origin in which, in contrast to fossil natural gas, living organisms are involved. The terms biomethane or natural gas are also frequently used.

Biogas is obtained from various sources in large bioreactors known as fermenters. The largest share is supplied by agriculture through the fermentation of any available biomass and renewable resources.
In sewage treatment plants, the digestion of sewage sludge produces digester gas on the one hand and sewage gas on the other, which escapes during the purification of wastewater.
Landfill gas is formed at landfill sites through the biological and bacteriological decomposition of organic waste.

Biogases from all these sources have different compositions with a wide range of fluctuation. The typical components of biogas are summarised here: Tab. 61.

Component	Fluctuation range	Average
Methane	45–70 vol%	60 vol%
Carbon dioxide	25–55 vol%	35 vol%
Vapour	0–10 vol%	3.1 vol%
Nitrogen	0.01–5 vol%	1 vol%
Oxygen	0.01–2 vol%	0.3 vol%
Hydrogen	0–1 vol%	< 1 vol%
Ammoniac	0.01–2.5 mg/m^3	0.7 vol%
Hydrogen sulphide	10–30 000 mg/m^3	500 mg/m^3

Tab. 61: Typical composition of biogas

The most important element of biogas from a technical perspective is methane, and this is covered in section „Natural gas“ on page 231. To make methane usable, raw biogas must undergo several processing steps (Tab. 62).

Preparation steps	Purpose
Desulphurisation	Prevention of corrosion due to hydrogen sulphide
Gas drying	Prevention of corrosion due to condensing water during compression and/or cooling
CO_2 separation	Increasing the methane concentration in the gas to adjust the calorific or heating value
Conditioning	Adjustment of the calorific value by means of gas composition
Odourisation	Detection of escaping gas by means of odour
Compression	Adaptation to the line pressure

Tab. 62: Biogas processing steps

As living organisms are involved in the production of biogas, it is necessary to keep the temperature in the fermenter at a relatively constant level. For this reason, a wall heating system is installed to prevent the walls from cooling down in ambient temperatures below the operating temperature of the fermenter. As a result, biogas production remains almost constant even at very low ambient temperatures.

Acetylene (ethine)

Properties

Acetylene (ethine) is a chemical compound consisting of carbon (C) and hydrogen (H) and carries the chemical formula C_2H_2. Under atmospheric conditions, pure acetylene is a colourless and odourless gas. In its less pure, commercial form, it has an odour typical of garlic.
It is slightly lighter than air and combusts in the presence of air with a very hot, illuminating and sooty flame. At atmospheric pressure, the explosive range of the acetylene-air mixture is between 2.3% and 82% acetylene.
In addition, acetylene very readily decomposes spontaneously into carbon and hydrogen. This can occur at even low to medium pressure in one of two ways. Degradation under deflagration[1] occurs at a relatively low reaction speed, whereas, under detonation, it can occur at supersonic speed.

Regulations

Due to the potential danger of acetylene, special care must be taken during its handling. With IGC Document 123/13/D[2], the "European Industrial Gases Association" (EIGA) has published the "Acetylene Code of Practice – Best Practice Guide for the safe handling of acetylenes" as a guide to the safety requirements to be met during the production, bottling and handling of acetylene.
The document also sets out the requirements for piping used to distribute acetylene. One such regulation addresses the deflagration and/or detonation of acetylene. Various operating ranges have been defined for the combination of absolute pressure p_{abs} and internal pipe diameter $\mathbf{d_i}$, see Fig. 140:

- **Operating range I**
  Below the limit pressure for a deflagration (Line A), the risk of acetylene decomposing is low.

[1] Explosion that occurs at subsonic speed
[2] The fixed reference number of the document is "123", with "13" denoting the current version (at the time of this document being printed). The letter "D" stands for the German translation. The English original is available as "123/13/E".

- **Operating range II**
  On Line A and below the limit pressure for a detonation (Line B), acetylene can decompose by deflagrating when combusted.
- **Operating range III**
  On and above Line B, acetylene decomposition starts as deflagration on combustion and can develop into detonation in sufficiently long pipes.

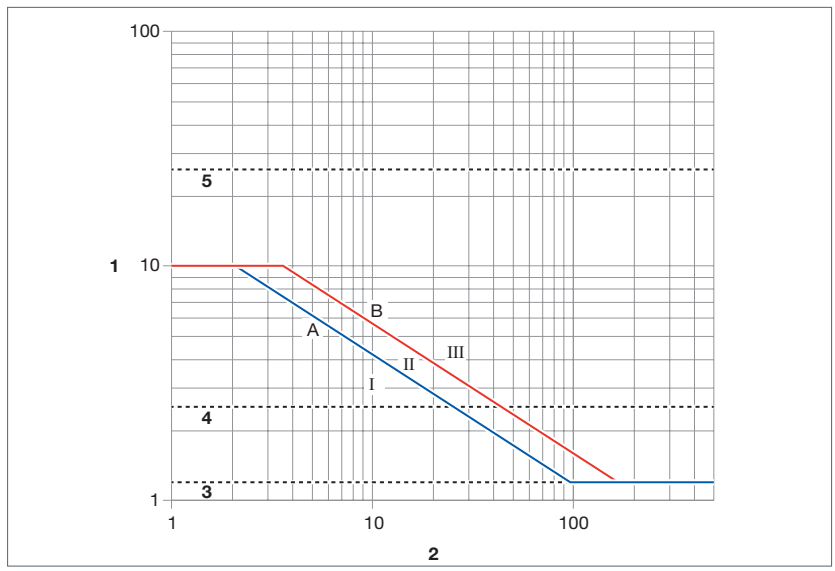


Fig. 140: Operating ranges according to the hazard in case of acetylene decomposition (Source: EIGA IGC Document 123/13/D)

1 Pressure [bar_{abs}]
2 Pipe dimension [mm]
3 Low pressure (< 0.2 bar_{abs})
4 Mid-range pressure (< 2.5 bar_{abs})
5 High pressure (< 26 bar_{abs})

Material selection

Copper piping

CAUTION!
Danger of explosion
Acetylene reacts with copper to form acetylides – compounds which are highly sensitive to energy input through shocks and friction and which can react by exploding.
- Shocks and friction must be avoided.

Copper is a prohibited material for the construction and maintenance of acetylene installations. Certain copper alloys with a copper content of less than 70%, however, are allowed to be used with restrictions for certain applications.

Stainless steel piping
Stainless steels need to be able to withstand the loads generated at maximum operating pressure, but also the thermal and mechanical loads occurring when acetylene decomposes within operating ranges II and II, see Fig. 140.
The corrosion that can potentially be caused by chloride – especially in the case of austenitic stainless steels – and which is usually more severe when calcium chloride drying is used as a drying agent, must also be taken into account.

Materials for seals
The materials used for packaging, seals and membranes must be resistant to acetone and dimethylformamide (DMF), commonly used as solvents. If this condition is satisfied, any type of packaging or seal may be used.

Liquid gases

Basics
Liquid gas refers to the C3 and C4 hydrocarbons propane, propylene (propene), butane, butylene (butene) and the mixtures thereof, which are specified in DIN 51622. These gases are obtained during the production of raw oil and natural gas, and also during the processing of raw oil. In Germany, they are used primarily for heating purposes. Liquid gas can be stored under low pressure at room temperature and is transformed to the gaseous phase for use in liquid gas systems.

Safety
Since gases take up only a fraction of their normal volume when in the liquid state, considerable amounts of energy are stored in liquid gas tanks. Because liquid gas is heavier than air, leaks can lead to dangerous concentrations at ground level, in recesses and in basements.

Biological hazard
Although liquid gas is non-toxic, it does have a narcotic effect because it displaces the oxygen in inhaled air and starves the brain of oxygen. Further down the line, it can lead to unconsciousness and, at higher concentrations, even respiratory arrest. For this reason, an odorant is added to the colourless and almost odourless gas so that a gas leak is perceptible at early stage.

Risk of fire and explosion
Liquid gas is combustible and, in the presence of air, forms explosive mixtures (ignition range approx. 1.7–9.5 volume percent) which can be made to explode by even a small spark. The indicated ignition range and also the spontaneous ignition temperature of over 365°C may vary depending on the composition of the gas. These values can be found in the safety data sheets issued by the manufacturer.

Liquid gas systems

Regulations

The planning, installation and testing of liquid-gas systems are governed by “Technische Regeln Flüssiggas 2021” (Technical Rules for Liquid Gas 2021), published by Deutscher Verband Flüssiggas e.V. (DVFG-TRF 2021).

Other than DVFG-TRF 2021, the following must be observed:

- Landesbauordnung (State building regulations)
- Feuerungsverordnung (Ordinance on firing installations)
- Rules of the Employer's Liability Insurance Associations

Components

A liquid gas system consists of a supply system and a consumption system.
A supply system includes:

- Liquid-gas cylinders or liquid-gas tanks for storage
- Regulating equipment – pressure / volume flow control for transport and usage
- Piping

Liquid gas cylinders

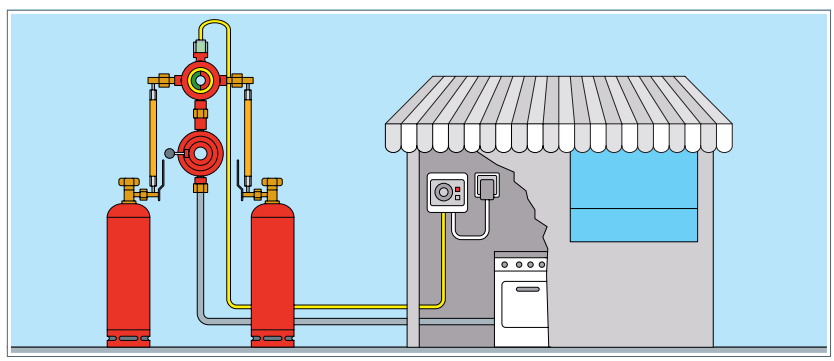


Fig. 141: Liquid gas cylinders

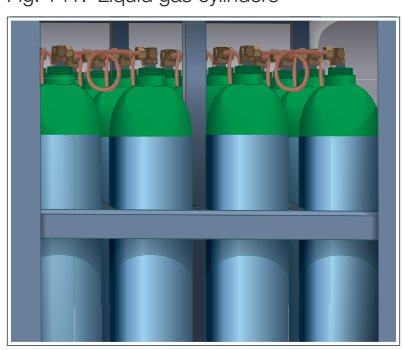


Fig. 142: Secured liquid gas cylinders

Secure liquid gas cylinders to prevent tipping over and damage.

A liquid gas cylinder is a pressure vessel that is not filled in situ. Consumers with a small liquid gas requirement, such as individual apartments, single-family homes or industrial applications supply their building or workplace by replacing liquid gas cylinders, see Fig. 141. These cylinders have to be stored in a secure manner to prevent damage by tipping over or other external influences, see Fig. 142.

Liquid gas tanks
Liquid gas tanks are permanently installed, cylindrical steel vessels that are filled from tankers. The tank dimensioning depends on consumption. A gas reserve sufficient for at least six months is recommended.

Fig. 143: Liquid gas tanks

The piping is connected to the tank at the top; underground tanks are accessible through a cylindrical top – the manhole. Geopress K or Geopress G adapters in combination with the Profipress G press connector system ensure a fast and reliable connection to the tank. The Geopress K or Geopress G adapters connect the underground PE pipe to copper pipe, allowing the tank to be continuously connected via press connection technology.

Liquid gas tanks are mainly erected outdoors because the safety requirements and hence the costs are lower than those for indoor installations. The following installation variants are possible:

- **Overground**
  The tank is fastened to a concrete base plate.
- **Half-overground**
  The tank is below ground up to the centreline.
- **Underground**
  The tank is embedded in sand on all sides and covered with at least 50 cm of earth. The manhole is accessible only through a cover embedded in the ground.

It is important that the installation site has road access for the tanker to allow direct connection of the hose (25 m).

Supplying several buildings from a central tank is known as insular supply. This is done by laying a ring system around the area to be supplied and hooking up each building to a connection line. The Geopress G tapping valve is the ideal solution for producing the connection line.

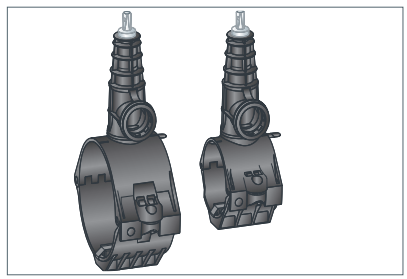


Fig. 144: Viega Geopress G tapping valve

Liquid gases as refrigerants

Liquid gases are naturally occurring refrigerants. They play a key role in refrigeration plants where they are used for heat transmission and for cooling at the same time. Their use for this purpose is nothing new. In the 1990s, they were the standard solution for domestic refrigerators until such time as they were replaced by non-combustible chlorofluorocarbons (CFC). However, once the harmful effects of CFCs on the environment and ozone layer had become increasingly apparent, they were largely replaced over the course of time with liquid gases, which also contribute less to the overall greenhouse effect than other possible substitutes (e.g. fluorinated hydrocarbons).

Coolant	Identifier
Ethane	R-170
Propene (propylene)	R-1270
Propane	R-290
n-Butane	R-600
2-Methylpropane (isobutane)	R-600a

Tab. 63: Examples of liquid gases as coolants

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

For fuel gases and liquid gases in the gaseous phase, Viega uses press connector systems with special sealing elements:

Parameter	HNBR	NBR
Operating temperature[1)]	-20 °C – +70°C	-20 °C – +40°C
Max. operating pressure[1)]	0.5 MPa (5 bar)	1.0 MPa (10 bar)
Press connector system	Profipress G[2)] Sanpress Inox G[2)] Megapress G[3)]	Geopress G[4) 5)] Geopress K
Max. operating pressure[1)] HTB		Not applicable
GT 1[2)] Press connector system	**0.1 MPa (1 bar)** Profipress G/ Sanpress Inox G	
GT 5[3)] Press connector system	**0.5 MPa (5 bar)** Megapress G	

[1)] The maximum operating pressure and the maximum operating temperature depend on the type of pipe used and the specific application.
2) GT 1 in accordance with DIN 3537-1
3) GT 5 in accordance with DIN 3537-1
4) Use of the support sleeve made of gunmetal/silicon bronze (model 9605) required.
5) NBR for the transition from copper pipes to metal pipes.

Tab. 64: Viega press connector systems with sealing elements for fuel and liquid gases – Technical data

Press connector systems for metal piping

The Profipress G, Sanpress Inox G and Megapress G press connector systems indicated in Tab. 64 are suitable as inseparable pipe connections for metal gas supply lines (carrying gases in accordance with DVGW Worksheet G 260) and certified in accordance with DVGW Worksheet G 5614 or G 5614-B1.

Use is possible in the gas installations described below:

- Gas installations
  - Low pressure range ≤ 100 hPa (100 mbar)
  - Medium pressure range from 100 hPa (100 mbar) up to 0.1 MPa (1 bar)
  - Industrial, commercial and technical processing systems with the corresponding directives and technical regulations up to 0.5 MPa (5 bar)

- Liquid gas installations
  - With liquid gas tank in medium pressure range downstream of the pressure regulating valve, 1st level on the liquid gas tank > 100 hPa (100 mbar) up to a permitted operating pressure of 0.5 MPa (5 bar)
  - With liquid gas tank in the low pressure range ≤ 100 hPa (100 mbar) behind the pressure regulating valve, 2nd level
  - With liquid gas pressure container (liquid gas cylinders) < 16 kg downstream of the small cylinder pressure regulating valve
  - With liquid gas tank (liquid gas cylinder) ≥ 16 kg downstream of the large cylinder pressure regulating device

The press connector systems mentioned are suitable for the media listed below:

- Natural gases
- Liquid gases, only in the gaseous state for domestic and commercial applications

Press connector systems for underground PE-HD and PE-X pipes

The Geopress G and Geopress K press connector systems indicated in Tab. 64 are suitable for underground PE-HD and PE-X pipes in accordance with the regulations in Tab. 65.

Scope / Notice	Regulations applicable in Germany
Permitted use with piping materials in gas installations (HDPE)	DIN 8074/75
Permitted types of pipes (PE) – gas supply	DVGW worksheet GW 335-A2
Types of PE pipes – gas supply	DIN EN 1555
Permitted types of pipes (PE-X) – gas supply	DIN 16893
Types of pipe (PE-X) – gas supply	DVGW worksheet GW 335-A3

Tab. 65: Suitability for underground PE pipes of press connector systems

Specifically, only the plastic pipes listed in Tab. 66 may be used for Geopress G and Geopress K. The code SDR[1] is the ratio between external diameter d_a and wall thickness s of a pipe SDR = $\frac{d_a}{s}$ and MOP[2] is the maximum operating pressure.

Pipe type	Pipe series SDR	MOP
PE 80	17,0[1) 2)]	0.1 MPa (1 bar)
PE 80	11,0	0.4 MPa (4 bar)
PE 100	17,0[1) 2)]	0.5 MPa (5 bar)
PE 100	11,0	1.0 MPa (10 bar)
PE-X	11,0	0.8 MPa (8 bar)

[1)] Only Geopress G
[2)] PE 80 and PE 100 piping of pipe series SDR 17 must only be used for a nominal diameter of ≥ 75 mm or greater.

Tab. 66: SDR and MOP of the plastic pipes permitted for Geopress G and Geopress K

Press connector systems for biogas plants
In the case of biogas, a distinction must be made as to whether the gas is to be transported before or after treatment („Biogas“ on page 233), because the composition of the gas and therefore its properties can have different effects on the materials used.
Viega provides the press connector systems listed at Tab. 67 with the parameters described for use with biogas.

Biogas		p_{max} [MPa]	T_{max} [°C]	Sanpress Inox	Sanpress Inox G	Profipress G	Megapress G
Before treatment	45–70 % CH_4 20–45 % CO_2 < 30 mg/m³ H_2S	0.5	70		✓		
After treatment	According to G 260 and G 262	0.5	70		✓	✓[1)]	✓
Fermenter heating	Substrate temperature 65 °C	1.0	105	✓			

[1)] Max. permissible operating pressure p_{max} = 0.1 MPa with HTR requirement (higher thermal resistance)

Tab. 67: Operating parameters of Viega press connector systems for mineral oils and diesel fuels

[1] SDR: Standard Dimension Ratio
[2] MOP: Maximum Operating Pressure

Press connector systems for acetylene
With its Sanpress Inox and Sanpress Inox stainless steel press connector systems, Viega provides PWIS-free solutions for low and medium pressures in Operating range I, see Fig. 140, with the parameters indicated in Tab. 68.

Acetylene	
Sanpress Inox Sanpress Inox LF	Press connector in combination with 1.4521 pipe
Dimension d	15 mm, 18 mm, 22 mm, 28 mm
Min. operating temperature T_{min} [°C]	-20
Max. operating temperature T_{max} [°C]	60
Max. Operating temperature p_{max} [MPa]	0,15
Test pressure p_{test} [MPa]	2,4

Tab. 68: Parameters for press connector systems for acetylene

Press connector systems for hydrogen
The properties of hydrogen are described in the relevant section of the "Technical gases" chapter on page 217. For hydrogen, Viega provides the press connector systems listed in Tab. 69 with the parameters indicated.

Hydrogen	**Profipress Profipress G**	**Sanpress Inox Sanpress Inox G**	**Temponox**	**Megapress [1)] Megapress G[1)]**
Material	Copper	Stainless steel	Stainless steel	Steel
Dimensions	12–108 mm			⅜–2 inches
Max. operating temperature T_{max} [°C]	60			
Max. Operating temperature p_{max} [MPa]	0,5			

[1)] Following consultation with the Viega Service Center

Tab. 69: Parameters for press connector systems for hydrogen

Leak detection as part of the leakage test

For leak detection in gas supply lines, Viega recommends the specially developed Viega leak detection spray, see Fig. 145, which has no negative reaction with the materials of either pipe or connector. Thanks to the press connector's SC-Contur, the Viega leak detection spray shows up inadvertently unpressed connectors immediately during a dry leakage test. The formation of bubbles makes leaks apparent immediately, see Fig. 14646.

Fig. 145: Viega leak detection pray

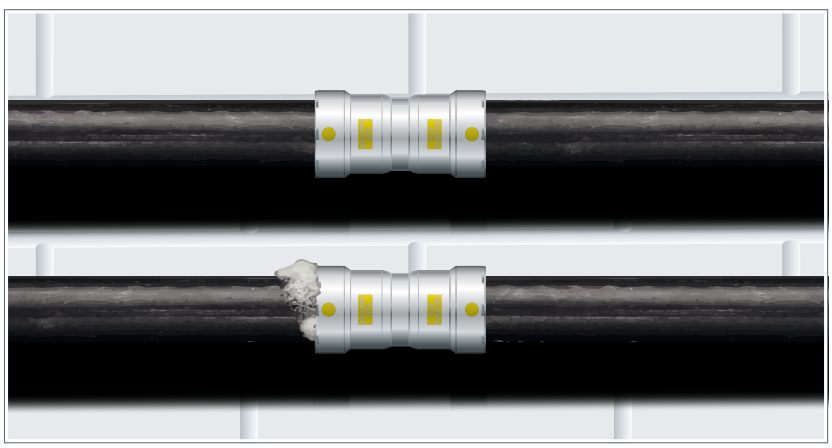


Fig. 146: Megapress G with bubble formation when the test medium escapes

The escaping test medium causes bubbles to visibly form on the SC-Contur of the unpressed press connection.

Low-pressure steam

Vapour is the term used to describe water in the gaseous state. It is used for a broad range of industrial applications, primarily in the form of heating processes and for generating power in steam turbine processes.

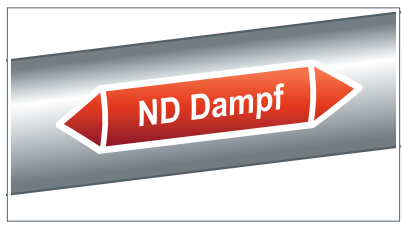


Fig. 147: Steam line with DIN 2403 marking

Vapour is used for a broad range of processes in industry, e.g. for

- Heating
- Powering turbines for power generation
- Transporting products
- Atomising
- Cleaning
- Moistening air or products

The most frequently occurring processes include

- Steam heating
- Steam cleaning
- Product moistening
- Air moistening

Steam heating

Steam systems use the physical properties of the two-phase system water/vapour. The large amount of heat provided for water evaporation (enthalpy of vaporisation) is released during condensation in heat exchangers and thus allows large amounts of heat to be transmitted.

As such, the advantages of a steam system compared to a hot water heating system essentially lie in the fact that they operate at a higher energy level. In practice this means

- Higher temperatures
- Higher thermal performance
- Greater heat transmission in heat exchangers

These properties are used in particular for systems involving high heat transformation, e.g. district heat supply systems (in buildings) and industrial processes. The disadvantages lie in the greater technical effort required to set-up and operation steam systems:

- Greater technical and safety demands
- More extensive planning, mounting, operation and maintenance
- TÜV approvals

The components used in steam systems and their installation are subjected to enormous pressures and temperatures and therefore must be planned and executed with care. Steam boilers are classified according to their area of application:

- Low-pressure steam boiler up to 0.1 MPa (1 bar) and 120°C
- High-pressure steam boiler over 0.1 MPa (1 bar) and 120°C

Steam cleaning

In industry, steam is used for cleaning surfaces. Coal- or oil-powered steam boilers are cleaned of soot deposits using steam soot blowers, for example. This improves the heat transition diminished by the soot deposits and hence the efficiency.

Product moistening

Steam is also used to heat up and hydrate a product at the same time. In paper production, steam is used to moisturise equipment to prevent the microscopic cracks that can occur when paper machines rotate at high speed, for instance. It is also used to provide heat and moisturise when pelleting animal feed.

Air moistening

Many industrial building complexes, especially in colder climates, are heated by steam at low pressure as a primary heat source. Air heaters are used in combination with steam humidifiers to treat suctioned air to create a pleasant room climate and a favourable atmosphere for storing books or files, and also for disinfecting air. When air heats up, its relative humidity decreases. Saturated steam is used to compensate this loss, see „Basics“ on page 248.

Basics

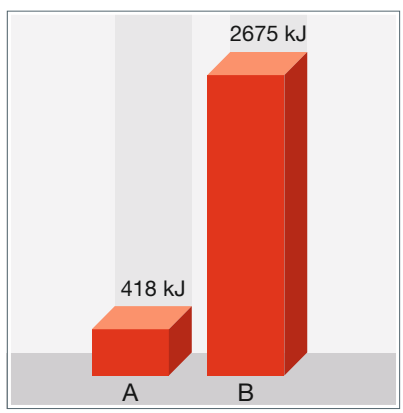
Steam states

Superheated steam is steam at a temperature above boiling point. The steam is dry and contains no droplets. In steam boilers, the generated steam is charged to this state by means of superheater.
When steam flows into a colder environment, some of the gaseous water condenses to form the finest droplets. Such a composition is referred to as wet steam, as can be observed when water is boiled, for example.
The limit range between wet steam and superheated steam is called saturated steam. The process that occurs at temperatures from 10 to 20°C above the saturated steam temperature is referred to as superheating.

Heat transmission

Water in liquid form has the highest thermal capacity of all inorganic substances. This is approx. 4.18 kJ/(kg * K). Therefore, approx. 418 kJ are required to heat up 1 kg water from 0 to 100°C. To vaporise the water at 100°C, 2257 kJ/kg of evaporation enthalpy is required. This is more than five times the amount of heat required to heat it up from 0°C to 100°C.

Hence the significant advantage of steam as an energy source. The amount of heat released again during the condensation process in heat exchangers can be moved with around of a fifth of the mass.



A Heat capacity of water
B Heat capacity of vapour

Fig. 148: Heat capacity of water and vapour per 1 kg at 100°C by comparison

The evaporation enthalpy of steam makes it suitable for numerous purposes, depending on its state. Superheated steam has a lower heat transmission capacity, and is therefore the better medium for transporting heat in long piping sections for example. Saturated steam, on the other hand, has an excellent heat transmission capacity and is therefore the better medium for transmitting heat. Saturated steam should therefore be used for heating purposes.

Steam quality
Steam circuits are continuously fed with fresh water. The boiler feed water is stored in feed water tanks. To avoid corrosion in the steam generator and in the installation, only treated feedwater should be used. Effective ventilation prevents harmful oxygen, which promotes corrosion, from getting into the pipes.

Risk of water hammer in steam pipelines
Water hammer in steam pipes should be avoided at all costs, since this presents a great danger to both pipes and fittings. If the condensate is not discharged from the steam pipe, it collects and forms pools. The flow velocity of steam is typically 25 m/s (90 km/h). The fast-flowing steam causes ripples on the surface of these pools, which ultimately entrains water droplets and drives them through the line at the velocity of the steam. If, at the same time, a water droplet arriving with this kinetic energy is suddenly decelerated by an obstacle, the pipeline develops water hammer, which can lead to localised pressure areas of several thousand bars. Temperature controls, pressure reducing valves or pipe bends can be destroyed or even completely ruptured. Numerous accidents, some involving fatal injuries, underline the importance of these procedures.

Piping Systems

Installations in steam systems must be designed so that the condensate which forms in the piping during cooling is effectively separated from the steam phase, see Fig. 149 to Fig. 152. The removal of condensate is aided by laying steam pipelines in the direction of flow at a gradient of at least 1% and guiding them to the lowest points of the installation in separate condensate pipelines for removal of the condensate. Condensate loops are included at the connection points between condensate drainers and steam pipelines. They fill with condensate and prevent steam from entering the condensate drainer. The arrangement and planning of these condensate drainers is specified in EN 26704.

The following four illustrations show examples of piping for low-pressure steam systems.

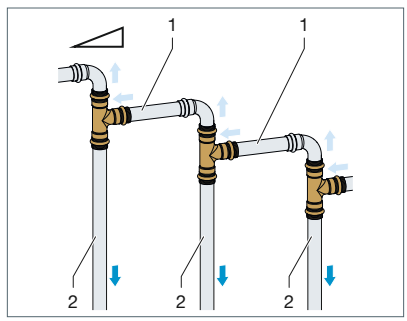


Fig. 149: Condensate discharge downwards

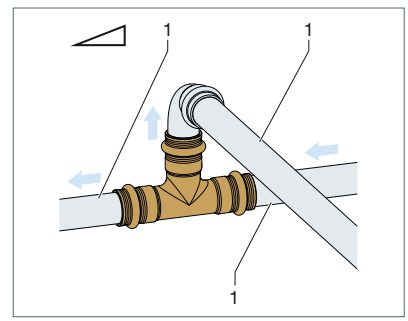


Fig. 150: Steam branch-off on the top of the pipe

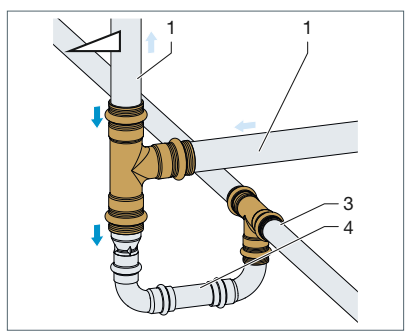


Fig. 151: Condensate loop – separation of steam and condensate

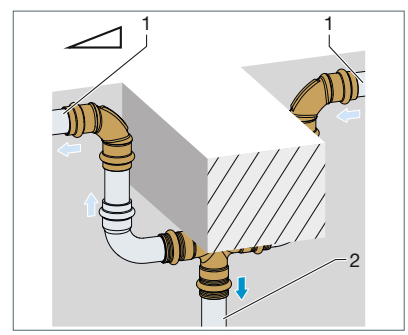


Fig. 152: Bypass around an obstacle

1 Steam/condensate
2 Drain pipeline
3 Condensate pipeline
4 Condensate loop

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Viega piping systems for low-pressure steam can be used for an operating pressure of up to max. 0.1 MPa (1 bar) and a temperature of up to max. 120°C. Steel, copper and stainless steel are very suitable materials for connectors and pipes. The pipe connectors must be designed to have a FKM sealing element. The medium being pumped must be free of additives.
The following Viega piping systems can be used for low-pressure steam processes. Further information can be found in the media list on the Viega website *viega.de:*

- Profipress S
- Megapress S
- Viega piping systems – with on-site replacement of the sealing elements with FKM sealing elements according to the media list on *viega.de*.

Oils and diesel fuels

Oils

The word “oil” is a collective term for liquids that are carbon-based and cannot be mixed with water. The term originates from “oleum”, the Latin term for the vegetable oil obtained from olives, a process known for over 8 000 years. If a liquid oil is made to solidify, it is referred to as fat.
Fig. 153 shows a classification of fats and various oils. Examples of oils and their applications are also provided. Oils are classified in various groups, each with their specific properties:

- Mineral oils
- Fatty oils
- Essential oils
- Silicone oils

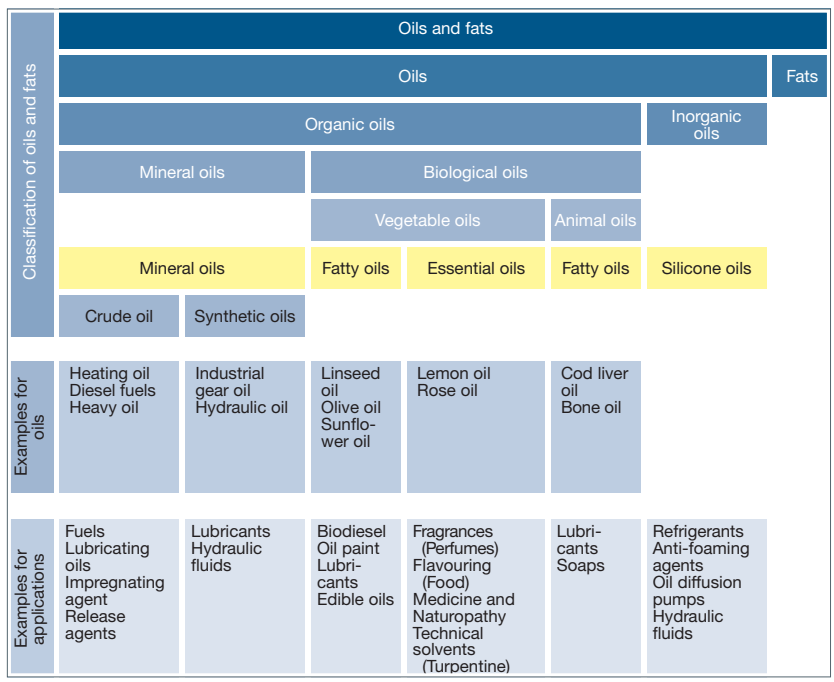


Fig. 153: Classification of oils and typical applications

Mineral oils

Crude oil

The name “mineral oil” is often used for crude oil in order to distinguish it from biological oils.
In the stricter sense, therefore, the expression also covers the heavier intermediates (base oils) produced during the distillation of raw oil (Fig. 154) or the liquefaction of coal. These intermediates can be further processed to form end products such as engine oils, cooling lubricants or lubricating greases.

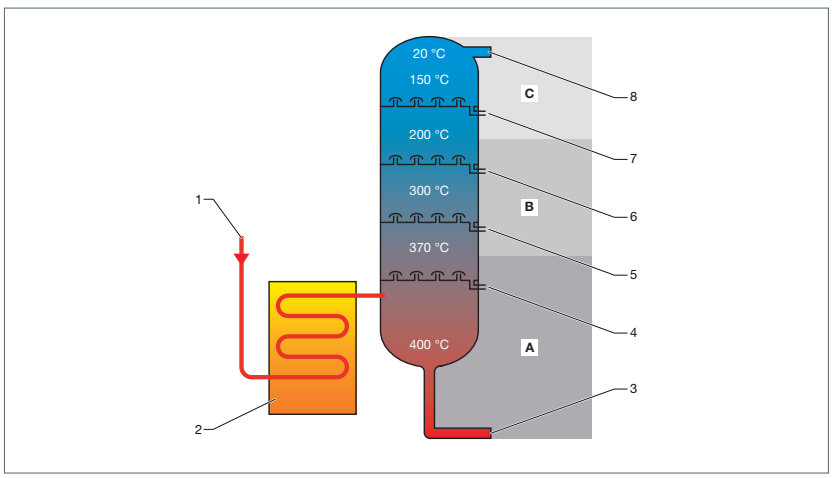


Fig. 154: Diagram of a distillation column for crude oil

1 Raw oil
2 Tube furnaces
3 Lubricating oils, paraffins, waxes, bitumen/tar, coke
4 Heavy oils
5 Diesel, heating oil
6 Kerosene, petroleum
7 Benzine
8 Liquid gas
A Base oils
B Oily fuels
C Highly volatile fuels

Fig. 155: Distillation column in a crude oil refinery

Synthetic oil

Likewise, synthetic oils are based on crude oil or coal, but they contain added synthetic hydrocarbons of molecular structures that do not occur in the two raw materials in this form.

However, the expression "synthetic oil" is not used consistently around the world. In Germany, there is a clear definition based on the oils and additives used. Oils that do not match this definition are often referred to as high-performance oil or premium oil.

The performance of oils is not in their name, but rather in the chemical and physical properties defined in the SAE J357 standard of the Society of Automotive Engineers (SAE).

Heating oil

Heating oil is a liquid fuel that is recovered from the middle part of a distillation column during the processing of mineral oil and mineral-oil products, see Fig. 154. It is a mixture of various products from the distillation process and special additives.

In Germany, DIN 51603 specifies the composition of heating oil, drawing a distinction between various grades and qualities.

Heating oil grades	Properties	Comments	Regulations
ULV, Standard	Ultra-low viscosity	■ Small, dwindling market share ■ Mixture of kerosine, gas oil fractions and additives	DIN 51603-1
ULV, low-sulphur	Ultra-low viscosity Sulphur content ≤ 50 mg/kg	■ Standard in Germany ■ Significantly lower harmful substance emissions than EL ■ For condensing systems ■ For private households and the trades	
ULV, low sulphur, low nitrogen	Ultra-low viscosity, sulphur content ≤ 50 mg/kg, nitrogen content ≤ 140 mg/kg	■ Rarely used today ■ Previously used for large-scale central heating firing systems	
EL A Bio	Bio heating oil	■ EL heating oil with admixtures of bio-diesel, see „Biodiesel“ on page 261	DIN SPEC 51603-6
S	Viscous	■ Used in firing systems with pre-heating equipment for transport, storage and combustion ■ Fuel for large diesel motors ■ Highly viscous at room temperature ■ Pumpable at approx. 40-50°C ■ Injection temperature for the combus-tion chamber approx. 130-140°C	DIN 51603-3
SA	Viscous, low-sulphur	-	DIN 51603-5
SA-LW	Viscous, low-sulphur low wear	■ LW refers to low aluminium and silicon content	DIN 51603-7
R	From the process-ing of aromatic mineral oil fractions from re-refining, sulphur content for: R-LS ≤ 0.5% R-TS ≤ 1.0%	■ In re-refined heating oils, the content of the harmful substances must be respected to prevent the emission thresholds specified by the relevant legislation being exceeded.	DIN 51603-4

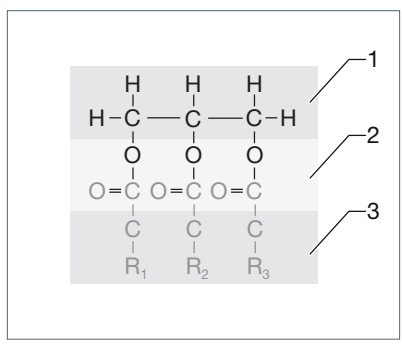
Tab. 70: Heating oil grades in accordance with DIN 51603

The quality of a heating oil is determined by
- its density
- its ash and sulphur content
- the ratio of carbon (C) to hydrogen (H)

Technically speaking, the heating oil used primarily in firing systems is similar to the diesel fuel („Diesel“ on page 260) that powers diesel motors. However, because heating oil and diesel fuel are taxed differently within the EU, a red pigment and the "Solvent Yellow 124" marker are mixed with the heating oil to make identification easier.

Fatty oils

Fatty oils are biological by nature. They are the fats obtained from plants and animals that are liquid at room temperature. In chemical terms, they are esters of glycerin with unbranched aliphatic monocarboxylic acids.



1 Glycerine content of the fat
2 Ester group (COO)
3 Aliphatic monocarboxyl acids with different structures (R_1 to R_3)

Fig. 156: Schematic representation of the structure of biological fats

Animal fatty oils are often processed to make soaps, surfactants for the laundry detergent industry and biogenic lubricants.
Vegetable fatty oils are likewise processed into lubricants and biodiesel or are often used directly as edible oils, e.g.
- Palm oil
- Soy oil
- Sunflower oil
- Olive oil
- Rapeseed oil

Since fatty oils are biological products, they are used in the food industry, for example, as food-safe lubricating oils and as a biodegradable substitute for lubricants made of mineral oils.

Essential oils
Essential oils are also biological in nature and obtained from plants. Each plant species gives the oil its characteristic aroma, which can sometimes be very powerful.

Essential oils are mixtures of numerous different chemical substances. Unlike the fatty oils produced from plants, they contain no fat and therefore evaporate completely. They are soluble in fats and oils, but not in water. In water, they usually form oil droplets because their density is lower.

Essential oils are used primarily in medicine and naturopathy (e.g. aroma-therapy, phytotherapy, allergy control), in the cosmetics for perfumes and in the food industry for tea, spices, etc.

Fig. 157: Typical uses of essential oils

Silicone oils
Unlike mineral and biogenic oils, silicone oils are not made purely from carbon. Instead, they are silicon-based compounds that have undergone a technical process of polymerisation. The backbone consists of silicon and oxygen atoms to which different side groups, which can also contain carbon atoms and determine the properties of the silicone oil concerned, attach.

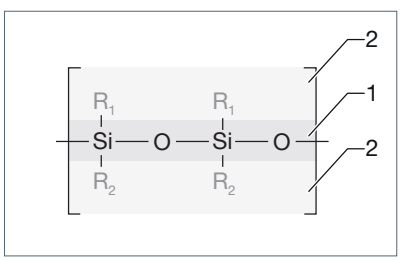


Fig. 158: Diagram of the structure of silicone oils

1 Backbone with silicon and oxygen atoms (Si and O)
2 Characteristic side groups (R_1 and R_2)

Under atmospheric conditions, silicone oils are transparent, colourless, water-repellant liquids. They are odourless, tasteless and non-toxic because they undergo barely any chemical reaction.
They are temperature resistant and, in a broad temperature range, have very good lubrication properties.

Because of their properties, they are used in numerous technical applications, including

- as heat transfer media in oil baths
- as refrigerants in refrigeration technology
- in Visco couplings
- as hydraulic fluids
- as hydrophobing agents ("water repellents")
- as anti-foaming agents in medical and food technology (food additive E900)

Technical use of oils

Of the numerous possible uses of the various oils, besides combustion and heat recovery („Heating oil“ on page 254), only a few selected examples are discussed here.

Cooling lubricants (CL)

Cooling lubricants (CL) are mixtures of numerous components and are used in machining metal. They perform three tasks:

1. Cooling the workpiece being machined
2. Lubrication of the contact surfaces of workpiece and tool to reduce the amount of friction
3. Flushing of the machining point to remove the metal chips produced

Fig. 159: Application of a cooling lubricant

Cooling lubricants have to meet numerous different requirements. These depend on the machining method and processing parameters concerned, including cutting speed, material hardness, machining temperature and so on.

To be able to meet the requirements placed on them, cooling lubricants have three major constituents (primary substances).

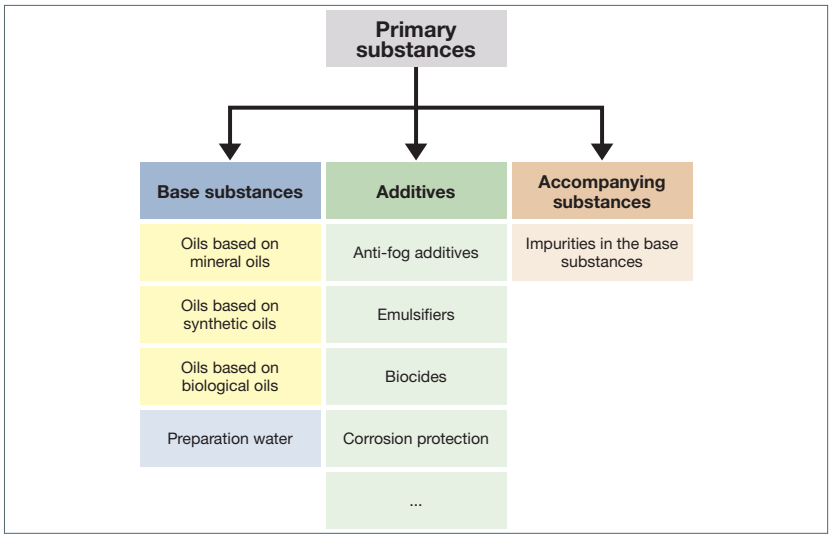


Fig. 160: Primary substances of the cooling lubricants (CL)

Since there is no obligation to label the constituents, the composition can be gleaned from the safety data sheet or, if necessary, requested from the manufacturer. General notes on the constituents used can also be found in the VKIS-VSI-IGM-BGHM list of substances. This contains specific requirements in accordance with DIN 51385 for water-miscible, water-mixed and water-immiscible cooling lubricants (Fig. 161), as well as additives, and is published and maintained by four groups of stakeholders:

- German group for users of industrial lubricants (VKIS)
- Verband Schmierstoffindustrie e.V. (VSI) (German Lubricant Industry Association)
- Industriegewerkschaft Metall (IGM) (Metalworkers' union in Germany)
- Berufsgenossenschaft Holz und Metall (BGHM) (German Social Accident Insurance Institution for the woodworking and metalworking industries)

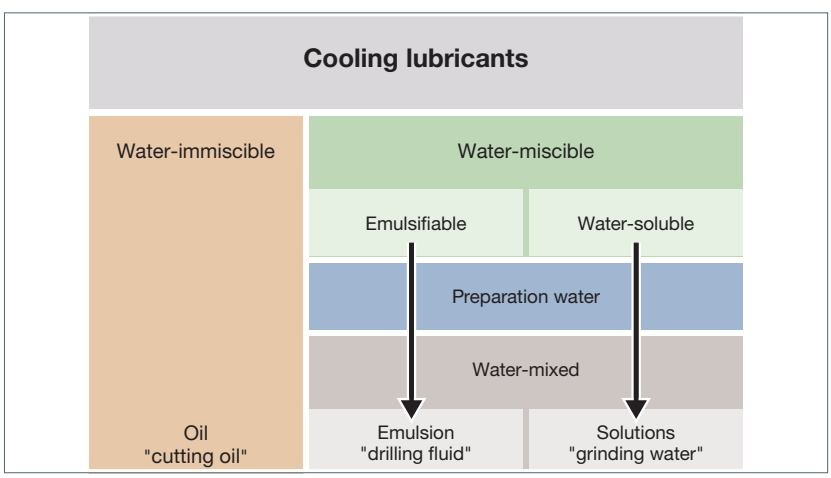


Fig. 161: Types of cooling lubricant (CL)

Fig. 162: Use of "cutting oil"

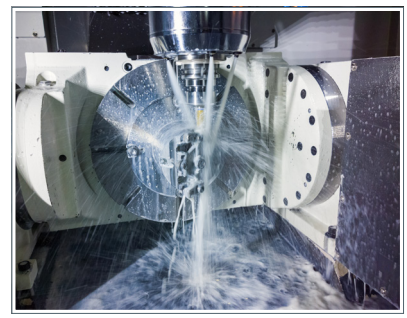


Fig. 163: Use of "drilling fluid"

Diesel fuels

Diesel

Diesel, also called diesel fuel or formerly gas oil, is a mixture of various hydrocarbons that are obtained from the middle fraction during the distillation of crude oil, see Fig. 154 on page 253. Technically speaking, it is suitable as a fuel for operating combustion engines in accordance with the diesel principle (diesel engine). Legally, the diesel fuels used for this purpose pursuant to Section 4 of the 10th Federal Emission Control Act (BImSchV) have to meet the requirements of DIN EN 590.
The properties of the diesel can be set to suit a broad range of specifications by varying the mixture ratios of the hydrocarbons in combination with various additives.

Fig. 164: Truck diesel engine

Fig. 165: Diesel-operated emergency generator

Marine diesel

Marine diesel is similar to this type of diesel but has a higher density. Its composition is specified in ISO 8217. It is used in smaller marine diesel engines, for example. Larger diesel engines for ocean-going vessels powered by so-called marine fuel, a mixture of heavy oil (Fig. 154 on page 253) and diesel.

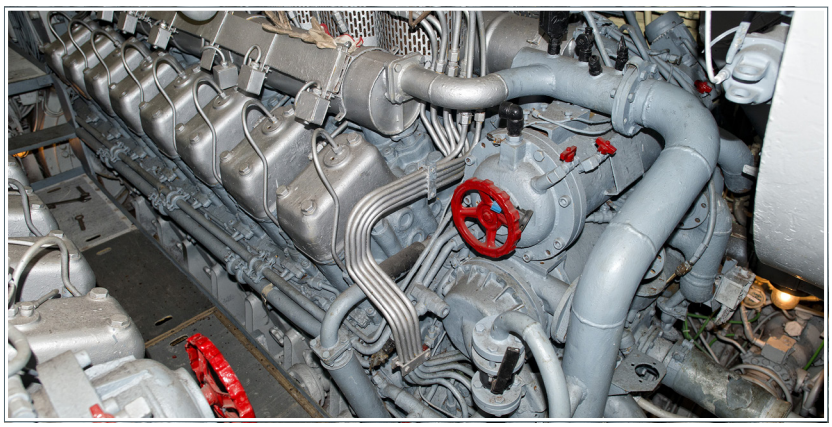


Fig. 166: Marine diesel engine

Biodiesel

Biodiesel is a fuel that has similar uses to mineral diesel fuel (diesel). Biodiesel, however, is biological in nature and obtained through the transesterification of animal or vegetable oils and fats with methanol. This combination of a fatty acid and methanol is called fatty acid methyl ester (FAME)). Biodiesel can be mixed with mineral oil-based diesel in any ratio and its properties easily set within broad ranges. The minimum requirements for biodiesel are described in DIN EN 14214.

Viega solutions

When selecting materials for fittings, pipes and sealing elements, the special operating and installation conditions, as well as other system requirements, must be considered on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form. You can find the form for this on the Viega website *viega.de* by entering "material durability" as the search term.

Mineral oils and diesel fuels

For the transport of mineral oils and diesel fuels, Viega offers press connector systems with special sealing elements made of HNBR[1]. These systems are certified by the German Institute for Structural Engineering (DIBt):

- Profipress G
- Sanpress Inox G
- Megapress G

Besides its suitability for transporting media, Megapress G is also the ideal solution for producing suction, pressure, filling, aeration and ventilation lines in systems used for storing heating oil in accordance with DIN 51603-1 and diesel fuel in accordance with DIN EN 590.

Fig. 167: Filling plant for diesel fuel

[1] cf. „Sealing elements“ on page 12

The operating conditions in Tab. 71 and regulations concerning the media apply for the uses of the press connector systems.

Medium	Regulations	Operating pressure [MPa]	Operating temperature [°C]	Profipress G	Sanpress Inox G	Megapress G	Megapress S
Mineral oils SAE	SAE J357	≤ 1.6	≤ 70	✗	✓	✓	✓
Heating oil	DIN 51603-1	≤ 0.5	≤ 40	✓	✓	✓	✗
Diesel	DIN EN 590						
Biodiesel	DIN EN 14214	see Tab. 72					

Tab. 71: Operating parameters of Viega press connector systems for mineral oils and diesel fuels

Biogenic oils and diesel fuels

Viega offers press connector systems with special sealing elements made of HNBR or FKM[1] for transporting biogenic oils and diesel fuels:

The operating conditions in Tab. 71 and regulations concerning the media apply for the uses of the press connector systems.

[1] cf. „Sealing elements“ on page 12

Medium	Regulations	Operating pressure [MPa]	Operating temperature [°C]	Sanpress Inox G	Sanpress Inox	Temponox	Megapress G	Megapress S
Biodiesel	DIN EN 14214	≤ 1.0	≤ 70	✗	✓1)	✓1)	✗	✓
Rapeseed oil	–			✓	✗	✗	✓2)	✓2)
Palm oil Soy oil Sunflower oil	–							

1) EPDM sealing elements have to be replaced with FKM
2) Following consultation with the Viega Service Center

Tab. 72: Operating parameters of Viega press connector systems for biogenic oils and diesel fuels

Cooling lubricants (CL)

Essentially, the following Viega press connector systems are also suitable for cooling lubricants (CL):

- Profipress G
- Sanpress Inox G
- Megapress G

Given the diversity of cooling lubricants and their compositions, the use of Viega press connector systems must be carefully checked on a case-by-case basis.

Fig. 168: High number of cooling lubricants managed using Viega Sanpress Inox G

Fig. 169: Cooling lubricant tanks filled and emptied using Viega Sanpress Inox G

Further information

Viega provides the “Areas of application for metal piping systems” data sheet, which describes not only installations for water but also areas of application for anti-freeze, oils, coolants and lubricants as well as other special media and technical gases.

For the selection of Viega piping systems for industrial applications and special media, see the chapters “Metal piping systems” and “Plastic piping systems”.

Software

viega.de/software

For more information, see
- “Viptool Engineering”
- “Viptool Master”

Corrosion protection in cold- and cooling water systems

Corrosion protection for thick-walled non-alloy steel pipes

Introduction

Due to prevailing operating temperatures, piping systems in cold and cooling water installations can be exposed to unwelcome corrosion processes to a significant extent. This is particularly critical in cases where non-alloy steel is being used. At low temperatures, the temperature may fall below the dew point, resulting in condensate forming on the pipe surfaces.

The insulation of cold and cooling water installations as required by section 70 of the German Buildings Energy Act has the primary purpose of protecting piping from losing energy through heat absorption. However, it also prevents corrosion processes and reduces sound emissions. Proper insulation ensures that the surface temperature of the insulation material surface is always at least equal to or higher than the dew point temperature of the ambient air. Failure to install the insulation properly, however, can also lead to corrosion processes occurring.

To prevent corrosion, it is therefore mandatory according to DIN 4140 to provide corrosion protection for non-alloy and low-alloy steel used under insulation in operational systems in industry and building services engineering.

This document summarises the legal framework, provides background information on the subject of corrosion protection in cold- and cooling water systems and outlines the possible applications and advantages of the Viega Megapress press connector system.

Legal framework

The requirements for insulating piping and fittings in cooling distribution and cold water pipes and fittings are described in the German Act on Saving Energy and Using Renewable Energies for Heating and Cooling in Buildings **(German Buildings Energy Act – GEG)**.

Section 70 stipulates a limit on heat absorption for both new construction and projects in which piping and fittings are being replaced in air conditioning systems or other room air technology technology systems. For example, the insulating layer thickness must be at least 6 mm when the insulating material has a thermal conductivity of 0.35 W per metre and kelvin. The thickness must be calculated accordingly for other thermal conductivity levels in insulating material.

DIN 4140 describes how to install heat and cold insulation in operational systems in industry and building services engineering. If piping systems with cold insulation are made of non-alloy or low-alloy steels, they must be treated with corrosion protection according to DIN 4140. This must be carried out either in accordance with Worksheet Q 151 issued by the Arbeitsgemeinschaft Industriebau e. V. (German Industrial Construction Association (AGI)) or as specified in DIN EN ISO 12944-1 to DIN EN ISO 12944-9.
The example applications from AGI Worksheet Q 151 mainly relate to operational industrial units. As corrosion protection for cold and cooling water installations in building services engineering is not adequately addressed by this worksheet, the **B**undesindustrieverband **T**echnische **G**ebäude**a**usrüstung e. V. (German Federal Industrial Association for Building Services Engineering (**BTGA**)) has developed a rule for technical practice in the form of BTGA Rule 3.004, which specifies how corrosion protection systems should be used in accordance with DIN EN ISO 12944.

In DIN EN ISO 12944-2, six corrosivity categories from C1 (very low) to C5 (very high) and CX (extreme) are defined for “outdoor” and “indoor” environments. For corrosivity categories C1 (very low) to C4 (high), BTGA rule 3.004 specifies suitable systems for **the subsequent application of coatings** to the following pipe materials: black steel, galvanised steel, stainless steel[1] copper[1] and plastic[1].
The coating is determined by the total coating thickness and number of layers, and is also based on the coating material.

Additionally, BTGA Rule 3.004 includes the option to verify the suitability of **factory-applied coatings**. This means that the manufacturer of system parts and components can verify the suitability of the factory-applied coating as per DIN EN ISO 12944-6 for the area of application specified in BTGA Rule 3.004 without the need for further processing or enhancement of the corrosion protection.

[1] Please observe the material restrictions according to Tab. 3 of BTGA rule 3.004.

Table 1 of DIN EN ISO 12944-6 lists specific ISO standards for testing coating systems according to test programme 1. The relevant DIN/EN standards are:

- DIN EN ISO 2812-2 – Paints and varnishes – Determination of resistance to liquids – Part 2: Water immersion method
- DIN EN ISO 6270-1 – Paints and varnishes – Determination of resistance to humidity – Part 1: Condensation (single-sided exposure)

DIN EN ISO 9227 – Corrosion tests in artificial atmospheres – Salt spray tests

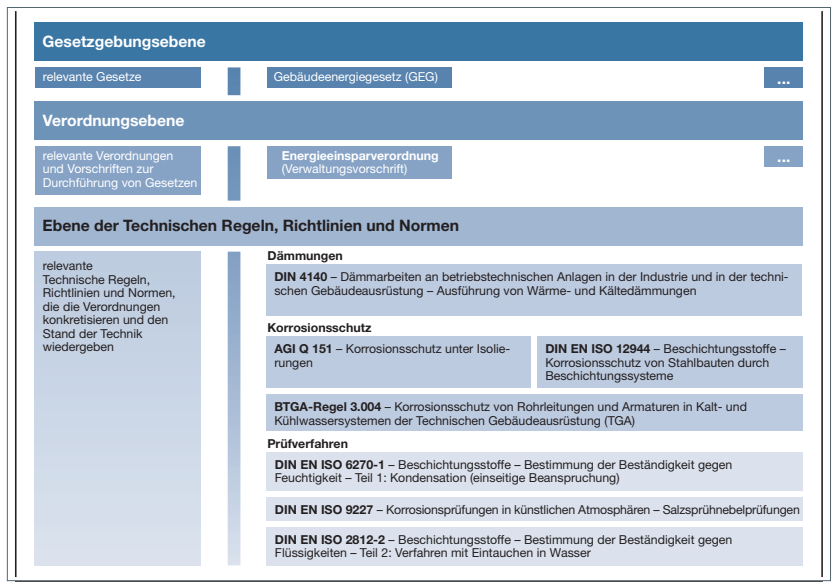


Fig. 170: Overview of important laws, regulations, standards and technical rules in connection with the insulation and corrosion protection of operational systems in industry and in building services engineering

Corrosion protection

Basics

Corrosivity is defined as the ability of an environment to cause corrosion on a metal. Corrosion occurs in the atmosphere as well as in water and top soil. Atmospheric corrosion has particular significance in cold- and cooling water installations. This is essentially due to the following factors:

- Increase in relative humidity
- Occurrence of condensation
- Increase in atmospheric contamination

If the relative humidity is 80 % or more and the temperature is above 0 °C, corrosion is to be expected.
Insulating piping and fittings in cooling and air conditioning systems, as required by Section 70 of the GEG, can further accelerate corrosion.
In contrast to surfaces exposed to the effects of the weather, insulated piping systems can encounter undesirable conditions that lead to corrosion as a result of moisture penetrating the insulating material (due to condensation on the pipe surface, leaks in the installation or moisture load from external sources, for example) and being retained for extended periods. Thermal bridges and system supports can also create conditions conducive to corrosion.

There are two ways in which moisture penetration presents a source of danger. Firstly, it can cause irreparable damage to some insulating materials, even leading to their complete destruction in some cases. Secondly, it can lead to an accumulation of corrosion-promoting substances (such as chloride ions and nitrates) at certain points, which can even trigger corrosion in austenitic steels.

Corrosion protection

Piping and components are often supplied with a coating that has been applied at the factory. There are also coating systems that can be applied at a later date.

Factory-applied coating systems

Products are usually provided with a suitable coating for the application case in question. This explains the large number of different coating processes used. The coating processes differ in terms of the chemical, mechanical, thermal and thermomechanical approaches used to apply the coating.

Galvanic coating

Galvanic surface coating is a chemical process in which an electric current causes metals to be deposited evenly on the surface of workpieces. In most cases, the metal layer protects against corrosion, but it can also be used to guard against mechanical wear or improve electrical conductivity. It is primarily the metals zinc, nickel, copper and tin that are used for coating steels.

Fig. 171: Caustic acid tank for galvanising metal parts in a galvanising workshop

Hot dip metal coating

Hot dipping is a group of coating processes in which a workpiece made from a metal or alloy with a higher melting point is completely immersed in a molten bath containing a metal or alloy with a lower melting point. When the workpiece is taken out of the molten bath, the liquid metal adheres to the dipped workpiece, then forms a solid metallic coating once it cools down.

Hot-dip galvanising is a metal coating process used to protect steel from corrosion. Hot dip galvanising involves applying a metallic zinc coating to steel by immersing it in molten zinc or a zinc alloy at approximately 450 °C.

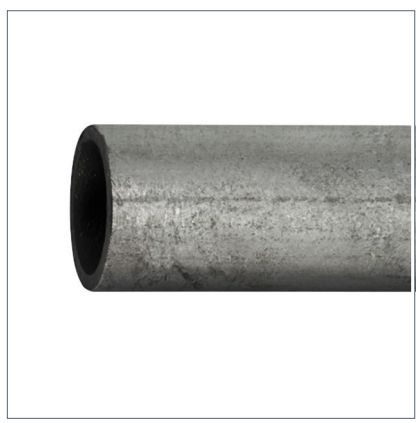


Fig. 172: Hot dip galvanised steel pipe

Brushing/spraying on
Suitable anti-corrosion agents can be used to insulate non-alloy steel against corrosive gases and liquids. In this case, epoxy (EP), polyurethane (PUR) or ethyl silicate (ESI)-bonded coatings with zinc dust offer good protection. Pigments such as zinc dust, zinc phosphate, zinc chromate or red lead are also called active pigments because they have an additional chemical or galvanic corrosion protection effect.

Brushing and spraying processes often require up to three layers, consisting of a primer, intermediate coat and cover coat. In the case of a two-layer application, the intermediate layer is omitted. In this type of application, the pigments used in the primer provide passive corrosion protection and adhesion to both the material being coated (substrate) and the subsequent layers.

Fig. 173: Coated steel pipes with Megapress S XL from Viega in the installation of a cooling system

Vapour coating
Vapour coating is a thermal coating process that involves heating the coating material to temperatures close to boiling point using an electric heater. The atom clusters or molecules that form in the process then condense on the substrate.

Verification of factory-applied coating systems
Factory-applied coating systems are not subject to any standardised specifications. Therefore, it is necessary to verify the suitability and potential use of products with factory-applied coatings without the need for further processing or enhancement of the corrosion protection. This manufacturer must do this for the area of application in question. This kind of verification can be provided in accordance with DIN EN ISO 12944-6 (see Chapter 5, “Evaluation of coating systems”).

Coating systems to be applied at a later stage
Epoxy (EP), polyurethane (PUR) and ethyl silicate (ESI)-bonded coatings with zinc dust are also used in coatings applied at a later stage. They are sufficient for low corrosivity categories C1 and C2 (see Chapter 5, "Evaluation coating systems") even as a single-layer application. However, if these coatings do not contain zinc dust, it is necessary to apply multiple layers of them.

Alkyd or acrylic resin-based coating systems are suitable for the higher corrosivity categories of C3 and C4. They do not require zinc dust, but do require multiple layers – and the layers need to be thicker.

Since many application cases require multiple coating layers, coatings applied at a later stage often prove to be time-consuming and cost-intensive.

Evaluation of coating systems

Corrosivity categories
DIN EN ISO 9223 classifies atmospheric conditions into six categories of atmospheric corrosivity:
- C1 Very low corrosivity
- C2 Low corrosivity
- C3 Medium corrosivity
- C4 High corrosivity
- C5 Very high corrosivity
- CX Extreme corrosivity

In DIN EN ISO 12944-2, corrosivity categories are assigned to the non-alloy steel and zinc, with the category determined by the environmental conditions and the anticipated loss of mass or reduction in material thickness.

Corrosivity categories for atmospheric environmental conditions and examples of typical environments

Corrosivity category	Loss of mass/reduction in thickness by surface area (after the first year of exposure)				Typical environment (example only)	
	Non-alloy steel		Zinc		Outdoor	Indoor
	Loss of mass g/m²	Reduction in thickness µm	Loss of mass g/m²	Reduction in thickness µm		
C1 (very low)	≤ 10	≤ 1.3	≤ 0.7	≤ 0.1	–	Heated buildings with neutral atmospheric conditions, e.g. offices, salesrooms, schools, hotels
C2 (low)	> 10–200	> 1.3–25	> 0.7–5	> 0.1–0.7	Atmospheric environment with low pollution; usually rural areas	Unheated buildings in which condensation can occur, e.g. warehouses, gyms
C3 (medium)	> 200–400	> 25–50	> 5–15	> 0.7–2.1	Urban and industrial atmospheric environment with moderate sulphur dioxide pollution; coastal atmosphere with low salinity	Manufacturing areas with high humidity and a certain level of air pollution, e.g. food processing plants, laundries, breweries, dairies
C4 (high)	> 400–650	> 50–80	> 15–30	> 2.1–4.2	Industrial areas and coastal areas with moderate salinity	Chemical plants, swimming pools, coastal shipyards and boating harbours
C5 (very high)	> 650–1 500	> 80–200	> 30–60	> 4.2–8.4	Industrial areas with high humidity and an aggressive atmospheric environment as well as coastal areas with high salinity	Buildings or areas with near-permanent condensation and heavy contamination
The loss values used for the corrosivity categories are identical to those given in ISO 9223						

Tab. 73: Test procedures for coating systems for non-alloy steel, hot-dip galvanised steel and steel with a thermally sprayed metal coating for atmospheric corrosivity categories (source: DIN EN ISO 12944-6)

Protection duration ranges
In addition to the corrosivity category, the duration over which a coating is protected is an important parameter for evaluating the quality of a coating. DIN EN ISO 12944-1 therefore distinguishes between four protection duration ranges:

- Low (L): up to 7 years
- Medium (M): 7 to 15 years
- High (H): 15 to 25 years
- Very high (VH): over 25 years

These areas do not represent a warranty period, but are intended to assist the owner/operator in planning maintenance. As a rule, the warranty period is shorter than the protection duration.

To determine the relevant corrosivity category and the range of protection duration, a coating must undergo a test procedure (test programme 1 or 2 based on Table 1 of DIN EN ISO 12944-6). Based on the results of the test programmes carried out on a selected coating, the coating can then be allocated to corrosivity category C2 to C5 according to DIN EN ISO 12944-6 and one of the four defined protection duration ranges.

By testing coating systems using test programme 1 or 2 according to Table 1 of DIN EN ISO 12944-6, it is possible to assign a coating to a protection duration range for the corrosivity category in question. This allows the planner or operator to select an appropriate type of coating for the intended application case and/or prevailing environmental conditions.

		Test programme 1			Test programme 2
Corrosivity category according to ISO 12944-2	**Protection duration according to ISO 12944-1**	**ISO 2812-2 (Immersion in water) h**	**ISO 6270-1 (Water condensation) h**	**ISO 9227 (Neutral salt spray) h**	**Appendix B (Cyclic aging test) h**
C2	Low	–	48	–	–
	Medium	–	48	–	–
	High	–	120	–	–
	Very high	–	240	480	–
C3	Low	–	48	120	–
	Medium	–	120	240	–
	High	–	240	480	–
	Very high	–	480	720	–
C4	Low	–	120	240	–
	Medium	–	240	480	–
	High	–	480	720	–
	Very high	–	720	1 440	1 680
C5	Low	–	240	480	–
	Medium	–	480	720	–
	High	–	720	1 440	1 680
	Very high	–	–	–	2 688

Tab. 74: Test procedures for coating systems for non-alloy steel, hot-dip galvanised steel and steel with a thermally sprayed metal coating for atmospheric corrosivity categories (source: DIN EN ISO 12944-6)

Viega press connection technology

All press connectors used in Megapress press connector systems are provided with an outer zinc-nickel coating at the factory, which is applied using a galvanic coating process.

Fig. 174: Megapress 90° elbow with SC-Contur

Viega approves the Megapress and Megapress S system press connectors for use with industrially corrosion-protected steel pipes in cold and cooling water systems in accordance with AGI Worksheet Q 151. Megapress and Megapress S can be pressed directly onto black, galvanised, industrially painted or powder-coated steel pipes according to DIN EN 10255, DIN EN 10220/DIN EN 10216-1 and DIN EN 10220/DIN EN 10217-1. It is not necessary to apply a subsequent corrosion protection coating to the press connectors.

The corrosion protection effect provided by the outer zinc-nickel coating of the Megapress and Megapress S systems has been verified by an independent testing institute using test programme 1 in accordance with table 1 of DIN EN ISO 12944-6. For this purpose,

- tests were carried out to determine resistance to moisture in accordance with DIN EN ISO 6270-1 and
- salt spray tests were performed in accordance with DIN EN ISO 9227.

Both tests verified that the outer zinc-nickel coating on the Megapress press connector systems was resistant over a test period of 720 hours.

This means that there is a very wide range of application cases for this type of coating:

- Buildings with a neutral atmosphere, such as offices, schools and hotels
- Unheated buildings subject to condensation (such as warehouses and gyms)
- Production facilities with high humidity levels and some contamination (such as laundries)
- Swimming pools, coastal shipyards or boating harbours

Even in buildings with continuous condensation and high levels of contamination, the Megapress and Megapress S press connector systems can still be used with an estimated protection duration of up to 15 years.

Corrosivity category according to DIN EN ISO 12944-2	Protection duration ranges according to DIN EN ISO 12944-1	Possible use of Viega Megapress/Megapress S for system service life in years
C1 – very low	Very high	> 25
C2 – low	Very high	> 25
C3 – medium	Very high	> 25
C4 – high	High	15–25
C5 – very high	Medium	7–15
CX – extreme	–	Not possible

Tab. 75: Protection duration ranges of Megapress/Megapress S according to the test procedure that applies to coating systems for non-alloy steel, hot-dip galvanised steel or steel with a thermally sprayed metal coating for atmospheric corrosivity categories (according to DIN EN ISO 12944-6)

Conclusion

If piping systems with cold insulation are made of non-alloy or low-alloy steels, they must be given some form of corrosion protection.

According to DIN 4140, this is carried out either in accordance with AGI Worksheet Q 151 or as specified in DIN EN ISO 12944-1 to DIN EN ISO 12944-9.

In operational systems, corrosion protection coatings can be applied at a later stage to cold and cooling water installations, but this is associated with increased costs and time.

The Megapress and Megapress S press connector systems are provided with an outer zinc-nickel coating from the factory. They combine the advantages of cold press connecting technology with a high-quality and long-lasting corrosion protection coating. Especially when used in combination with industrially corrosion-coated pipes, they offer a very efficient alternative. Contractually agreed corrosion protection according to DIN EN ISO 12944 eliminates the need for any follow-up work to apply corrosion protection in the area of the connection points.

PRODUCTS

Metal piping systems

General information

Instructions for use
Use of the systems for areas of application and media other than those described must be agreed in consultation with Viega. Detailed information about applications, restrictions and national standards and directives can be found in the product information, either printed or on the Viega website.

press connector with SC-Contur
Viega press connectors are equipped with the SC-Contur. This ensures that the press connector is guaranteed to leak in an unpressed state.

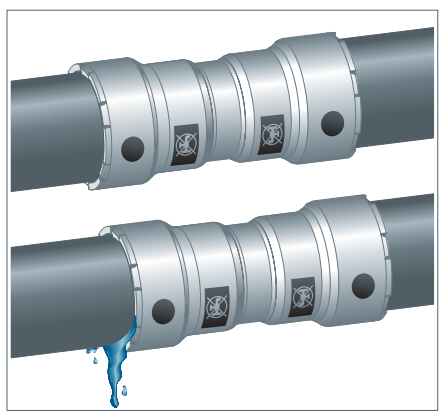


Fig. 175: SC-Contur using the Megapress as an example

Profipress / Profipress S / Prestabo / Megapress / Megapress S / Sanpress Inox / Sanpress / Temponox
Inadvertently unpressed connections are noticed immediately during a leakage test. Viega guarantees the detection of unpressed connections in the following pressure ranges using water, compressed air or inert gases:
- min. water pressure: 0.1 MPa/1 bar/14.5 PSI
- max. water pressure: 0.65 MPa/6.5 bar/94.3 PSI
- min. air pressure: 22 hPa/22 mbar/0.3 PSI
- max. air pressure: 0.3 MPa/3 bar/43.5 PSI

Profipress G / Megapress G / Sanpress Inox G
Inadvertently unpressed connections are noticed immediately during a leakage test. Viega guarantees the detection of unpressed connections in the following pressure ranges using compressed air or inert gases:
- min. air pressure: 22 hPa/22 mbar/0.3 PSI
- max. air pressure: 0.3 MPa/3 bar/43.5 PSI

Profipress

Flow-optimised press connector system made of copper (99.9% Cu-DHP), gunmetal or silicon bronze for copper pipes. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

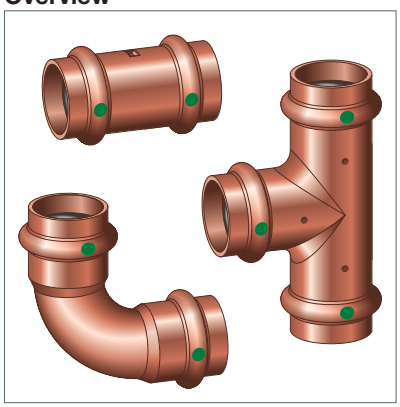


Fig. 176: Profipress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Heating and cooling systems
- Rainwater
- Compressed air, inert gas
- Cooling water pipelines
- Industrial applications
- Plant engineering
- Wet extinguishing water systems (according to DIN 14462)
- Wet sprinkler units (according to VdS CEA 4001)

Limitations of use for potable water
The Profipress press connector system is suitable for the construction of potable-water installations according to DIN 1988-200 and EN 806-2, taking into account material selection according to DIN EN 12502-1 and in accordance with the Federal Environmental Agency's assessment policy for metallic materials in contact with potable water. For use in other areas of application and in case of any doubts concerning correct material selection, please contact Viega.
With regard to the possibility of exceeding the limit for copper ions according to the Potable-Water Ordinance, pipes and connectors made of copper may only be used when pH is ≥ 7.4 or the total volume of organic carbon (TOC) does not exceed 1.5 mg/l at a pH between 7.0–7.4!

Press connector materials
- Copper: 99.9% Cu-DHP
- Gunmetal: CC499K
- Silicon bronze: CC246E / CW246E

Further information
For more information, see:

- „Sealing elements“ on page 12
- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Process water“ on page 134
- „Water for heat transmission“ on page 153
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Technical gases“ on page 211
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Profipress G

Flow-optimised press connector system made of copper (99.9% Cu-DHP), gunmetal or silicon bronze for copper pipes. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

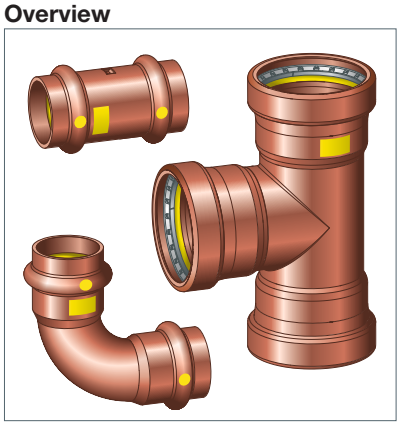


Fig. 177: Profipress G product selection

Sealing elements

- HNBR (hydrogenated NBR), yellow, pre-assembled

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0
Size availability in accordance with the national regulations

Areas of application

- Natural gas/liquid gas
- Heating oil/diesel fuel (d 12–54)

Press connector materials

- Copper: 99.9% Cu-DHP
- Gunmetal: CC499K
- Silicon bronze: CC246E / CW246E

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Oils and diesel fuels“ on page 252
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Profipress S

Optimised-flow press connector system made of copper (99.9 % Cu-DHP), gunmetal or silicon bronze for copper pipes. Press connector for protecting the sealing element equipped with cylindrical pipe guide. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

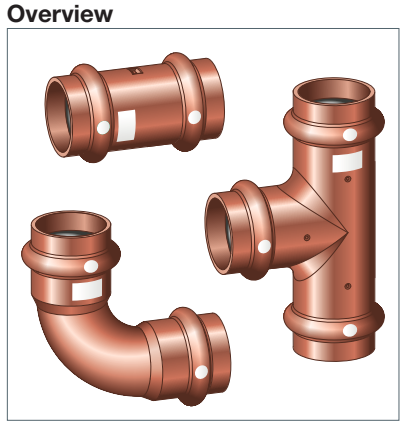


Fig. 178: Profipress S product selection

Sealing elements

- FKM (fluorocarbon rubber), matt black, pre-assembled

NOTE!
The use of Profipress S and Profipress connectors with FKM sealing elements in potable water and gas installations is not permitted!

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35
Size availability in accordance with the national regulations

Areas of application

- Solar installations (flat/vacuum collectors)
- District heat supply systems
- Low-pressure steam systems

Usage for systems with additives (e.g. anti-corrosion agents or anti-freeze) in heating water or for areas of application other than those described must be agreed in consultation with Viega.

Press connector materials
- Copper: 99.9% Cu-DHP
- Gunmetal: CC499K
- Silicon bronze: CC246E / CW246E

Further information
For more information, see:
- „Sealing elements“ on page 12
- „Low-pressure steam“ on page 246
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Prestabo

Flow-optimised press connector system with press connectors made of non-alloy steel 1.0308. Galvanised (blue chromated) on the outside. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

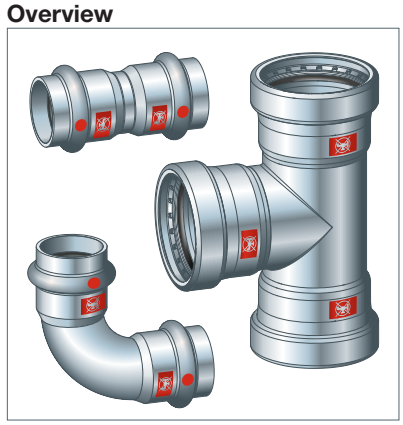


Fig. 179: Prestabo product selection

System pipe made of non-alloy steel 1.0308 (E235)
- Galvanised (blue chromated) on the outside.
- Suitable for heating, solar and cooling systems.

PP-coated system pipe made of non-alloy steel 1.0308 (E235)
- Galvanised (blue chromated) on the outside.
- Covered on the outside with a polypropylene (PP) plastic coating in white (RAL 9001).
- Suitable for heating, solar and cooling systems.

System pipe made of non-alloy steel 1.0215 (E220)
- Hot dip galvanised on the inside and outside.
- Suitable for extinguishing water, sprinkler and compressed-air systems.

Sealing elements
- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions
Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application
- Closed heating and cooling systems
- Industrial and plant engineering
- Sprinkler units (piping galvanised using the Sendzimir process)
- Compressed air systems (hot dip galvanised pipe)
- Solar installations with flat collectors
- Solar installations with vacuum tube collectors (only with FKM sealing element)

Press connector materials
1.0308 steel

Note – storage and transport
To guarantee the impeccable quality of Prestabo pipes, observe the following points during transport and storage:
- Packing and protective cover (only with PP-coated pipes) should not be removed until immediately before use.
- The pipe ends must be closed with protective caps when delivered.
- Do not store the pipes directly on the bare floor.
- Do not stick any protective foils or plastics to the pipe surfaces.
- When loading and unloading, do not pull the pipes over the truck sill.

Note – protection against external corrosion
Prestabo pipes and press connectors are protected by external galvanisation. In case of contact with dampness (condensation, precipitation during the construction phase, plaster and splash water etc.) or corrosive building materials (surfacer, levelling screed etc.), however this layer of zinc cannot provide permanent protection against external corrosion. The following protective measures are recommended:
- Use of closed-cell insulating tubes with professional sealing of all abutting and cut edges using a suitable filler.
- Damp-proofing of the laid piping through separating foil in the floor construction.
- Installing piping outside areas at risk of moisture.
- Visible radiator connections rising from the floors should be avoided if floors are to be frequently cleaned with water and/or cleaning agents/ disinfectants, for example in retirement homes and care facilities, as well as hospitals. Wall connections make cleaning easier and also exclude any additional risk of corrosion.
- If the radiator connections do come from the floor, proper corrosion protection and sealing of the joints must be ensured. If not, there is a risk of the cleaning water penetrating, which will moisten the insulation and could cause corrosion.

If the measures in the examples above fail to provide permanent moisture protection or the areas of application have to meet special requirements, e.g. in cooling circuits, a complete external corrosion protection must be applied that reliably prevents any impact promoting corrosion.

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Process water“ on page 134
- „Water for heat transmission“ on page 153
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Prestabo LF

Flow-optimised press connector system with press connectors made of non-alloy steel 1.0308. Galvanised (blue chromated) on the outside. Free of paint-wetting impairment substances (PWIS-free) such as silicone, grease or oil. Especially suitable for the use of pipeline installations in paint shops. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

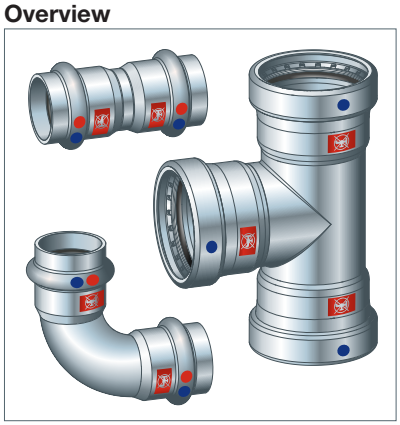


Abb. 180: Prestabo LF product selection

System pipe made of non-alloy steel 1.0308 (E235)

- Galvanised (blue chromated) on the outside.
- Suitable for heating, solar and cooling systems.

System pipe made of non-alloy steel 1.0215 (E220)

- Hot dip galvanised on the inside and outside.
- Suitable for sprinkler and compressed air systems.

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application
- Closed cooling and heating systems
- Industrial and plant engineering
- Wet extinguishing water systems (according to DIN 14462, with piping galvanised using the Sendzimir process)
- Wet sprinkler units (according to VdS CEA 4001, piping galvanised using the Sendzimir process)
- Compressed air systems (hot dip galvanised pipe)
- Solar installations

Press connector materials
- 1.0308 steel

Note – storage and transport
To guarantee the impeccable quality of Prestabo pipes, observe the following points during transport and storage:
- Packing and protective cover (only with PP-coated pipes) should not be removed until immediately before use.
- The pipe ends must be closed with protective caps when delivered.
- Do not store the pipes directly on the bare floor.
- Do not stick any protective foils or plastics to the pipe surfaces.
- When loading and unloading, do not pull the pipes over the truck sill.

Note – protection against external corrosion
Prestabo pipes and press connectors are protected by external galvanisation. In case of contact with dampness (condensation, precipitation during the construction phase, plaster and splash water etc.) or corrosive building materials (surfacer, levelling screed etc.), however this layer of zinc cannot provide permanent protection against external corrosion. The following protective measures are recommended:
- Use of closed-cell insulating tubes with professional sealing of all abutting and cut edges using a suitable filler.
- Damp-proofing of the laid piping through separating foil in the floor construction.
- Installing piping outside areas at risk of moisture.
- Visible radiator connections rising from the floors should be avoided if floors are to be frequently cleaned with water and/or cleaning agents/ disinfectants, for example in retirement homes and care facilities, as well as hospitals. Wall connections make cleaning easier and also exclude any additional risk of corrosion.
- If the radiator connections do come from the floor, proper corrosion protection and sealing of the joints must be ensured. If not, there is a risk of the cleaning water penetrating, which will moisten the insulation and could cause corrosion.

If the measures in the examples above fail to provide permanent moisture protection or the areas of application have to meet special requirements, e.g. in cooling circuits, a complete external corrosion protection must be applied that reliably prevents any impact promoting corrosion.

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Water for heat transmission“ on page 153
- „Extinguishing water“ on page 160
- „PWIS conformity“ on page 183
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Megapress

Flow-optimised press connector system made of non-alloy steel 1.0308 with an externally galvanised zinc-nickel coating for black, galvanised, industrially painted and powder-coated steel pipes. Press connectors with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

Fig. 181: Megapress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), profile sealing element, black, pre-assembled

NOTE!
Not suitable for fuel gases in accordance with DVGW Worksheet G 260, potable-water installations and other open systems!

Dimensions

D⅜ (DN10); D½ (DN15); D¾ (DN20); D1 (DN25); D1¼ (DN32); D1½ (DN40); D2 (DN50);
External diameter 38.0 (DN32); 44.5 (DN40); 57.0 (DN50)
Size availability in accordance with the national regulations

Areas of application

- Industrial and plant engineering
- Closed cooling and heating systems
- Compressed air systems
- Wet extinguishing water systems (according to DIN 14462) – observe the required minimum and maximum wall thickness
- Wet, wet/dry and dry sprinkler units (according to VdS CEA 4001) – observe the required minimum and maximum wall thickness
- Systems for technical gases (request required)

Press connector materials
- 1.0308 steel
- Silicon bronze: CC246E / CW246E

Note – protection against external corrosion
A zinc-nickel coating provides the press connectors with optimum protection against corrosion – e.g. when condensation water forms in cooling systems. The pipe being used should have suitable corrosion protection – observe the manufacturer's specifications.
Pipes and pipe connectors should be insulated the same way in accordance with the generally recognised rules of engineering.

Further information
For more information, see:

- „Sealing elements“ on page 12
- „Process water“ on page 134
- „Water for heat transmission“ on page 153
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Technical gases“ on page 211
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Megapress G

Optimised-flow press connector system made of non-alloy steel 1.0308 with an externally galvanised zinc-nickel coating for black and galvanised steel pipes. Press connectors with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

Fig. 182: Megapress G product selection

Sealing elements

- HNBR (hydrogenated nitrile butadiene rubber), profile sealing element, yellow, pre-assembled

Dimensions

D½ (DN15); D¾ (DN20); D1 (DN25); D1¼ (DN32); D1½ (DN40); D2 (DN50) size availability in accordance with national regulations

Areas of application

- Natural gas/liquid gas
- Compressed air systems
- Heating oil
- Diesel fuel

Press connector materials

- 1.0308 steel

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Oils and diesel fuels“ on page 252
- „Compressed air“ on page 187
- „Technical gases“ on page 211
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Megapress S

Flow-optimised press connector system made of non-alloy steel 1.0308 with an externally galvanised zinc-nickel coating for black, galvanised, industrially painted and powder-coated steel pipes. Press connectors with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

Fig. 183: Megapress S product selection

Sealing elements

- FKM (fluorocarbon rubber), matt black, pre-assembled

NOTE!
Not suitable for fuel gases in accordance with DVGW Worksheet G 260, potable-water installations and other open systems!

Dimensions

D⅜ (DN10); D½ (DN15); D¾ (DN20); D1 (DN25); D1¼ (DN32); D1½ (DN40); D2 (DN50); D2½ (DN65); D3 (DN80); D4 (DN100)
Size availability in accordance with the national regulations

Areas of application

- Industrial and plant engineering
- Local and district heat systems in accordance with AGFW FW 524 (after entry into the building, ≤ DN50)
- Closed cooling and heating systems
- Compressed air systems
- Wet extinguishing water systems (according to DIN 14462) – observe the required minimum and maximum wall thickness
- Wet, wet/dry and dry sprinkler units (according to VdS CEA 4001) – observe the required minimum and maximum wall thickness
- Systems for technical gases (request required)

Press connector materials
- 1.0308 steel

Note – protection against external corrosion
A zinc-nickel coating provides the press connectors with optimum protection against corrosion – e.g. when condensation water forms in cooling systems.
The pipe being used should have suitable corrosion protection – observe the manufacturer's specifications.
Pipes and pipe connectors should be insulated the same way in accordance with the generally recognised rules of engineering.

Further information
For more information, see:

- „Sealing elements“ on page 12
- „Process water“ on page 134
- „Water for heat transmission“ on page 153
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Technical gases“ on page 211
- „Low-pressure steam“ on page 246
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Sanpress Inox

Flow-optimised press connector system with press connectors made of 1.4401 stainless steel and pipes from 1.4401 and 1.4521 stainless steel. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

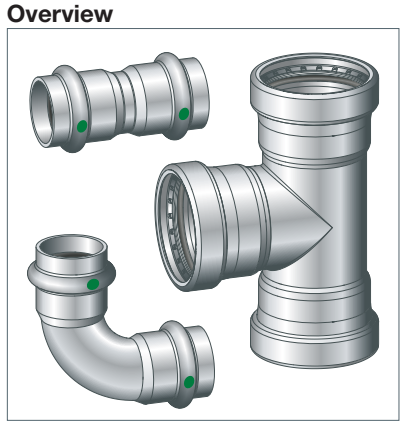


Fig. 184: Sanpress Inox product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Heating / radiator connection
- Rainwater
- Compressed air systems
- Agriculture
- Industrial applications
- Wet extinguishing water systems (according to DIN 14462)
- Dry and wet/dry extinguishing water systems (according to DIN 14462) ≤ DN65
- Wet, wet/dry and dry sprinkler units (according to VdS CEA 4001)

Press connector materials

- Stainless steel 1.4401

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Process water“ on page 134
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Sanpress Inox LF

Flow-optimised press connector system with press connectors made of 1.4401 stainless steel and pipes from 1.4401 and 1.4521 stainless steel. Free of paint-wetting impairment substances (PWIS-free) such as silicone, grease or oil. Especially suitable for the use of pipeline installations in paint shops. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

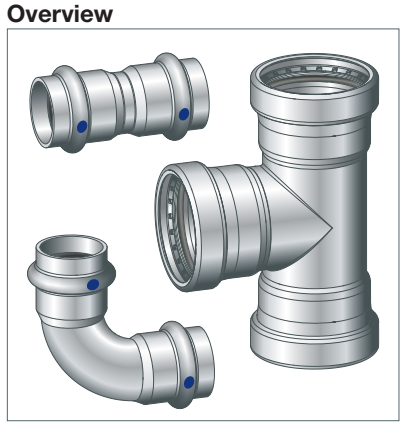


Abb. 185: Sanpress Inox LF product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Rainwater
- Compressed air systems
- Agriculture
- Industrial applications
- Wet extinguishing water systems (according to DIN 14462)
- Dry and wet/dry extinguishing water systems (according to DIN 14462) ≤ DN65
- Wet, wet/dry and dry sprinkler units (according to VdS CEA 4001)

Press connector materials

- Stainless steel 1.4401

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Process water“ on page 134
- „Extinguishing water“ on page 160
- „PWIS conformity“ on page 183
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Sanpress Inox G

Flow-optimised press connector system with press connectors and pipes made of 1.4401 stainless steel. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d64.0 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

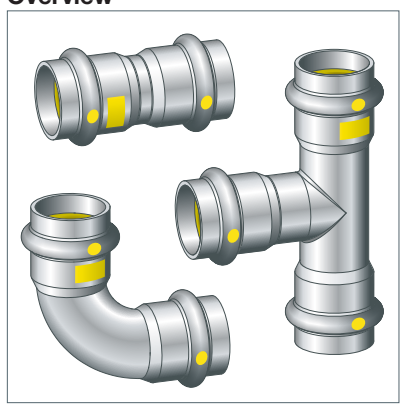


Fig. 186: Sanpress Inox G product selection

Sealing elements

- HNBR (hydrogenated NBR), yellow, pre-assembled

Dimensions

Standard sizes: d15; 18; 22; 28; 35; 42; 54
XL sizes: d64.0; 76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Natural gas/liquid gas
- Heating oil
- Diesel fuel

Press connector materials

- Stainless steel 1.4401

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Technical gases“ on page 211
- „Oils and diesel fuels“ on page 252
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Sanpress

Optimised-flow press connector system with press connectors made of gunmetal or silicon bronze (change of material due to the current production changeover from gunmetal to the new Viega global standard of silicon bronze alloy) and pipes made of stainless steel 1.4401 and 1.4521. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d76.1 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

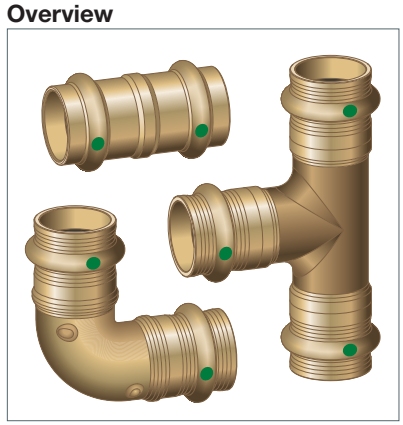


Fig. 187: Sanpress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Rainwater
- Compressed air systems
- Agriculture
- Industrial applications
- Wet extinguishing water systems (according to DIN 14462)
- Dry and wet/dry extinguishing water systems (according to DIN 14462), DN80

Press connector materials

- Copper: 99.9% Cu-DHP
- Gunmetal: CC499K
- Silicon bronze: CC246E / CW246E

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Process water“ on page 134
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Sanpress LF

Optimised-flow press connector system with press connectors made of gunmetal or silicon bronze (change of material due to the current production changeover from gunmetal to the new Viega global standard of silicon bronze alloy) and pipes made of stainless steel 1.4401 and 1.4521. Free of paint-wetting impairment substances (PWIS-free) such as silicone, grease or oil. Especially suitable for the use of pipeline installations in paint shops. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d76.1 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

Fig. 188: Sanpress LF product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d12; 15; 18; 22; 28; 35; 42; 54
XL sizes: d76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Rainwater
- Compressed air systems
- Agriculture
- Industrial applications
- Wet extinguishing water systems (according to DIN 14462)
- Dry and wet/dry extinguishing water systems (according to DIN 14462), DN80

Press connector materials
- Copper: 99.9% Cu-DHP
- Gunmetal: CC499K
- Silicon bronze: CC246E/CuSi4Zn9MnP

Further information
For more information, see:

- „Sealing elements“ on page 12
- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Process water“ on page 134
- „Extinguishing water“ on page 160
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Temponox

Optimised-flow press connector system with press connectors made of 1.4301 stainless steel and pipes made of 1.4520 stainless steel. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d76.1 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. Pipes are equipped with plugs for protection. The pressing force is located before and behind the sealing element seat. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

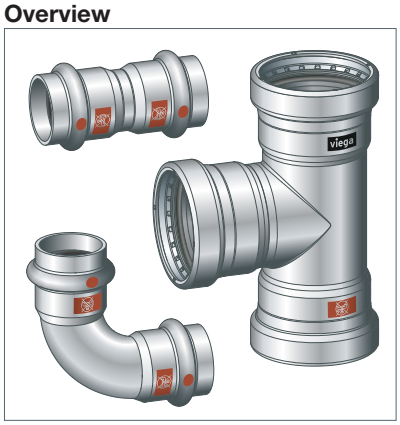


Fig. 189: Temponox product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d15; 18; 22; 28; 35; 42; 54
XL sizes: d76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application

- Closed cooling and heating systems
- Compressed air systems
- Solar installations with flat collectors
- Solar installations with vacuum collectors (only with FKM sealing element)
- Industrial applications

Connector material

- Stainless steel 1.4301

Pipe materials

- Stainless steel 1.4520

Further information

For more information, see:

- „Sealing elements“ on page 12
- „Process water“ on page 134
- „Water for heat transmission“ on page 153
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Seapress

Flow-optimised press connector system made of CuNiFe alloy for CuNiFe pipes. Especially suitable for applications involving seawater. Press connector for protecting the sealing element equipped with cylindrical pipe guide. Press connectors from d76.1 with a stainless-steel cutting ring to ensure the mechanical strength of the connection. The pressing force is located before and behind the sealing element seat. Suitable for installations of manifolds and riser pipes.

Overview

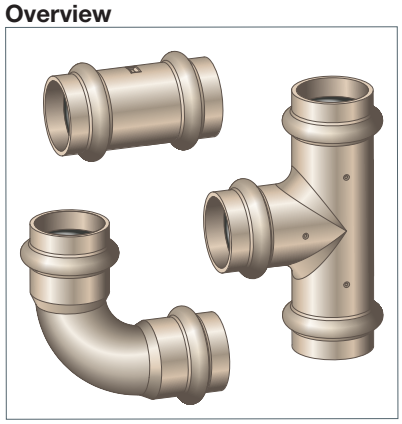


Fig. 190: Seapress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimensions

Standard sizes: d15; 22; 28; 35; 42; 54
XL sizes: d76.1; 88.9; 108.0
Size availability in accordance with the national regulations

Areas of application in the shipbuilding industry

- Extinguishing water and sprinkler systems
- Seawater cooling
- Bilge and ballast systems
- Seawater desalination systems

NOTE!
Before installation, refer to the relevant valid certificate for verification of suitability and approval, or contact the appropriate certification body.

Press connector materials
- CuNiFe1.6 Mn

Further information
For more information, see:
- „Sealing elements“ on page 12
- „Extinguishing water“ on page 160
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Plastic piping systems

General information

Instructions for use

Use of the systems for areas of application and media other than those described must be agreed in consultation with Viega! Detailed information about applications, restrictions and national standards and directives can be found in the product information, either printed or on the Viega website.

Press connector with SC-Contur

Viega press connectors are equipped with the SC-Contur. This ensures that the press connector is guaranteed to leak in an unpressed state.

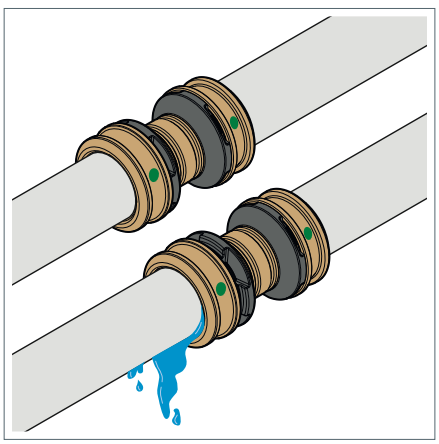


Fig. 191: SC-Contur using the Raxofix as an example

Raxofix / Geopress K

Inadvertently unpressed connections are noticed immediately during a leakage test.
Viega guarantees the detection of unpressed connections in the following pressure ranges with water, compressed air or inert gases:

- min. water pressure: 0.1 MPa/1 bar/14.5 PSI
- max. water pressure: 0.65 MPa/6.5 bar/94.3 PSI
- min. air pressure: 22 hPa/22 mbar/0.3 PSI
- max. air pressure: 0.3 MPa/3 bar/43.5 PSI

Geopress G

Inadvertently unpressed connections are noticed immediately during a leakage test. Viega guarantees the detection of unpressed connections in the following pressure ranges using compressed air or inert gases:

- min. air pressure: 22 hPa/22 mbar/0.3 PSI
- max. air pressure: 0.3 MPa/3 bar/43.5 PSI

Raxofix

Flow-optimised press connector system with press connectors made of silicon bronze and multi-layer pipes and solid plastic pipes. Multi-layer pipe, dimensionally stable, oxygen-proof, colour: grey. Press connector with PPSU support body to ensure the leak tightness and mechanical strength of the connection. Safe and fast connection without widening or calibration of the pipe ends thanks to O-ring-free press technology for all pipe dimensions. Pipes are equipped with plugs for protection. Solid plastic pipe, flexible. Suitable for pre-wall and concealed installations of riser pipes and floor installations.

Overview

Fig. 192: Raxofix product selection

Dimensions

Solid plastic pipe:
d 10
Multi-layer pipe:
d 16; 20; 25; 32; 40; 50; 63
Size availability in accordance with the national regulations

Area of applications: solid plastic pipe

- Potable water

Areas of applications: multi-layer pipe

- Potable water
- Rainwater
- Heating systems
- Compressed air systems

Press connector materials

- Silicon bronze: CC246E / CW246E

Further information

For more information, see:

- „Potable water“ on page 78
- „Potable water in first aid facilities“ on page 129
- „Water for heat transmission“ on page 153
- „Compressed air“ on page 187
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Geopress K

Press connector system made of fibre-glass reinforced polyamide. Permitted pipe types: PE 80/100/100RC and PE-X of SDR series 11. Support sleeve function integrated into the press connector. Suitable for underground, municipal supply lines.

Overview

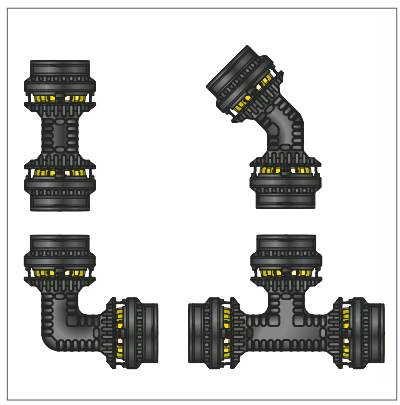


Fig. 193: Geopress K gas product selection

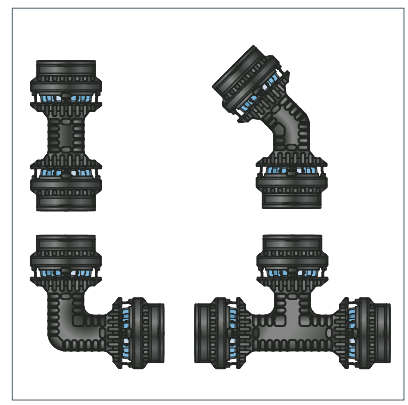


Fig. 194: Geopress K product selection

Dimensions

d 25; 32; 40; 50; 63
Tapping valves: d63; 90; 110; 125; 140; 160; 180; 200; 225
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Gas
- Liquid gas in the gaseous phase
- Hydrogen

Press connector materials

- Fibre-glass-reinforced polyamide GF-PA / POM / CuSi4Zn9MnP

Further information

For more information, see:

- „Potable water“ on page 78
- „Oils and diesel fuels“ on page 252
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Geopress

Press connector system made of corrosion-resistant gunmetal for plastic pipes. Permitted pipe types: PE 80/100/100RC and PE-X of SDR series 11. PE-X pipes only in conjunction with a support sleeve made of gunmetal (model 9605). Suitable for underground municipal potable-water supply pipelines.

Tapping valves

For connecting the service connection to non-pressurised and pressurised supply lines.
Permitted pipe types: PE-HD, PE-X and PVC-U.

Overview

Fig. 195: Geopress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimension

d25; 32; 40; 50; 63
Tapping valves: d63; 90; 110; 125; 140; 160; 180; 200; 225
Size availability in accordance with the national regulations

Areas of application

- Potable water
- Hot water
- Local heat supply systems
- Geothermal energy
- Rainwater

Press connector materials

- Gunmetal: CC499K

Further information

For more information, see:

- „Potable water“ on page 78
- „Process water“ on page 134
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Maxiplex

Clamping ring connector system made of corrosion-resistant gunmetal for plastic pipes. Permitted pipe types: PE 80/100/100-RC, PE-Xa and PVC-U. High tenacity due to a serrated clamping ring made of fibre-glass-reinforced plastic. High degree of safety due to separate sealing and clamping function. Equalisation of pipe unevenness provided by the sealing element. When used multiple times, the clamping ring must be replaced (accessories). Suitable for underground municipal potable-water supply pipelines.

Tapping valves

For connecting the service connection to non-pressurised and pressurised supply lines.
Permitted pipe types: PE-HD, PE-X and PVC-U.

Overview

Fig. 196: Geopress product selection

Sealing elements

- EPDM (ethylene propylene diene rubber), black, pre-assembled

Dimension

d20; 25; 32; 40; 50; 63
Tapping valves: d63; 90; 110; 125; 140; 160; 180; 200; 225
Size availability in accordance with the national regulations

Areas of application

- Potable water

Press connector materials

- Gunmetal: CuSn4Zn6Pb3-C-GS

Further information

For more information, see:

- „Potable water“ on page 78
- „Further information“ on page 324

This QR code will take you to the Viega online catalogue.

Flushing systems for maintaining potable water quality

To maintain potable water hygiene in industry, Viega offers flushing stations and the universal flush valve. The systems can be combined with numerous Viega press connector systems directly.

Flushing stations

With Viega Hygiene function for cold potable water (PWC) as well as hot and cold potable water (PWH, PWC), automatic flushing system for supporting operation as intended in case of foreseeable usage interruptions. Each run can be freely configured as PWC or PWH. For use in ring systems and pipes in series, wall and concealed mounting, installation in wet and dry construction and pre-wall systems. Time-based flush actuation in freely definable time intervals, freely selectable flush volume with and without temperature testing.
Use-based flush actuation in freely definable time intervals based on a preselected time for usage interruptions, water exchange check by a sensor in the pipeline, freely selectable flush volume with and without temperature testing. Temperature-based flush actuation of the flushing process via a sensor in the piping, check of impermissible stagnation temperature at freely-definable time intervals, freely selectable flush volume with and without temperature monitoring.
Communication options through browser-based software via Ethernet or WLAN. Connection options to existing building management systems via Ethernet connection.

Overview

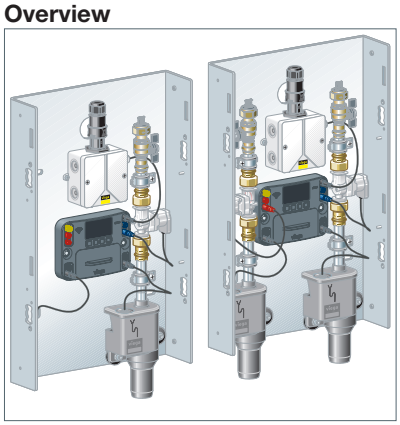


Fig. 197: Flushing stations

Product comparison

Both flushing stations are suitable for:

- Hot or cold potable water (PWH or PWC)
- Use in ring systems and pipe in series, wall-mounted and concealed mounting
- Installation in brick wall, dry construction and pre-wall systems

Technical data for both flushing stations:

- Flush volume: 4.2 l/min (0.1 to 0.3 MPa)
- Operating pressure max. 1.0 MPa
- Operating: temperature max. 75 °C
- Minimum flow pressure: 1 000 hPa
- Mains voltage: 100–240 V AC/50–60 Hz

Model	for one flushing line	for two flushing lines
2241.10	✓	
2241.20		✓

Tab. 76: Product comparison of flushing stations

Compatible components

Model	Name	Features
2241.81	Flow meter fitting	■ for the exact determination of volumetric flows and function testing of magnet valves ■ Reverse-polarity-protected and water-tight plug contacts ■ Measuring range: 1–10 l/min
2241.62	External sensor	■ for light and sound signal: 12 V DC / 200 mA – for light signal: 12 V DC / 90 mA ■ Light signal alarm in the event of a malfunction, with additional acoustic signal as an option ■ Operating temperature range: 0–40°C ■ Sound pressure at 1 meter: 95 dB
2241.68	BMS module binary	■ 8 inputs (signals from building management, potential-free) ■ 12 outputs (signals for building management, relay contact max. 24 V / 100 mA)
2241.90	Concealed protective cover	■ For concealed mounting ■ Depth-adjustable from 12.5 to 50 mm
2241.89	Wall-mounted protective cover	For wall-mounted assembly

Model	Name	Features
2241.53	Blue multi-functional sensor	■ Brass screw-in piece ■ Screw-in sensor with G-thread ■ Blue plug connector for media marking
2241.54	Red multi-functional sensor	■ Brass screw-in piece ■ Screw-in sensor with G-thread ■ Red plug connector for media marking
2241.60	Blue screw-in sensor	■ Adapter ring for transition from Rp¼ to Rp½ ■ Connection cable ■ Reverse-polarity-protected and waterproof plug contacts
2241.61	Red screw-in sensor	
2241.95	Extension cable PWC	■ Blue plug connector for media marking ■ Reverse-polarity-protected and waterproof plug contacts
2241.96	PWH extension cable	■ Red plug connector for media marking ■ Reverse-polarity-protected and waterproof plug contacts

Tab. 77: Compatible components for flushing stations

This QR code will take you to the Viega online catalogue.

Flush valve universal PWH/PWC

With Viega Hygiene function for potable water cold (PWC), or potable water hot (PWH), automatic flushing system for supporting operation as intended in case of foreseeable usage interruptions. For use in ring systems and pipes in series, wall and concealed mounting, installation in wet and dry construction and pre-wall systems. Volume-controlled actuation of the flushing process via (max. four settings) via freely-defined flush volumes. Connection to the Building Management System via potential-free contacts and analogue incoming signals 0–20 mA.

Overview

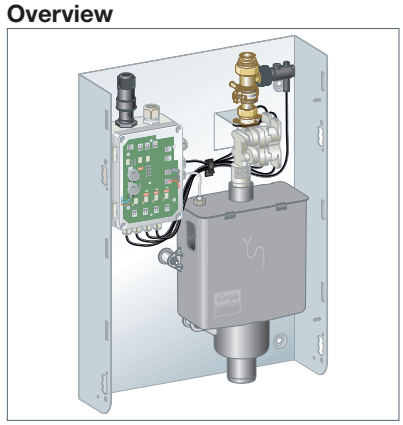


Fig. 198: Flush valve PWH/PWC (model 2243.10)

Model	Features
2243.10	■ for potable water cold or hot (PWC or PWH) ■ Use in ring systems and pipe in series, wall-mounted and concealed mounting ■ Installation in brick wall, dry construction and pre-wall systems Technical data: ■ Up to DN80 max. 45 l/m ■ Operating pressure max. 1.0 MPa ■ Operating temperature max. 75°C ■ Minimum flow pressure 1 000 hPa ■ Mains voltage 100–240 V AC/50–60 Hz

Tab. 78: Product overview of flush valve model 2243.10

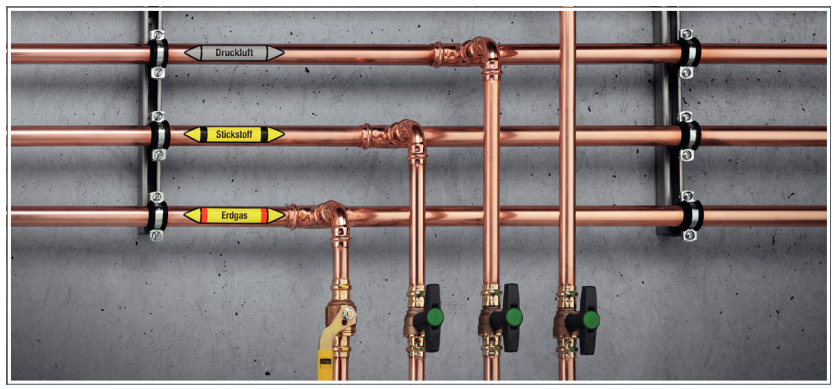
Compatible components

Model	Name	Features
2243.11	protective cover	■ For concealed mounting ■ Depth-adjustable from 12.5 to 50 mm
2243.12	protective cover	For wall-mounted assembly

Tab. 79: Compatible components, flush valve

This QR code will take you to the Viega online catalogue.

FURTHER INFORMATION



The up-to-date “Areas of application for metal piping systems” data sheet can be found on the website at *viega.de*.

For many years, Viega press connection technology with the Megapress, Sanpress, Sanpress Inox, Prestabo, Profipress, Temponox and Seapress systems has been a proven solution for use in potable-water and building services installations. More and more, they are used in industrial units with special operating conditions in terms of pressure, temperature and concentration of the transported media, which require great care in selecting pipe and sealing materials.
Viega provides the “Areas of application for metal piping systems” data sheet, which not only describes installations for water but also areas of application for anti-freeze, oils, coolants and lubricants as well as other special media and technical gases.
In special cases, please contact our Service Center to discuss whether your application is in compliance with the intended use of a system.

Viega piping systems with press connectors cannot be used for piping systems in the food industry as well as for water used in the manufacture of pharmaceutical products (Aqua valde purificata) or for injection purposes (Aqua ad iniectabilia).

Check the use of Viega press systems in the pharmaceutical and food industries on a case-by-case basis.

Send your detailed enquiries to the Viega Service Center using the "Enquiry for material durability" form.

You can find the form on the Viega website *viega.de* by using the search term “material durability”

Sealing elements – Technical data

Sealing element short name	Technical Name	Viega press connector system application	Colour
EPDM	Ethylene propylene diene rubber	Sanpress Inox / Sanpress / Profipress / Megapress	Black polished
HNBR	Acrylonitrile butadiene rubber	Sanpress Inox G / Profipress G / Megapress G	Yellow
FKM	Fluor rubber	Sanpress Inox / Sanpress / Profipress / Megapress S	Black matt

Tab. 80: Technical data

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