

# COOL-FIT 4.0
## Planning Fundamentals

**Plan, Build, Operate**

# Design and Installation

## COOL-FIT 4.0

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CH-8201 Schaffhausen/Switzerland

# Pre-Insulated Solutions

## COOL-FIT 4.0

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# COOL-FIT 4.0

## 1.1 General Information

COOL-FIT 4.0 is a pre-insulated piping system for the delivery of secondary refrigerants. The COOL-FIT 4.0 system is a completely pre-insulated plastic piping system for secondary refrigerant circuits that run with water, brine, or Glycol based solutions. Thanks to its insulation thickness of 40 mm, typical areas of application are industrial refrigeration systems with medium temperatures up to -50 °C and chilled water systems for media above 0 °C.

COOL-FIT 4.0 is based on established, impact resistant and corrosion free PE pipe and fittings. The smooth inner surface of the fluid pipe provides minimal losses of pressure. The low thermal conductivity and high quality insulation guarantee low operating cost over the entire lifespan of the system. Thanks to the 3 in 1 design – Fluid pipe / Insulation / Robust jacket – installation time is kept very short.

All components are pre-insulated or supplied with mountable insulation shells. The COOL-FIT 4.0 tools allow for fast and safe installation of the system.

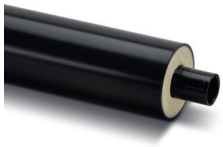



The COOL-FIT 4.0 system is suitable for use in applications like:

- Fruit and vegetable processing
- Bakeries
- Fish and meat processing
- Cold stores
- Breweries and wineries
- Air conditioning
- Airports
- Apartments
- Hospitals
- Industrial buildings
- Data centers
- Hotels
- Shopping centers
- Sports centre / leisure centre
- Universities
- Bank / public institutions

# 1.2 System Specification

## 1.2.1 COOL-FIT 4.0

| Specification | | COOL-FIT 4.0 | COOL-FIT 4.0F | COOL-FIT 4.0 Push System |
|---|---|---|---|---|
| | |  |  |  |
| Materials[1] | Pipe | PE100 | PE100 | Multilayer composite pipe PE-RT/Al/PE-RT |
| | Insulation | GF-HE foam, halogen free, closed-cell | GF-HE foam, halogen free, closed-cell | Pipe: EPDM foam<br>Fitting: XPE foam |
| | Outer jacket | Pipe HDPE | Flame retardant - GF-FR | Stainless steel polyester fabric |
| | | Fitting GF-HE | | TPE |
| Size | | d32DN25 – d450DN450 | d32DN25 - d225DN200 | d25DN20 - d32DN25 |
| Connection technology | | Electrofusion | Electrofusion | Push-in connector |
| Nominal pressure[2] | 16 bar, SDR 11<br>10 bar, SDR17 | d32DN25-d450DN450<br>d160DN150-d450DN450 | d32DN25-d225DN200<br>d160DN150 + d225DN200 | 16 bar |
| Temperature | Medium | -50 °C to +60 °C | SDR11: -30 °C to +60 °C<br>SDR17: 0 °C to +60 °C | -20 °C to +60°C |
| | Environment | -30 °C to +60 °C | 0 °C to +55 °C | +0 °C to +55°C |
| Insulation | Thermal conductivity $\lambda_{10°C}$ | | | |
| | PE Inner pipe | 0.38 W/mK | 0.38 W/mK | |
| | GF-HE foam | 0.022 W/mK (d32-d110);<br>0.026 W/mK (d140-d450) | 0.026 W/mK | |
| | PE jacket | 0.38 W/mK | | |
| | GF-FR jacket | | 0.15 W/mK | |
| | Multilayer composite pipe | | | 0.43 W/mK |
| | EPDM Foam | | | 0.037 W/mK |
| | Density | ≥ 70 kg/m³ | ≥ 70 kg/m³ | 50-60 kg/m³ |
| | Foam cell size | max. Ø 0.5 mm | max. Ø 0.5 mm | |
| | Nominal thickness | 40 mm | 40 mm | 20 mm |
| Mechanical strength (from insulation) | Axial shear strength | ≥ 0.12 N/mm² | ≥ 0.12 N/mm² | |
| | Compressive strength | ≥ 0.3 N/mm² | ≥ 0.3 N/mm² | |
| Colour | Outer jacket | Black | Black | Black |
| Weight (without medium) | Pipe d32 | 1.39 kg/m | | 0.84 kg/m |
| | Pipe d110 | 6.12 kg/m | | |
| | Pipe d225 | 16.42 kg/m | 19.84 kg/m | |
| Oxygen diffusion at ≤ 14.5°C | ISO 17455 | ≤ 0.32 mg/(m² d) | Oxygen diffusion tight acc. DIN 4726 | Oxygen diffusion tight acc. DIN 4726 |
| Fire classification[3] | EN 13501-1 | E | B-s2, d0 | D-s2, d0 |
| Environment | Stability | Moisture and vapor-tight | Moisture and vapor-tight | Moisture and vapor-tight |
| | Resistance | Weather resistant<br>UV resistant | For indoor use | For indoor use |
| | Ozone Depletion Potential | Zero | Zero | Zero |
| | Hail resistance acc. to SIA 261/1 | HW5 (VKF hail register No 40470) | | |

| Specification | | COOL-FIT 4.0 | COOL-FIT 4.0F | COOL-FIT 4.0 Push System |
|---|---|---|---|---|
| Standards and Guidelines | DIN EN 12201-2 | Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) | | |
| | DIN EN 15494 | Plastics piping systems for industrial applications - Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system - Metric series | | |
| | DIN 8074 | Polyethylene (PE) - Pipes PE 80, PE 100 - Dimensions | | |
| | DIN 8075 | Polyethylene (PE) - Pipes PE 80, PE 100 - General quality requirements, testing | | |
| | ISO 7 | Threaded Joints | | |
| | EN ISO 16135<br>EN ISO 16136<br>EN ISO 16137<br>EN ISO 16138 | Industrial valves ...<br>– Ball valves made of thermoplastics<br>– Butterfly valves made of thermoplastics<br>– Backflow protection made of thermoplastics<br>– Diaphragm valve made of thermoplastics | | |
| | EN ISO 16871 | Plastic piping and ducting systems – Plastic pipe and fittings – Method for exposure to direct (natural) weathering | | |
| | EN ISO 13501-1 | Fire classification of construction products and building elements | | |
| | SIA261/1 | Loads on Structures – Supplementary Specifications | | |
| Product declarations Green buildings | | BNB BN 2015<br>BREEAM Int 2016<br>DGNB 2015<br>DGNB 2018<br>LEED V3<br>LEED V4<br>WELL V1 2019 | | |
| eco-bau | (BKP 240, 244, 250) | basic | basic | |

1) All three materials are firmly bonded together. Does not apply to COOL-FIT 4.0 Push System.

2) At 20°C, medium water, the specified value is valid for all system components, with the exception of the butterfly valves, PN10 applies to the nominal pressure and for flexible hoses with maximum pressure according product datasheet.

3) The pipes were tested according to DIN EN 13823. Additional information in chapter "Fire behavior and fire prevention measures".

# 1.2.2 Polyethylene (PE)

The dominant material for the COOL-FIT 4.0 system is polyethylene (PE). As the inner pipe which comes into contact with the media is made of PE100, its properties are of particularly high relevance.

## Properties of PE (approximate)

| Property | PE100-value[1] | Unit | Testing standard |
|---|---|---|---|
| Density | 0.95 | g/cm³ | EN ISO 1183-1 |
| Yield stress at 23 ° C | 25 | N/mm² | EN ISO 527-1 |
| Tensile modulus at 23 ° C | 900 | N/mm² | EN ISO 527-1 |
| Charpy notched impact strength at 23 ° C | 83 | kJ/m² | EN ISO 179-1/1 eA |
| Charpy notched impact strength at -40 ° C | 13 | kJ/m² | EN ISO 179-1/1 eA |
| Crystallite melting point | 130 | °C | DIN 51007 |
| Thermal conductivity at 23 ° C | 0.38 | W/m K | EN 12664 |
| Water absorption at 23 ° C | 0.01 to 0.04 | % | EN ISO 62 |
| Color | 9,005 | | RAL |
| Oxygen Index (LOI) | 17.4 | % | 4589-1 |

[1] Typical, measured on material characteristics, should not be used for calculations.

## General information

All polymers made from hydrocarbons of the formula CnH2n are constructed with a double bond (ethylene, propylene, butene-1, isobutene) are referred to collectively as polyolefins. Among them is polyethylene (PE). It is a semi-crystalline thermoplastic. Polyethylene is probably the best known plastic. The chemical formula is: -(CH2-CH2)n. PE is a non-polar material. Therefore, it is insoluble and scarcely swellable in conventional solvents. PE pipe cannot therefore be adhesively bonded to fittings. Welding is the appropriate connection method for the material.

The most widespread in piping system construction is PE for use in underground gas and water pipe. In this area polyethylene has become the dominant material in many countries. However, the advantages of this material mean that it is also used in domestic installations and industrial piping.

**Advantages of PE**

- Light weight
- Excellent flexibility
- Good wear resistance (abrasion resistance)
- Corrosion resistance
- Ductile fracture properties
- High impact strength even at very low temperatures
- Very good chemical resistance
- Weldable

## Mechanical properties, chemicals, weathering and abrasion resistance

### UV and weather resistance



Because of the black pigments used, polyethylene is very weather resistant. Even at long exposure to direct sunlight, wind and rain the material can be used without restrictions.

### Chemical resistance



Polyethylene exhibits good resistance to a wide range of media. For detailed information, please see the detailed chemical resistance list from Georg Fischer Piping Systems, or contact the person responsible at Georg Fischer Piping Systems directly.

### Abrasion resistance



PE has excellent resistance to abrasive wear. You can therefore find PE piping systems in use in numerous applications for transporting solids and media containing solids. For many applications, PE has proven especially advantageous with metals.

## Thermal and electrical properties

### Operating limits



The application limits of the material depend on both embrittlement and softening temperatures and on the manner and method of application. Details are provided in the relevant pressure-temperature charts.

### Electrical properties



Polyethylene, like most thermoplastics, is non-conductive. This means that systems in PE do not suffer from electrolytic corrosion. However, the non-conductive properties must be taken into consideration, as electrostatic charges can build up in the pipe. Polyethylene has good electrical insulation properties. The volume resistance is 3.5 x $10^{16}$ Ωcm, the surface resistance $10^{13}$ Ω. This must be taken into account in applications where there is danger of fire or explosion.

# 1.3 Technical Details

## 1.3.1 COOL-FIT 4.0 Pipe and Fittings

### COOL-FIT 4.0 Pipe

COOL-FIT 4.0 pipe are made from PE100. The high efficiency GF-HE hard foam insulation exhibits a thermal conductivity λ of 0.022 W/mK (d32-d110) respectively 0.026 W/mK (d140-d450). The pipe are protected by an impact- and weather resistant PE jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5m lengths for dimensions d32 to d225, and in 5.9m for dimensions d250 to d450. The pipe have free, uninsulated ends, prepared already for the jointing with the COOL-FIT 4.0 fittings.



| Standard range (inner pipe SDR17 for d160-d450mm) | Inner pipe | Inner pipe | Pipe class | Outer jacket | Weight | | Volume | Insu-lation thick-ness | Heat transfer coefficient (U) | Fire load |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | empty | with water | | | | |
| (mm) | d x e (mm) | $d_i$ (mm) | SDR | D x e1 (mm) | (kg/m) | (kg/m) | (l/m) | (mm) | (W/m K) | (kWh/m) |
| d32/90 | 32 x 2.9 | 26.2 | 11 | 90 x 3 | 1.39 | 1.93 | 0.54 | 26.0 | 0.13 | 14.96 |
| d40/110 | 40 x 3.7 | 32.6 | 11 | 110 x 3.4 | 2.02 | 2.85 | 0.83 | 31.6 | 0.14 | 21.66 |
| d50/110 | 50 x 4.6 | 40.8 | 11 | 110 x 3.4 | 2.19 | 3.49 | 1.31 | 26.6 | 0.18 | 24.02 |
| d63/125 | 63 x 5.8 | 51.4 | 11 | 125 x 3.8 | 2.94 | 5.02 | 2.07 | 27.2 | 0.21 | 32.72 |
| d75/140 | 75 x 6.8 | 61.4 | 11 | 140 x 4 | 3.70 | 6.66 | 2.96 | 28.5 | 0.23 | 41.35 |
| d90/160 | 90 x 8.2 | 73.6 | 11 | 160 x 4 | 4.75 | 9.00 | 4.25 | 31.0 | 0.24 | 53.07 |
| d110/180 | 110 x 10 | 90.0 | 11 | 180 x 4 | 6.12 | 12.48 | 6.36 | 31.0 | 0.28 | 68.94 |
| d140/225 | 140 x 12.7 | 114.6 | 11 | 225 x 5 | 9.68 | 19.99 | 10.31 | 37.5 | 0.35 | 109.43 |
| d160/250 | 160 x 9.5 | 141.0 | 17 | 250 x 5 | 9.81 | 25.42 | 15.61 | 40.0 | 0.37 | 109.29 |
| d225/315 | 225 x 13.4 | 198.2 | 17 | 315 x 6 | 16.42 | 47.27 | 30.85 | 39.0 | 0.50 | 187.00 |
| d250/355 | 250 x 14.8 | 220.4 | 17 | 355 x 5.1 | 19.04 | 57.19 | 38.15 | 47.4 | 0.47 | 213.97 |
| d280/400 | 280 x 16.6 | 246.8 | 17 | 400 x 5.3 | 23.61 | 71.45 | 47.84 | 54.7 | 0.46 | 264.28 |
| d315/450 | 315 x 18.7 | 277.6 | 17 | 450 x 5.6 | 29.46 | 89.99 | 60.52 | 61.9 | 0.46 | 329.19 |
| d355/500 | 355 x 21.1 | 312.8 | 17 | 500 x 6.3 | 36.88 | 113.73 | 76.85 | 66.2 | 0.48 | 413.79 |
| d400/560 | 400 x 23.7 | 352.6 | 17 | 560 x 7.0 | 46.31 | 143.95 | 97.65 | 73.0 | 0.49 | 520.18 |
| d450/630 | 450 x 26.7 | 396.6 | 17 | 630 x 7.6 | 58.19 | 181.72 | 123.54 | 82.4 | 0.49 | 653.01 |

| Extended range (inner pipe SDR11 for d160-d450mm) | Inner pipe | Inner pipe | Pipe class | Outer jacket | Weight | | Volume | Insu-lation thick-ness | Heat transfer coefficient (U) | Fire load |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | empty | with water | | | | |
| (mm) | d x e (mm) | $d_i$ (mm) | SDR | D x e1 (mm) | (kg/m) | (kg/m) | (l/m) | (mm) | (W/m K) | (kWh/m) |
| d160/250 | 160 x 14.6 | 130.8 | 11 | 250 x 5 | 11.88 | 25.31 | 13.44 | 40 | 0.37 | 134.53 |
| d225/315 | 225 x 20.5 | 184 | 11 | 315 x 6 | 20.47 | 47.06 | 26.59 | 39 | 0.49 | 236.4 |
| d250/355 | 250 x 22.7 | 204.6 | 11 | 355 x 5.1 | 24.05 | 56.92 | 32.88 | 47.4 | 0.46 | 275.1 |
| d280/400 | 280 x 25.4 | 229.2 | 11 | 400 x 5.3 | 29.86 | 71.12 | 41.26 | 54.7 | 0.46 | 340.54 |
| d315/450 | 315 x 28.6 | 257.8 | 11 | 450 x 5.6 | 37.37 | 89.57 | 52.2 | 61.9 | 0.46 | 425.69 |
| d355/500 | 355 x 32.2 | 290.6 | 11 | 500 x 6.3 | 46.87 | 113.20 | 66.33 | 66.2 | 0.48 | 535.73 |
| d400/560 | 400 x 36.3 | 327.4 | 11 | 560 x 7.0 | 59.09 | 143.28 | 84.19 | 73.0 | 0.49 | 676.16 |
| d450/630 | 450 x 40.9 | 368.2 | 11 | 630 x 7.6 | 74.39 | 180.87 | 106.48 | 82.4 | 0.49 | 850.72 |

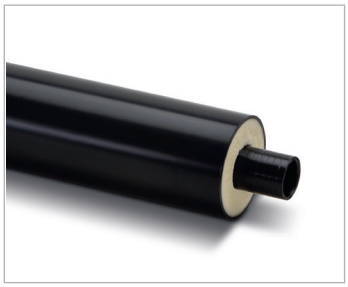
| | |
|---|---|
| d | Nominal outer diameter of the PE pipe |
| $d_i$ | Nominal inside diameter of the pipe |
| D | Nominal outside diameter of the outer PE jacket |
| e, e1 | Nominal wall thickness |

## COOL-FIT 4.0F pipe

COOL-FIT 4.0F inner pipe is made from PE100. The GF-HE foam insulation has a thermal conductivity λ of 0.026 W/mK. The pipe is protected by the GF fire retardant GF-FR jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5m bars and are already prepared for jointing. They can be connected with all fittings from COOL-FIT 4.0.



| Pipe size | Inner Pipe | | Pipe class | Outer jacket | Weight | | Volume | Insulation thickness | Heat transfer coefficient (U) | Fire load |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | empty | with water | | | | |
| (mm) | d x e (mm) | $d_i$ (mm) | SDR | D x e1 (mm) | (kg/m) | (kg/m) | (l/m) | (mm) | (W/m K) | (kWh/m) |
| d160/250 | 160 x 9.5 | 141.0 | 17 | 250 x 3 | 9.48 | 25.09 | 15.61 | 42.0 | 0.36 | 81.51 |
| d225/315 | 225 x 13.4 | 198.2 | 17 | 315 x 3.5 | 15.79 | 46.65 | 30.85 | 41.5 | 0.48 | 144.33 |

| Pipe size | Inner Pipe | | Pipe class | Outer jacket | Weight | | Volume | Insulation thickness | Heat transfer coefficient (U) | Fire load |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | empty | with water | | | | |
| (mm) | d x e (mm) | $d_i$ (mm) | SDR | D x e1 (mm) | (kg/m) | (kg/m) | (l/m) | (mm) | (W/m K) | (kWh/m) |
| d32/90 | 32 x 2.9 | 26.2 | 11 | 90 x 1.8 | 1.32 | 1.86 | 0.54 | 27.2 | 0.13 | 9.06 |
| d40/110 | 40 x 3.7 | 32.6 | 11 | 110 x 1.8 | 1.82 | 2.65 | 0.83 | 33.2 | 0.13 | 12.95 |
| d50/110 | 50 x 4.6 | 40.8 | 11 | 110 x 1.8 | 1.99 | 3.29 | 1.31 | 28.2 | 0.17 | 15.31 |
| d63/125 | 63 x 5.8 | 51.4 | 11 | 125 x 1.8 | 2.59 | 4.66 | 2.07 | 29.2 | 0.20 | 21.14 |
| d75/140 | 75 x 6.8 | 61.4 | 11 | 140 x 2.5 | 3.62 | 6.58 | 2.96 | 30.0 | 0.22 | 29.31 |
| d90/160 | 90 x 8.2 | 73.6 | 11 | 160 x 2.5 | 4.65 | 8.90 | 4.25 | 32.5 | 0.24 | 39.24 |
| d110/180 | 110 x 10 | 90.0 | 11 | 180 x 2.8 | 6.21 | 12.58 | 6.36 | 32.2 | 0.28 | 54.39 |
| d140/225 | 140 x 12.7 | 114.6 | 11 | 225 x 2.8 | 9.20 | 19.52 | 10.31 | 39.7 | 0.33 | 83.61 |
| d160/250 | 160 x 14.6 | 130.8 | 11 | 250 x 3.0 | 11.55 | 24.98 | 13.44 | 42.0 | 0.35 | 106.75 |
| d225/315 | 225 x 20.5 | 184.0 | 11 | 315 x 3.5 | 19.84 | 46.43 | 26.59 | 41.5 | 0.47 | 193.74 |

| | |
|---|---|
| d | Nominal outer diameter of the PE pipe |
| $d_i$ | Nominal inside diameter of the pipe |
| D | Nominal outside diameter of the outer PE jacket |
| e, e1 | Nominal wall thickness |

## COOL-FIT 4.0 Fittings

### General

The media fitting and insulation used for COOL-FIT 4.0 fittings fulfill the same specifications as the COOL-FIT 4.0 pipe. The COOL-FIT 4.0 fittings are based on ELGEF electrofusion fittings, which have been in use successfully for years. They provide an easy and safe connection.

The pre-insulated COOL-FIT 4.0 fittings are available in two types:

### Type A

Electrofusion fitting with integrated heat coils for direct electrofusion pipe-to-fitting connections.

90° elbow as an example



### Type B

Spigot fitting with free ends for electrofusion with COOL-FIT 4.0 electrofusion fittings.

Reduction as an example



### Usefull functions

### Fusion indicators

After the welding process, the indicator pin shows that energy has been applied to the welding zone.



### Sealing lip at fittings Type A d32-d225 (plus coupler d250)

The sealing lip ensures a moisture-proof and vapour tight sealing of the insulation towards the outside.

On joining the fittings to the pipe, it's sealing mechanically. Due to this an additional sealing of the joints is not necessary.



### Label

The fittings have abrasion-resistant marking.




### Trace code

Relevant product data can be traced back to production via traceability codes.



**Angle marking**

By marking the ends of the fittings, connections between pipe and fittings can be optimally aligned.




## Jointing

**Pipe and Fitting**

Type A fittings have integrated resistance wires, which are put under electric current during the welding operation through welding contacts on the fittings. This heats up the inside of the fitting and bonds the melting zone with the pipe.

Type B fittings feature non-insulated spigot ends. They are connected with electrofusion fittings type A to a pipe.

**Fitting-to-fitting**

Two COOL-FIT 4.0 fittings are usually connected by using a piece of COOL-FIT 4.0 pipe with free ends. For compact joints, the special COOL-FIT 4.0 barrel nipple with insulation can be used.

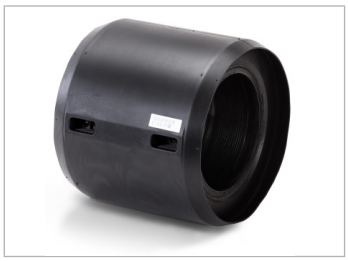
Two COOL-FIT 4.0 Type B fittings can be joined using an electrofusion fittings type A.

The direct connection of a COOL-FIT 4.0 fitting Type A and Type B is also possible.

**Components**

**COOL-FIT 4.0 Electrofusion coupler**

COOL-FIT 4.0 electrofusion couplers are used to connect pipe and components with free ends like type B fittings, valves and transition fittings.



**COOL-FIT 4.0 Elbows 45° and 90°**

(Refer to „General Information“ chapter above)



**COOL-FIT 4.0 T90° equal and COOL-FIT T90° reduced**

The equal and reduced type A 90° tees have, like the coupler, resistance wires for electrofusion. The central branches can be connected to the type A fitting, so all combinations are possible.



### COOL-FIT 4.0 Reducer

The COOL-FIT 4.0 reducer can be used to reduce the flow of the starting size by up to 3 to 5 sizes (e.g. from d225 up to d63).



### Combination of T90° and Reducer

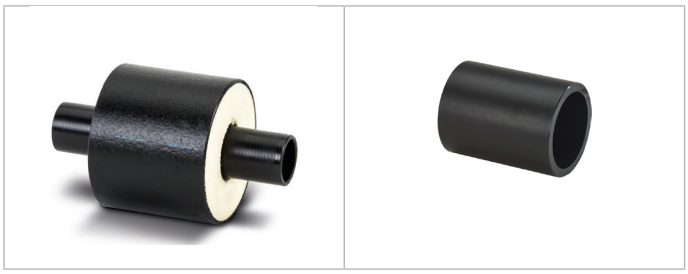
If a reducer in a system is fitted behind a tee, either a COOL-FIT 4.0 T90° reduced or a COOL-FIT 4.0 T90° reduced/equal connected to a reducer should be used.

| Run<br>Branch | 40 | 50 | 63 | 75 | 90 | 110 | 140 | 160 | 225 |
|---|---|---|---|---|---|---|---|---|---|
| 32 | X | X | X | O | O | O | O | O | O |
| 40 | | X | X | O | O | O | O | O | O |
| 50 | | | X | O | O | O | O | O | O |
| 63 | | | | Δ | Δ | Δ | Δ | Δ | Δ |
| 75 | | | | | Δ | Δ | Δ | [ ] | [ ] |
| 90 | | | | | | Δ | Δ | Δ | Δ |
| 110 | | | | | | | Δ | Δ | Δ |
| 140 | | | | | | | | Δ | Δ |

Δ T90° reduced
X T90° equal + reducer type A
O T90° reduced to d63 + reducer type A
☐ T90° reduced to d90 + coupler d90 + reducer type B

### COOL-FIT 4.0 Barrel nipple

COOL-FIT 4.0 Barrel nipple serves as a compact direct connector for type A fittings.



### COOL-FIT 4.0 Sliding coupler kit

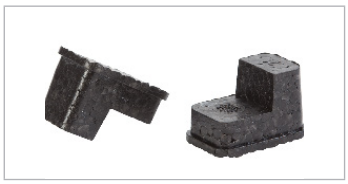
The sliding coupler kit is a radially insertable element for connecting two fixed pipe spigots.



# 1.3.2 Accessories for dimensions d32 - d250

**Insulation for fusion contacts**

Supplied with each fitting. Prevent formation of a cold bridge at the fusion contacts. Insulation parts can also serve as an indicator that a connection has been welded. Install insulation after welding to show that the welding has been completed.



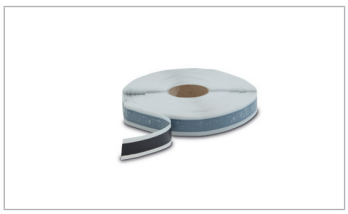
**Sealing clamps**

For vertical installations outdoors, sealing clamps mounted at the top lip of the fitting are recommended.



**Sealing tape**

As an alternative to the sealing clamps, the sealing tape with width 25mm is intended to be used for vertical installations outdoors, to seal the top lip of the fitting.



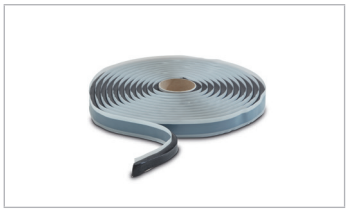
**Sealant**

The silicone-free sealant is used to join the EPDM insulation of Weld-in ports to the COOL-FIT pipes, as well as to cement the end caps d250-d450.




**Transition of insulation**

The Transition of insulation is used for a moisture-proof and vapour tight sealing of the interface of COOL-FIT 4.0 Fitting to COOL-FIT 2.0 pipe.



**Cement**

For frontal bonding of the insulations of transition fittings and flexible hoses.




**Adhesive tape**

Optional for covering hand-cut faces as well as for bonding of the insulations of transition fittings to the insulation of flexible hoses.



## COOL-FIT 4.0 Valves

The plastic valves designed for COOL-FIT 4.0 valves are based on Georg Fischer Piping Systems standard plastic valves. The valves are supplied including PE-/GF-HE insulation shells with a protective PE jacket. The sealing faces between the shells are vapor tight by their design. No additional tape or sealant is required.



Releasable plastic bands for sizes d32DN25 – d63DN50 and metal straps with tension locks for sizes d75DN65 – d225DN200 permit the pre-insulated shells to be fitted to and removed from the valves easily, allowing easy maintenance.

The insulated ball valve in ABS is available in sizes d32DN25 – d90DN80. For the sizes d110DN100 – d225DN125, butterfly valves kits are available that consist of butterfly valve, flange adaptor, backing flange PP-St, screw-kits and insulation half shells.

Both valve types are available either as manually operated or electric actuated version.



The electric actuators used feature following benefits:

- Position feedback via relais (open/close/middle)
- Heating element to prevent condensation
- Optical position indicator with LED status monitoring
- Third position between “open” and “closed” optional
- Relay output for “ready to operate” and 7-segment error display
- Integrated manual override with magnetic lock
- Long service life due to robust design and superior electronics
- Flexible configuration thanks to modular concept
- Numerous monitoring and control options
- Simple handling

## COOL-FIT 4.0 Transition fittings, flange joints

Transition fittings and flange connectors enable connections to different systems in either metal or plastic, such as the Georg Fischer systems iFIT or Sanipex MT. The components are supplied including PE- insulation half shells with a protective PE jacket. The sealing faces between the shells are vapor tight by their design. No additional tape or sealant is required.



| | Size | Material | Thread type/connector/ bolt circle |
|---|---|---|---|
| Adaptor fitting to metal | d32 – d63<br>½“ – 2“ | PE – stainless steel | male thread (R, NPT), female thread (Rp, NPT),<br>loose nut (G) |
| Adaptor Fitting to iFIT or Sanipex MT | d32 | Stainless steel / Brass | iFIT, Sanipex MT |
| Unions | d32 – d63<br>d32 – d110 | PE – PE,<br>PE – ABS | Welding spigots<br>cementing sockets |
| Flange Adaptor (flange joints) | d32 – d225 | PE | Suitable for Bolt circle PN 16/10 |

## COOL-FIT 4.0 Installation fittings type 313

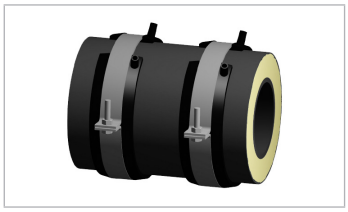
Installation fittings are used to install various types of sensors to the system. Pressure or temperature sensors can be connected using the ½ "or ¾" Rp or NPT female thread.

The insulation is comprised of highly efficient GF-HE foam with excellent insulating capabilities.



## COOL-FIT 4.0 Fixed point

The fixed point is used to direct pipe movement or retain forces from pipe weight at risers. The electrofusion welding tapes allow a permanent connection and transmit occuring forces between pipe and clamp.



## COOL-FIT 4.0 Fixed point for high forces

The fixpoint placed on the media pipe alows the transmition of higher forces. The fixed point is placed between two electrofusion fittings.



## COOL-FIT 4.0 Weld-In Port

The COOL-FIT Weld-in port significantly increases the flexibility by enabling the branching-off on already laid, unfilled an dry COOL-FIT pipes in dimensions d63-d225.

The product range of fittings includes Weld-in ports with transitions to female threads, as well as Weld-in ports that allow transitions within the GF piping portfolio.

The EPDM soft foam insulation supplied with the Weld-in ports is designed to ensure a condensation-free connection to the COOL-FIT pipe, and to insulate the ports up to the corresponding interface.



| Connection type, material | Size | Purpose |
|---|---|---|
| Female threads RP + NPT, PE/Stainless steel | ½", ¾", 1" | Installation of instruments, probes, sensors as well as transition to other piping systems |
| iFIT, PE/Brass | 25/32 | Transition from COOL-FIT 2.0 and COOL-FIT 4.0 to COOL-FIT 4.0 Push System |
| Sanipex MT, PE/Brass | 32 | Transition from COOL-FIT 2.0 and COOL-FIT 4.0 to GF Sanipex MT |
| PE spigot SDR11 | 32, 40, 50 | Connection within COOL-FIT 2.0 and COOL-FIT 4.0 |

The Weld-in ports can be used with pipes COOL-FIT 2.0, COOL-FIT 2.0F, COOL-FIT 4.0 and COOL-FIT 4.0F.

### Jointing

After the controlled local tapping of jacket and inner pipe of the respective COOL-FIT pipe, the welded joint is made.

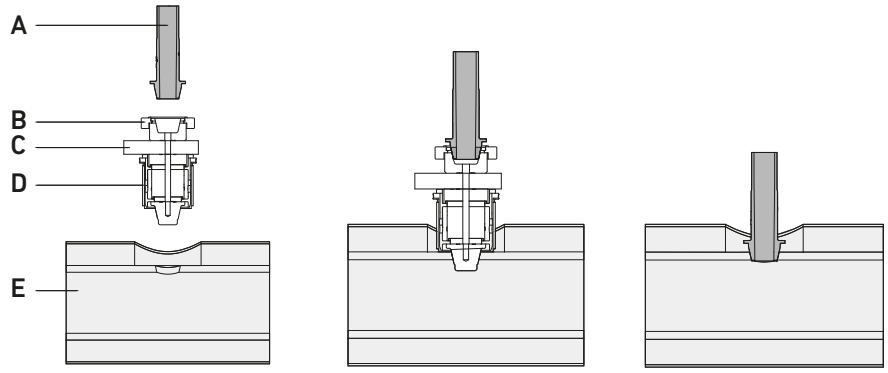
In the cone welding process used here, a modified version of heating element socket welding, the inner pipe of the COOL-FIT pipe and the Weld-in port are welded in an overlapping material-to-material bond without the use of additional filler materials.

The welding surfaces of the pipe and the fitting are heated to welding temperature on a conical socket- or spigot-shaped heating element and then joined together.

The dimensionally matched geometry of the components ensures the welding pressure during joining and a homogeneous joint.

### Jointing principle

| Components | Heating | Finished joint |
|---|---|---|



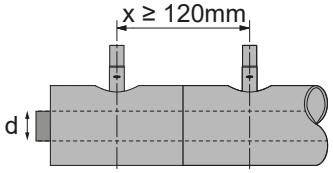
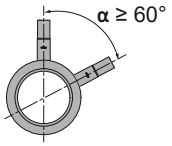

**A** Weld-in port
**B** Heating bush
**C** Fusion tool
**D** Heating spigot
**E** COOL-FIT Pipe

After the fusion process, the EPDM insulation is mounted to the Weld-in port. Bonding of insulation the COOL-FIT pipe is done using the COOL-FIT sealant.

### Distance of COOL-FIT Weld-in ports and pressure de-rating of main pipes

On positioning the Weld-in ports on the COOL-FIT pipe, the following distances must be taken into account:

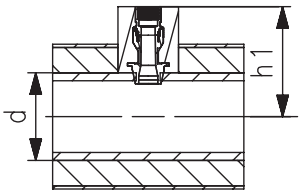
- Distances between Weld-in ports along the pipe axis.
- Arrangement around the circumference of the pipe.

| | | Ports with metal insert | Ports with PE spigot |
|---|---|---|---|
| **Distances along pipe axis*** |   | x ≥ 120 mm<br>► no pressure de-rating of main pipe | x ≥ 2 * d main pipe<br>► no pressure de-rating of main pipe<br><br>or<br><br>x < 2 * d main pipe<br>► pressure de-rating factor of main pipe of 0.8 |
| **Arrangement around circumference** |   | x ≥ 0 mm (along pipe axis), α ≥ 60°<br>► no pressure de-rating of main pipe | |

* The minimum distance due to the tool dimensions is 120 mm.

**Heigth of Weld-in ports ½"-1" towards the middle of the pipe axis**

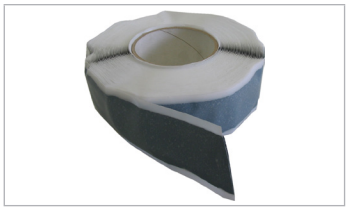
| Heigth h1 [mm]/d [mm] | d63 | d75 | d90 | d110 | d140 | d160 | d225 |
|---|---|---|---|---|---|---|---|
| ½" Rp | 117 | 123 | 130 | 140 | 155 | 165 | 198 |
| ½" NPT | 120 | 126 | 134 | 144 | 159 | 169 | 201 |
| ¾" RP + NPT | 117 | 123 | 130 | 140 | 155 | 165 | 198 |
| 1" Rp + NPT | 118 | 124 | 131 | 141 | 156 | 166 | 199 |




## 1.3.3 Accessories for dimensions d280 - d450

**Sealing tape**

A roll of 40 mm wide butylene rubber-based sealing tape. For a water- and vapor-tight connection of inspection gaps with shrink sockets. The sealing tape is affixed to the circumference of the pipe or fitting.



**Shrink socket**

The shrink socket is used to water and vapor seal the respective welded joints on the outer jacket and can seal only components with the same outside diameter. Functionality is ensured only in combination with the butylene-rubber sealing tape. This version provides additional mechanical strength with regard to bending forces. The socket shrinks uniformly, resulting in a good visual appearance. It can be shrunk with an open, soft flame.



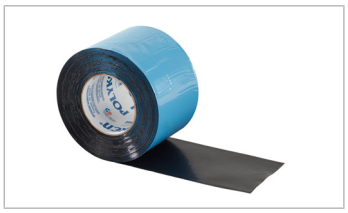
**End cap**

End caps are used to cap the pre-insulated system. They seal the PUR insulation and prevent moisture from entering. Sealing PUR is achieved by using a suitable sealant.



**Cold shrink tape**

The cold shrink tape is used on the respective welded joints for the water- and vapor-tight sealing of the outer jacket. It is only suitable for indoor applications and can be applied by hand without heat.



## COOL-FIT 4.0 Heat tracing

Frozen pipes can cause high costs. When water-filled COOL-FIT pipes are exposed to temperatures below zero °C without circulation and for extended periods of time, the water freezes and proper operation of the cooling system can no longer be maintained.
The heat-tracing system for COOL-FIT 4.0 offers an effective solution for the freeze protection of COOL-FIT lines. The self-regulating heating tape in combination with the insulation of the COOL-FIT 4.0 pipe system prevents the cooling pipe from freezing.

With the COOL-FIT 4.0 heat tracing, reliable frost protection down to -30°C ambient temperature is provided across all COOL-FIT 4.0 dimensions from d32 - d450.

Please contact GF if you need antifreeze protection at ambient temperatures below -30°C.

### Tracing cable

The COOL-FIT heat-tracing system uses a self-regulating heat-tracing cable installed inside the pipe. This efficiently protects the medium from freezing directly and without heat loss through the pipe wall insulation.



### Cable glands

The entry and exit of the cable into the COOL-FIT system is performed via cable glands, which are connected to the COOL-FIT system via metallic thread transitions.



### Thermostat

The thermostat is designed to provide userfriendly measurement and control for the self regulating heating cable for COOL-FIT. It can be chosen between efficient temperature control via the media temperature or proportional ambient sensing control (PASC) algorithm for enhanced energy savings in ambient sensing mode.




### Cold lead connection and end seal kit

The kit contains all necessary components like crimps and shrink sleeves for the joining of the heating cable to power cable as well as for the end seal of the heating cable.



# 1.3.4 COOL-FIT 4.0 Push System

## COOL-FIT 4.0 Push System pipe

Inside the multilayer composite pipes of the COOL-FIT 4.0 Push System is a medium-bearing layer made of polyethylene (PE-RT). The outer layer, which protects the pipe from mechanical loads, is also made of PE-RT. In between is a longitudinally butt-welded aluminum carrier pipe, which is permanently bonded to the other two layers by means of bonding agents - also PE-based.

The EPDM insulation has a thermal conductivity of 0.037W/mK at 10°C and is covered with an additional polyester/stainless steel mesh, which prevents wrinkling and protects the pipe from mechanical stress.

The pipes are available in 5m rod and 25m roll.

| Pipe size | Inner Pipe | Inner Pipe | Outer jacket | Weight | | Volume | Insu-lation thick-ness | Heat transfer coeffi-cient (U) | Fire load | Ben-ding radius R with ben-ding spring | Ben-ding radius R with tool |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Weight empty | Weight with water | | | | | | |
| (mm) | d x e (mm) | $d_i$ (mm) | D x e1 (mm) | (kg/m) | (kg/m) | (l/m) | (mm) | (W/m K) | (kWh/m) | 5x d (mm) | 3,5 x d (mm) |
| d25/78 | 25 x 2.5 | 20 | 78 x 1 | 0.728 | 1.042 | 0.314 | 25.5 | 0.19 | 2.34 | 200 | 98 |
| d32/85 | 32 x 3 | 26 | 85 x 1 | 0.843 | 1.374 | 0.521 | 25.5 | 0.22 | 3.09 | | 112 |

| | |
|---|---|
| d | Nominal outer diameter of the PE pipe |
| $d_i$ | Nominal inside diameter of the pipe |
| D | Nominal outside diameter of the outer jacket |
| e, e1 | Nominal wall thickness |

## COOL-FIT 4.0 Push System Fittings

**General**

The Push System fittings are made of high-performance polyphenylsulfone (PPSU) plastic. This material has proven itself for fittings in building services and is characterized above all by excellent corrosion resistance and low incrustation. The Push System fittings have a high degree of robustness, i.e. special impact strength and impact resistance.

To further increase mechanical strength, the iFIT adapters are additionally protected by a glass-fiber-reinforced polyamide (PA-GF30).

The insulation half-shells supplied fit onto the Push System fittings and can be closed quickly and easily with integrated tabs and hooks.



## Connection

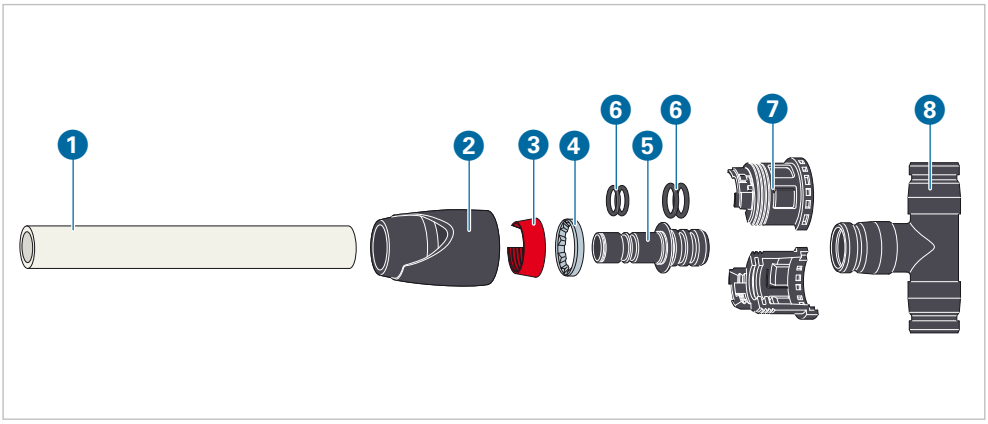
The connection is made using adapter module technology, a push system that requires few tools and no electrical power. It is possible to work across dimensions via the module.

The adapters are pushed onto the tube and module. A viewing window and "click" sounds allow the correct assembly to be checked during the installation process.

### Push fitting

An iFIT tool is used for the processing and it is done manually. The iFIT push fitting guarantees a secure, fast and detachable connection. The modules are reusable. The adaptors can only be used once. This also applies to adaptors if the clicking action was not completed.

An iFIT push fitting consists of several components:




**iFIT push fitting**
1 Multilayer pipe

**Adaptor**
2 Adaptor housing
3 Clamping ring
4 Toothed ring
5 Insert
6 O-rings (EPDM)
7 Half shells
8 Module made of PPSU or low-lead, dezincification-resistant brass

The iFIT adaptor is plugged into a chamfered pipe end. The push fitting is then closed by clicking the module into the adaptor.

### Inadmissible system connections

! NOTE! Damage due to inadmissible system connections!
→ When using the COOL-FIT 4.0 Push System, **use** only multilayer composite pipes from the COOL-FIT 4.0 Push System or iFIT assortment.

## Components

### COOL-FIT-4.0 Push System coupler

The sockets are used for straight connection of pipes.



### COOL-FIT 4.0 Push System 90° elbow

The 90° elbows can be used to change the direction of the pipe when space is limited and it is not possible to bend the pipe.



### COOL-FIT 4.0 Push System T90° equal

The T90° equal are supplied with two adapters and compression rings only. At the outlet, a choice can be made between two dimensions in any case. Additional adapters must be ordered separately.



### COOL-FIT 4.0 Push System ball valve

The ball valves suitable for the COOL-FIT 4.0 Push System can be connected directly to the pipe via the adapters through a push fitting connection.



**COOL-FIT 4.0 Push System flow control valve**

The COOL-FIT 4.0 Push System volume flow controller, based on the TacoSetter, can be used to balance a wide variety of systems such as fan coils.



**COOL-FIT 4.0 Transition fitting PE/iFIT**

The COOL-FIT 4.0 transition fitting PE/iFIT provides a direct connection option from COOL-FIT 4.0 to the COOL-FIT 4.0 Push System.



# 1.3.5 COOL-FIT Tools

## Electrofusion machines

Electrofusion machines are required to join COOL-FIT 4.0 components. The range includes dedicated and multipurpose electrofusion machines which are reliable and easy to use.

Georg Fischer Piping Systems recommends: MSA-Series electrofusion machines.




## Long fusion adaptors

Long Fusion adaptors serve as an extension of the fusion plugs of electrofusion machines. Compared to standard adaptors, the longer adaptor length matches the insulation of the COOL-FIT 4.0 electrofusion Fittings. The long fusion adapters are needed for electrofusion of fittings
d ≥ d160/D250



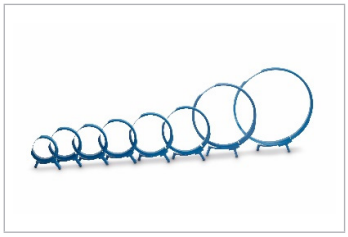
## Y-cable kit for COOL-FIT fixed point

Saves half of the normal welding time of the COOL-FIT fixed points.




## Assembly aids

The COOL-FIT 4.0 assembly aids are used for an easy mounting of COOL-FIT 4.0 Fitting on COOL-FIT 4.0 pipe. The assembly aid splays the pre-stressed sealing lips of the fittings enabling the easy insertion of the COOL-FIT 4.0 pipe.



## Foam removal tool and peeling tool – manually operated



The foam removal tool is used to prepare shortened COOL-FIT 4.0 pipe for electrofusion. The tool removes the foam and cuts outer jacket, and also peels the surface of the inner pipe. Any oxide layer present is removed when the welding zone is treated.The tool is available in three dimension range versions:

1. for sizes d32 – d90,
2. for sizes d110 – d225.
3. for sizes d250 – d450.

## Clamping tool



The fusion process gives rise to forces that can pull the pipe out of the coupler. Therefore it is recommended that the assembly should be fitted with COOL-FIT installation clamps. This prevents movement during the welding and cool-down process.

The central hinge allows the use of the clamps on elbows and reducers. Depending on the length of the pipe, 2 or 4 of the glass-reinforced plastic holders can be used. The linkage is made of galvanized steel. Tension bands are included and a T-adapter is optional available.

**Weld-In Port installation tool**




Using the installation tool, the different COOL-FIT Weld-in ports can be installed safe, reliable, reproducible and quick.

Drilling of jacket, drilling of inner pipe as well as the subsequent welding joint is supported in a clever way.

Depending on the need in Weld-in ports to be installed, the tool is available in 230V as well as in 110V in different equipment variants.

**Plastic pipe cutter PEcut 1200**




Plastic pipe cutter for precise and safe cutting of COOL-FIT pipes in dimension from d160.

**iFIT tool set**



iFIT tool set enables a fast and safe installation of COOL-FIT 4.0 Push System components.

# 1.4 Dimensioning and Design

## 1.4.1 General information about the dimensioning and installation of plastic piping

Plastics have different physical characteristics to metals. When designing and installing thermoplastic piping systems, this needs to be taken into account. Although PE and
COOL-FIT 4.0 are very robust systems, care should be taken to avoid damage during handling and transportation.

For over 50 years, GF Systems has developed and sold a variety of plastic piping systems which are subjected to very rigorous demands, such as optimized insulation properties in cooling applications. Experience has shown that plastic provides an economical and reliable alternative to metal when designers and installers take account of the recommendations in the technical documentation. In the professional production of plastic piping systems, for example, piping systems must be able to move to accommodate changes in length caused by temperature and pressure changes. To allow for these changes in length, the use of pipe holders that permit this movement is vital.

The following technical information contains the basic information needed to ensure an economical and trouble-free installation. However, this chapter does not contain all of the details. For more information, or if you have specific questions, please contact your local GF Industry & Infrastructure Flow Solutions representative. Additional information is available on the official GF Industry & Infrastructure Flow Solutions website.

## 1.4.2 COOL-FIT 4.0 pressure-temperature diagram

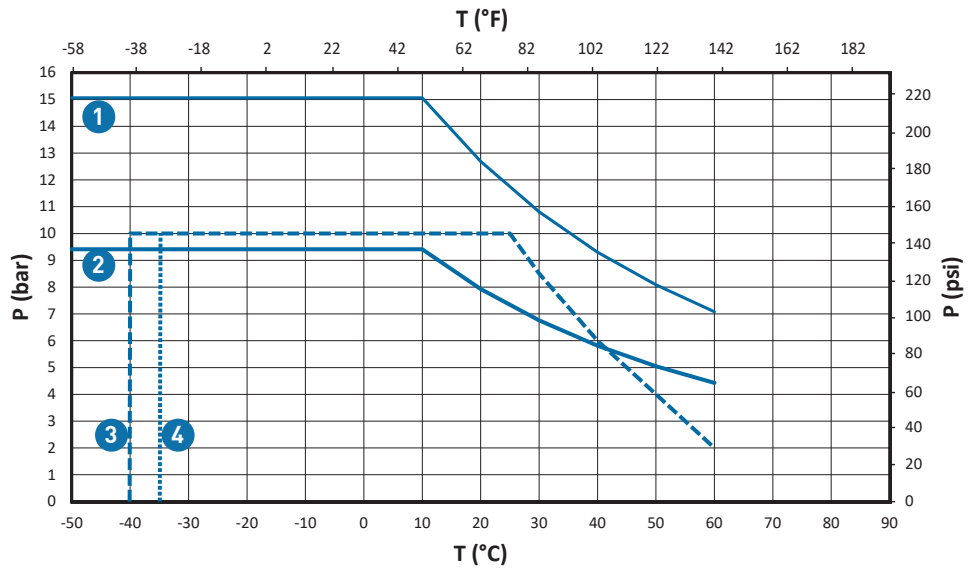
The pressure resistance for thermoplastic pipe for water is always specified at +20 °C. At higher temperatures allowance must be made for a lower maximum operating pressure.

The graphs show the maximum permissible pressure for COOL-FIT 4.0 pipe and fittings at various temperatures, up to the maximum permissible media temperature of +60 °C. The graph is based on an ambient temperature of +20 °C. A safety factor of 1.6 and a minimum lifespan of 25 years have been allowed for in all calculations.

## Pressure/temperature limits for COOL-FIT 4.0 pipe, fittings, valves – water as secondary refrigerant

Limits for COOL-FIT 4.0: 25-year values allowing for the safety factor 1.6 (with water as the secondary refrigerant).

In case of long-term operating pressure at temperatures above 47 °C, please contact your authorized GF Industry & Infrastructure Flow Solutions representative.

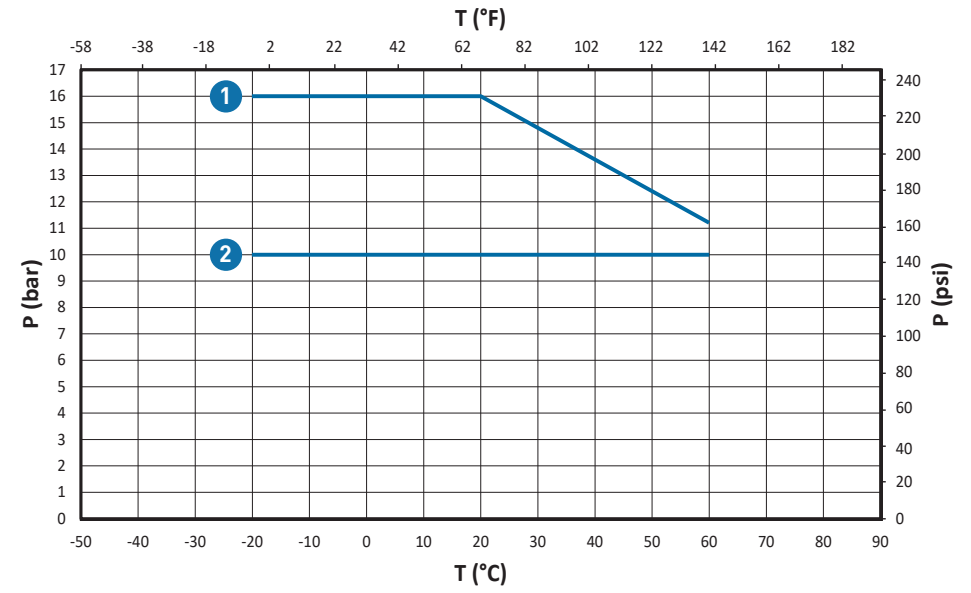



P Allowable pressure (bar, psi)
T Temperature (°C, °F)
C Safety factor

**1** COOL-FIT 4.0 Pipe and fitting d32 – d450, C1.6, SDR11
**2** COOL-FIT 4.0 Pipe and fitting d160 – d450, C1.6, SDR17
**3** COOL-FIT 4.0 Ball valve PN10
**4** COOL-FIT 4.0 Butterfly valve PN10

## Pressure/temperature limits for COOL-FIT 4.0 Push System fittings, pipe, valves – water coolant

Limits for COOL-FIT 4.0: 25-year values (with water as the coolant).




P Allowable pressure (bar, psi)
T Temperature (°C, °F)

**1** COOL-FIT 4.0 Push System pipe, fitting and ball valve
**2** COOL-FIT 4.0 Push System Flow control valve

## Influence of secondary refrigerants with antifreeze additives

At media temperatures below 0 °C, antifreeze must be used in the water to prevent it from freezing during a plant shut-down.

COOL-FIT 4.0 is generally resistant to secondary refrigerants such as glycol and salt solutions. For some refrigerants a reduction factor is necessary depending on the type and mixing ratio. The permissible operating pressure is corrected downwards from the pressure-temperature curve for water.

For COOL-FIT 4.0 Push System, no reduction factor is necessary.

| Reduction factors | COOL-FIT 4.0 Pipe and Fitting | COOL-FIT 4.0 Valves |
|---|---|---|
| Inorganic brine solutions | F = 1 | F = 1 |
| Organic salt solutions | F = 1 | F = 1.25 |
| Glycol solutions (max. 50 %) | F = 1.1 | F = 1.7 |

For the calculation, the following formula is used:

$$P_{AF} = \frac{P_w}{AF}$$

$P_{AF}$ Permissible pressure with reduction factor
$P_W$ Permissible pressure for water
AF Reduction factor

## Glycol solutions

COOL-FIT 4.0 can be used with glycol solutions with concentrations up to 50%. The chemical resistance of COOL-FIT 4.0 systems is suitable for the following antifreeze types:

| Brand name | Manufacturer | Type |
|---|---|---|
| Antifrogen N | Clariant | Ethylene glycol |
| Antifrogen L | Clariant | Propylene glycol |
| Showbrine Blue Showa standard EC brine | Showa Brine | Ethylene glycol |
| Tyfocor L | Tyfo | Propylene glycol |
| Tyfocor | Tyfo | Ethylene glycol |
| DOWFROST | DOW | Propylene glycol |
| Zytrec FC | Frigol | Propylene glycol |
| Zytrec LC | Frigol | Propylene glycol |
| Zytrec MC | Frigol | Ethylene glycol |
| Neutrogel Neo | Climalife Dehon | Ethylene glycol |
| Friogel Neo | Climalife Dehon | Propylene glycol |
| DOWTHERM SR-1 | DOW | Ethylene glycol |

When using other secondary refriegerants, compatibility with COOL-FIT 4.0 should be clarified with Georg Fischer Piping Systems.

Example – glycol dissolved in water

For water-glycol mixture ≤ 50%, the reduction factor for the pressure-temperature diagram is 1.7 (for COOL-FIT 4.0 valves). Thus, at +10 °C, with a minimum life of 25 years, the maximum allowable working pressure is reduced as follows:

$$P_{AF} = \frac{10 \text{ bar}}{1.7} = 5.88 \text{ bar}$$

### Organic salt solutions

These media are usually potassium formates or potassium acetates: aqueous solutions with low viscosity at low temperatures. COOL-FIT 4.0 can be used with the media below. The manufacturer's instructions must be followed.

| Brand name | Manufacturer | Type |
|---|---|---|
| Antifrogen KF | Clariant | Brine |
| Zytrec S-55 | Frigol | Brine |
| Temper | Temper | Brine |
| Hycool | Addcon | Brine |

For detailed information on resistance and reduction factors, see Planning Fundamentals "Material selection – Chemical resistance".

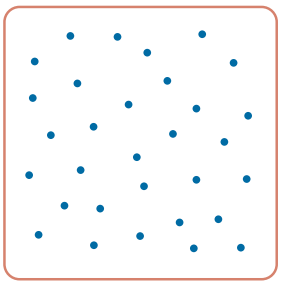
## 1.4.3 Condensation assessment and prevention

### Introduction

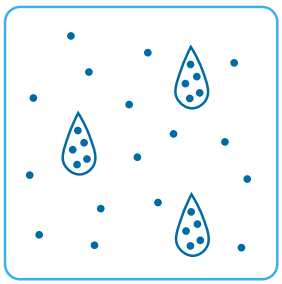
Piping in cooling applications is funeral to condensation due to its chilled media and therefore may need to contain preventive measures. Various factors influence the occurrence of condensation which, therefore, need to be considered during the planning stage.

Condensation occurs when humid air faces a cold surface such as a chilled pipe and releases some of its moisture as water droplets onto the pipe surface. This is since cold air cannot contain as much humidity as warm air. The state when condensation occurs is named dew point and is the temperature when air becomes saturated with water vapor.

Dew point



Molecules of water in warm air



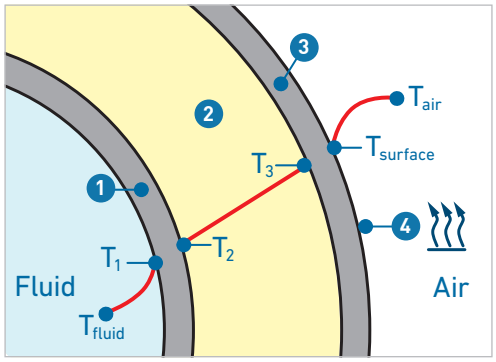
Molecules of water in cold air.
Excess water condenses into droplets.

Thus, if the temperature of a surface falls below the dew point temperature, condensation occurs. The dew point temperature ($T_{dp}$) depends on the ambient temperature ($T_{air}$) plus the ambient relative humidity (rH) and can be calculated with these two variables.

A high relative humidity increases the dew point temperature which raises the probability for condensation.

Next to the dew point temperature, also the surface temperature of the COOL-FIT system can be calculated by considering following information:

- material insulation properties (λ),
- dimensional information,
- media temperature ($T_{fluid}$),
- emittance (radiation and convection)




1 $\lambda_{inner\ pipe}$
2 $\lambda_{insulation}$
3 $\lambda_{jacket}$
4 $\varepsilon_{mitt}$

Emittance (radiation and convection) describes the dissipation of energy to the surrounding environment. Especially the convection is an important factor which is largely dependent on the air movement on the outer surface. Therefore, the air movement around the pipe surface is a critical variable to be considered during condensation assessment.

⚠ A low air movement lowers the convection and thus raises the risk of condensation occurrence.

## Basic assessment

A calculation can support the assessment of the situation. The COOLING Tool-Box module “Condensation” uses a simplified calculation method for a rough assessment, see „1.4.17 COOLING Tool-Box“ on page 72. As pipe specific information, i.e., insulation and dimensional properties, are already set, representative environmental parameters such as air temperature ($T_{air}$), relative humidity (rH), air velocity ($v_{air}$) and media temperature ($T_{fluid}$) need to be provided.

The COOLING Toolbox calculates and matches the dew point and surface temperature and gives out a result per dimension:

√ **Calculation**

- $T_{dp} > T_{surface}$ = condensation
  ↳ dew point $T_{dp}$ above the surface temperature result in condensation.
- $T_{dp} < T_{surface}$ = no condensation
  ↳ dew point $T_{dp}$ below the surface temperature results in no condensation.

⚠ This calculation does only a simple matching between the 2 calculated temperatures. In case of a small deviation or harsh and ambiguous environments, a basic assessment should not be the only basis.

## Advanced assessment

In case of a harsh or ambiguous environment, an advanced assessment is needed. Additionally, it needs to be considered that a basic calculation can only support the assessment of the occurrence of condensation but does not give information about the condensation intensity.

Additionally, for the determination of the input variables, it must be considered that the environment undergoes fluctuations and individual situations might deviate.

**Factors influencing ambient temperature and humidity:**

- local climate variances
- weather variances (rainy-sunny periods, day-night rhythm)
- microclimate in enclosed spaces
- influences in proximity of the pipe routing (another piping, cold walls, ...)
- opening/closing of doors to areas with other conditions

**Deviations between input and actual values:**

- tolerances in measured air movement
- tolerances in media temperature

Therefore, the worst-case conditions must be taken into account, and each area must be evaluated separately.

Certain environmental conditions might be so harsh that a technical solution without condensation might be not feasible or economical. These are typically,

- spaces which are concealed and have no air movement (pipe trays, intermediate ceilings)
- spaces with extreme relative humidity

In such situations additional measures, such as increasing air movement or lowering relative humidity might be inevitable.



For an advanced evaluation - Get support by your local GF Industry & Infrastructure Flow Solutions representative.

# 1.4.4 Fire behavior and fire prevention measures

## Firestop classes

**Classification of fire behavior**

Construction materials are classified into different firestop classes depending on their fire behavior. The classification is decisive for whether specific materials may be legally used for construction in certain areas of construction projects.

**European classification according to EN 13501-1**

In the year 2001, the EN 13501-1 was introduced, a European classification system for construction materials. EN 13501-1 defines 6 construction material classes from A to F:

| | |
|---|---|
| A | No contribution to the development of a fire (A1, A2) |
| B | Very little contribution to the development of a fire |
| C | Limited contribution to the development of a fire |
| D | Acceptable contribution to the development of a fire |
| E | Acceptable fire behavior |
| F | No performance criteria detected |

In addition to the fire behavior, the European standard also rates fire side effects: smoke release (s1, s2, s3) and burning droplets (d0, d1, d2).

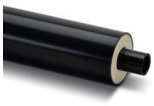
Smoke release:

| | |
|---|---|
| s1 | Limited smoke release |
| s2 | Average smoke release |
| s3 | High smoke release, or smoke release not tested |

Burning droplets:

| | |
|---|---|
| d0 | No burning droplets/fall off within 600 seconds |
| d1 | No burning droplets/fall off with an afterglow time of more than 10 seconds within 600 seconds |
| d2 | No performance criteria detected |

## Fire prevention classes according to EN13501-1

| | COOL-FIT 4.0 | COOL-FIT 4.0F | COOL-FIT 4.0 Push System | COOL-FIT 4.0/ mineral wool [1)] |
|---|---|---|---|---|
| |  |  |  |  |
| EN 13501-1* | E | B – s2, d0 | D – s2, d0 | $A2_L$ |

[1)] Type: Rockwool 800

* The pipes were tested acc to DIN EN 13823

## Thermal load

The thermal load corresponds to a thermal potential (energy release) related to a specific base area, fire section area in $m^2$, for example an escape route. The physical unit for the thermal load is energy per surface area $kWh/m^2$. The calculative thermal load is equivalent to the sum of the different thermal potentials of all used combustible used elements, such as pipelines. When the energy released per running meter of the pipe (kWh/m) is known, the thermal load of the pipe is calculated from the used pipe length.

| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 |
|---|---|---|---|---|---|---|---|---|
| Thermal load COOL-FIT 4.0 SDR11 pipes (kWh/m) | 15.0 | 21.7 | 24.0 | 32.7 | 41.4 | 53.1 | 68.9 | 109.43 |

| d/D (mm) | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
|---|---|---|---|---|---|---|---|---|
| Thermal load COOL-FIT 4.0 SDR17 pipes (kWh/m) | 109.3 | 187.0 | 214.0 | 264.3 | 329.2 | 413.8 | 520.2 | 653.0 |

| d/D (mm) | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
|---|---|---|---|---|---|---|---|---|
| Thermal load COOL-FIT 4.0 SDR11 pipes (kWh/m) | 134.5 | 236.4 | 275.1 | 340.5 | 425.7 | 535.7 | 676.2 | 850.7 |

| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 |
|---|---|---|---|---|---|---|---|---|---|---|
| Thermal load COOL-FIT 4.0F SDR11 pipes (kWh/m) | 9.06 | 12.95 | 15.31 | 21.14 | 29.31 | 39.24 | 54.39 | 83.61 | 106.75 | 193.74 |

| d/D (mm) | 160/250 | 225/315 |
|---|---|---|
| Thermal load COOL-FIT 4.0F SDR17 pipes (kWh/m) | 106.75 | 193.73 |

| d/D (mm) | 25/78 | 32/85 |
|---|---|---|
| Thermal load COOL-FIT 4.0 Push System pipes (kWh/m) | 2.34 | 3.09 |

## Fire resistance of components

While the fire behavior characterizes individual materials, the fire resistance must be considered for complete components, for example a solid wall with pipe perforations. The fire resistance is equivalent to the amount of time in which a component maintains its function during a standard fire.

The European system allows classification according to different criteria, stating the respective fire resistance duration in minutes.

## Fire resistance and classification according to the European standards

Pipe insulation systems are exposed to a standard fire according to EN 1363-3. Classification is according to EN 13501-2 and generally includes the criteria integrity (E, Étanchéité) and thermal insulation (I, Insulation).

| Abbreviation | Criterion | Rating |
|---|---|---|
| E – Étanchéité | Flame protection or integrity | Measurement of an element's capacity of preventing the passage of gases and flames in case of fire. |
| I – Insulation | Insulation or thermal insulation | Measurement of the insulation capacity of an element, i.e. the duration in which the side of the element facing away from the fire does not exceed 180° C + the ambient temperature. |

## Firestop collars/Fire sealing

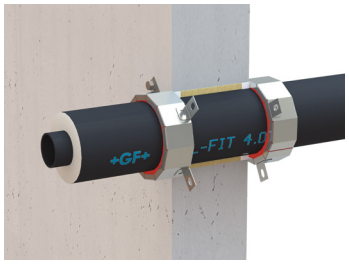
**When pipes are installed through fire-rated assemblies, whose reliable functioning must not be affected, firestop collars that comply with local requirements and legislation must be used.**

### Hilti firestop

**System description**

The firestop collar (inlc.fastening hook) is made of galvanized steel sheet into which strips of intumescent material (i.e. that swells in case of fire) are inserted.

The fire retardation sealing with straight pipes is regulated in conjunction with the following products in the individual countries:




| Product | Proof of applicability | Countries |
|---|---|---|
| Hilti firestop collar CP 644 | Allgemeine Bauartgenehmigung (aBg) Z-19.53-2330 | DE |
| Hilti firestop collar CP 644 | VKF Technische Auskunft 14108 | CH |
| Hilti firestop collar CFS-C P | ETA-10/0404 | EU |

The respective details of the proofs of application must be taken into account.

Additional information is available at Hilti online or from your Hilti contact person.

**Hilti CP 644**

Info | Shop

qr.hilti.com/r3069

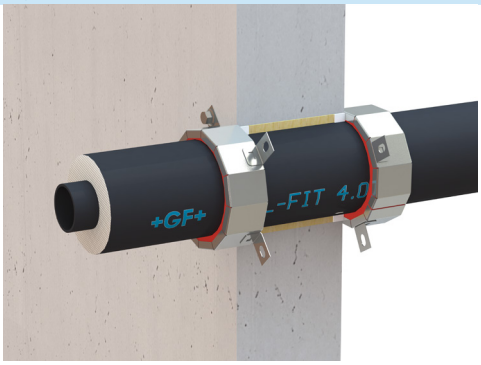
**Hilti CFS-C P**

Info | Shop

qr.hilti.com/r4831

The following applications are regulated via the above proofs of application:

**Rigid walls, thickness ≥ 100 mm**




**Rigid floor, thickness ≥ 150 mm**



## Fire-retarding sealing

COOL-FIT 4.0 pipes up to and including an outside diameter D of 250mm*, can be sealed in rigid walls and D of 140mm in rigid floors by a Hilti fire protection collar.

| Wall ≥ 100mm solid | | Product DE, CH | Product EU | Fire resistance | Mounting |
|---|---|---|---|---|---|
| d [mm] | D (mm) | CP 644 | CFS-C P | | Number of hooks |
| 32 | 90 | CP 644-90/3" | CFS-C P 90/3" | EI 120-U/C | 3 |
| 40 | 110 | CP 644-110/4" | CFS-C P 110/4" | EI 120-U/C | 4 |
| 50 | 110 | CP 644-110/4" | CFS-C P 110/4" | EI 120-U/C | 4 |
| 63 | 125 | CP 644-125/5" | CFS-C P 125/5" | EI 120-U/C | 4 |
| 75 | 140 | CP 644-160/6" | CFS-C P 160/6" | EI 120-U/C | 6 |
| 90 | 160 | CP 644-160/6" | CFS-C P 160/6" | EI 120-U/C | 6 |
| 110 | 180 | CP 644-180/7" | CFS-C P 180/7" | EI 120-U/C | 8 |
| 160 | 250 | CP 644-250/10" | CFS-C P 250/10" | EI 120-U/C | 12 |

| Ceiling ≥ 150mm solid | | Product DE, CH | Product EU | Fire resistance | Mounting |
|---|---|---|---|---|---|
| d (mm) | D (mm) | CP 644 | CFS-C P | | Number of hooks |
| 32 | 90 | CP 644-90/3" | CFS-C P 90/3" | EI 120-U/C | 3 |
| 40 | 110 | CP 644-110/4" | CFS-C P 110/4" | EI 120-U/C | 4 |
| 50 | 110 | CP 644-110/4" | CFS-C P 110/4" | EI 120-U/C | 4 |
| 63 | 125 | CP 644-125/5" | CFS-C P 125/5" | EI 120-U/C | 4 |
| 75 | 140 | CP 644-160/6" | CFS-C P 160/6" | EI 120-U/C | 6 |

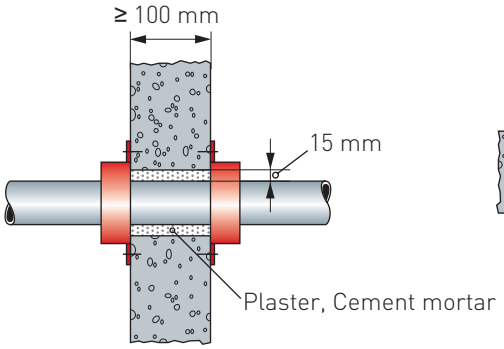
* For bigger dimensions see chapter "Additional approved fire retarding sealing".

## Gap sealing

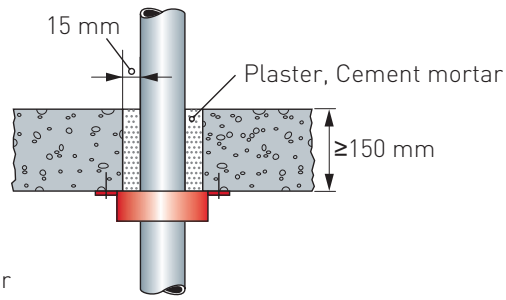
For the installation situations there are several options for sealing gaps against smoke gas.

Gap sealing with non-combustible construction materials:

**Rigid wall**

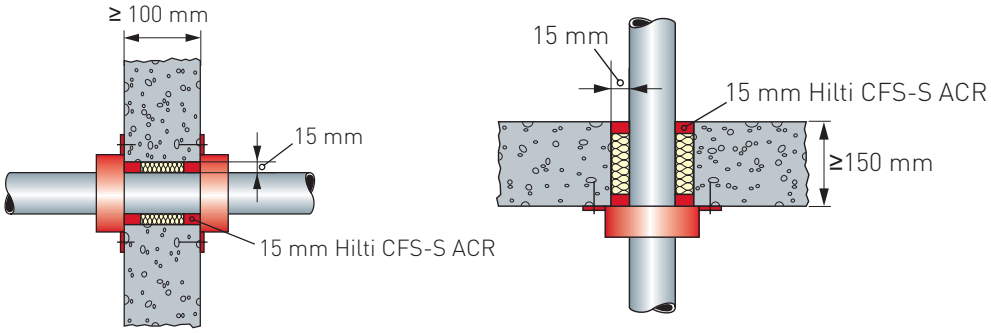



**Rigid floor**




Joint closure with Hilti firestop sealant CFS-S ACR and mineral wool backfill up to 15mm annular gap width for Hilti firestop collar CP 644 and CFS-C P.

| Rigid wall | Rigid floor |
|---|---|




## Distance regulations

The distance of the component openings to be closed to other openings or installed elements must comply with the data provided in the following table.

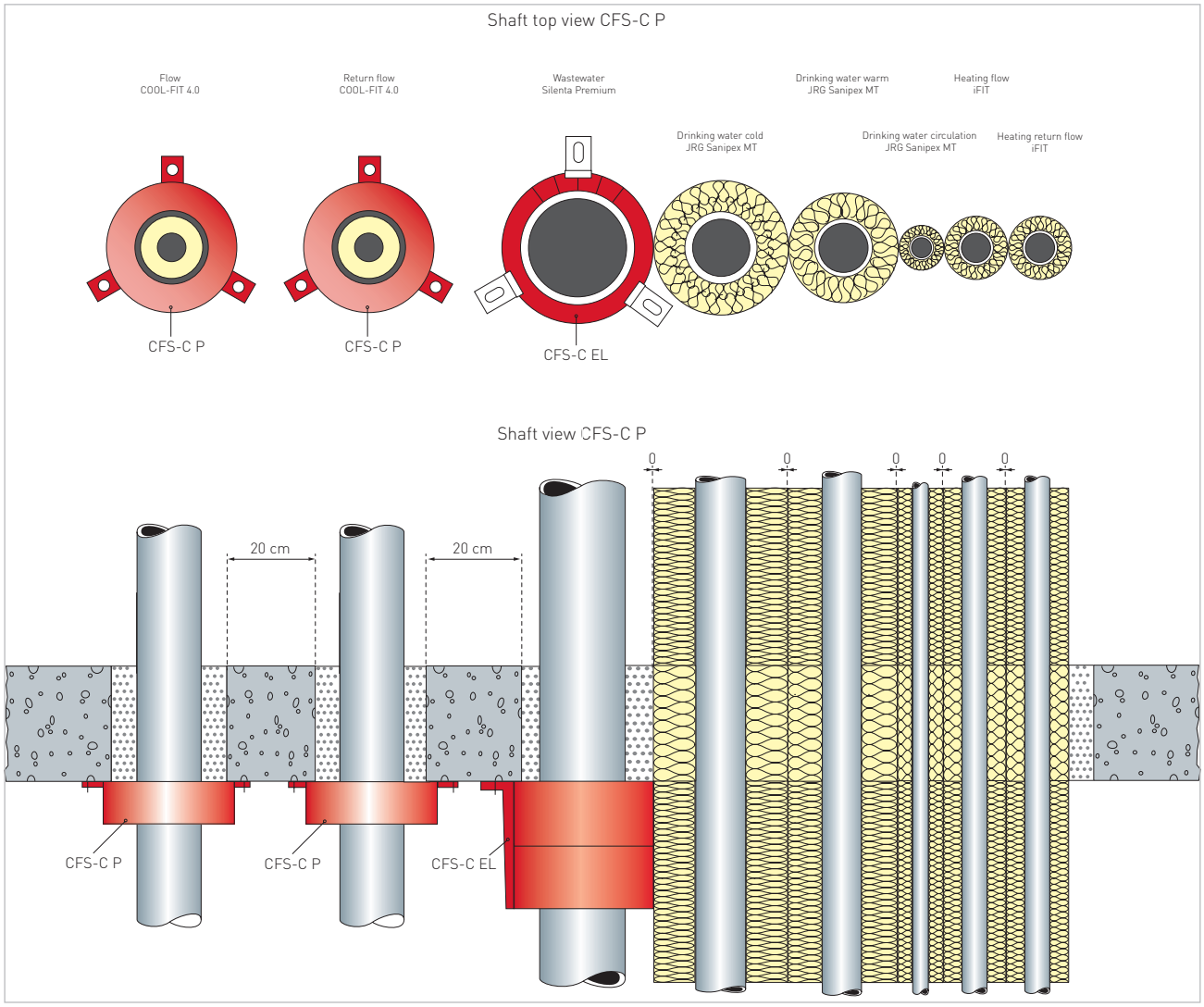
| Distance of the pipe sealing to | Size of the adjacent openings | Distance between the openings DE, CH | Distance between the openings EU |
|---|---|---|---|
| Other cable or pipe sealing | one/both openings > 40cm x 40cm | ≥ 20cm | ≥ 20cm |
| | Both openings ≤ 40cm | ≥ 10cm | |
| Other openings or installed elements | one/both openings > 20cm x 20cm | ≥ 20cm | ≥ 20cm |
| | Both openings ≤ 20cm | ≥ 10cm | |

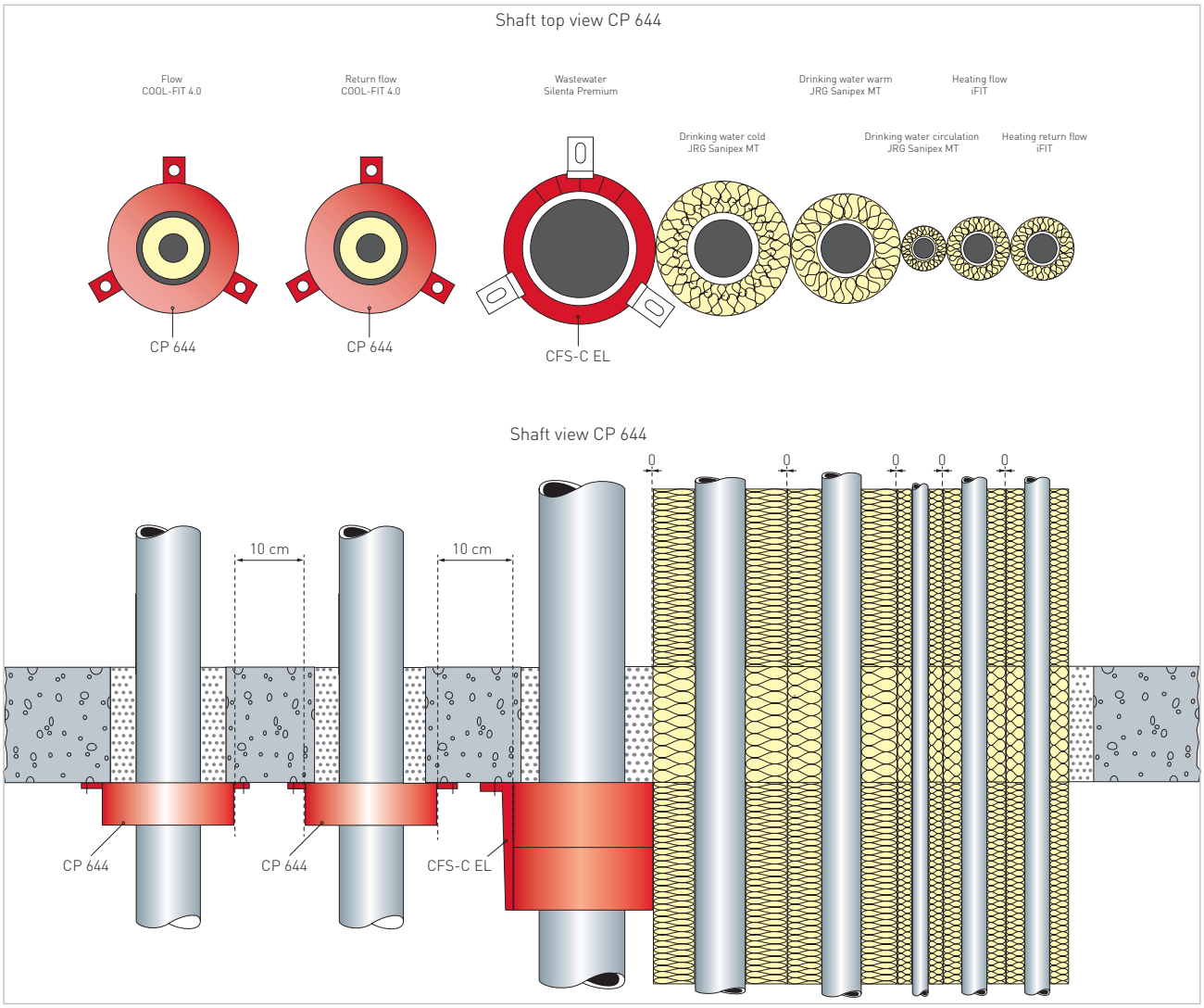
The following pipe distances between the openings of the pipe lead through are derived from this for pipe sealing with the Hilti firestop collar for COOL-FIT 4.0:



## Shaft installation

A shaft installation with additional pipelines, for example for heating and drinking water, may look as follows:






## Additional approved fire retarding sealing

The following firestop collars were tested with COOL-FIT 4.0 / 4.0F pipes.

| Fire-retarding sealing | Manufacturer | Approval |
|---|---|---|
| ROKU ® AWM II | Rolf Kuhn GmbH | ETA 17/0753 |
| BIS Pacifyre ® AWM II | Walraven | ETA 17/0753 |

The firestop system ROKU® R – type AWM II carries the European technical approval ETA 17/0753. COOL-FIT 4.0 (up to dimensions d355/D500) and 4.0F was tested with AWM II firestop collars.

For detailed product information on AWM II see www.svt-global.com

## ROKU® System AWM II

**System description**

The ROKU® system AWM II consists of a firestop collar housing, which is equipped on the inside with several layers of the highly effective intumescent material "ROKU® Strip." In case of fire, the foaming material reacts with a strong foaming pressure and permanently seals the construction component opening against fire and smoke. On walls, one collar should be fitted on each side, and on ceilings only one collar underneath the ceiling.

**Application areas**

- Sealing of plastic pipes up to Ø 400 mm in solid walls, light partition walls, and solid ceilings
- For plastic pipes, mineral fiber-reinforced plastics, plastic composite pipes
- Suitable for insulated and non-insulated plastic pipes and acoustically insulating sewage pipes

## Solutions for emergency corridors

Within emergency corridors the use of only non-combustible materials is allowed. The supplier Rockwool offers with Rockwool 800 a protection sleeve, made of mineral wool, which allows the use of normal combustible pipe within emergency areas. This solution is approved on pipe outer diameters of up to 160 mm.

For detailed information about Rockwool 800 see: www.rockwool.de.



## Roxtec RS PPS seal

**System description**

The Roxtec RS PPS is a sealing for pipes through steel decks and bulkheads in vessels. The intumsecent-based sealing stips that wrap around the plastic pipe ensure blocking of smoke, flames and water in case of fire.

| Fire-retarding sealing | Manufacturer | Approval |
|---|---|---|
| Roxtec RS PPS und RS PPS/S | Roxtec International AB | MEDB000036A<br>LR2090258SF |

For detailed information about Roxtec see www.roxtec.com

# 1.4.5 Hydraulic design

## Determination of pipe diameter based on flow rate

As a first approximation, the required pipe cross-section for a certain flow rate can be calculated using the following formula:

$$d_i = 18.8 \cdot \sqrt{\frac{Q_1}{v}} \quad \text{oder} \quad d_i = 35.7 \cdot \sqrt{\frac{Q_2}{v}}$$

| | |
|---|---|
| v | flow velocity (m/s) |
| $d_i$ | Pipe internal diameter (mm) |
| $Q_1$ | Flow rate ($m^3/h$) |
| $Q_2$ | Flow rate (l/s) |
| 18.8 | Conversion factor for units $Q_1$ ($m^3/h$) |
| 35.7 | Conversion factor for units $Q_2$ (l/s) |

Example calculation of an internal diameter $d_i$

| | |
|---|---|
| COOL-FIT 4.0 pipe | SDR17 |
| Flow rate $Q_2$ | 55 l/s |
| Usual flow velocity v | 1.5 m/s |

$$d_i = 35.7 \cdot \sqrt{\frac{55}{1.5}} = 216.2 \text{ mm}$$

A pipe with d225/D315 is used. After the internal diameter has been determined that way, the actual flow rate is determined with the following formula:

$$v = 354 \cdot \frac{Q_1}{d_i^2} = 1.8 \frac{m}{s} \quad \text{oder} \quad v = 1275 \cdot \frac{Q_2}{d_i^2} = 1.8 \frac{m}{s}$$

| | |
|---|---|
| v | Flow velocity v (m/s) |
| $d_i$ | Pipe internal diameter (mm) |
| $Q_1$ | Flow rate ($m^3/h$) |
| $Q_2$ | Flow rate (l/s) |
| 354 | Conversion factor for units $Q_1$ ($m^3/h$) |
| 1275 | Conversion factor for units $Q_2$ (l/s) |

## Determination of pipe diameter based on cooling capacity

As a first approximation, the required pipe cross section for a certain cooling power can be calculated using the following formula.

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{Q_L \cdot 3600}{\Delta T \cdot c \cdot \rho}\right)}{v}}$$

| | |
|---|---|
| di | Pipe inner diameter (mm) |
| $Q_L$ | Cooling capacity in kW |
| $\Delta T$ | Temperature difference supply - return (K) |
| c | Specific heat capacity (kW*s/(kg*K)) |
| $\rho$ | Density of the medium ($kg/m^3$) |
| v | Flow velocity (m/s) |

Example for calculating the inner diameter di, based on cooling capacity with medium water.

| | |
|---|---|
| Cooling capacity $Q_L$ | 2'000 kW |
| Specific heat capacity (20 °C) c | 4.187 kJ/(kg*K) |
| Water density (20 °C) ρ | 998.2 kg/m³ |
| Temperature difference ΔT | 10 K |
| Flow velocity v | 1.5 m/s |

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{2000 \cdot 3600}{10 \cdot 4.187 \cdot 998.2}\right)}{1.5}} = 18.8 \cdot \sqrt{\frac{172.3}{1.5}} = 201.5 \text{ mm}$$

The flow rate should be estimated on the basis of the intended purpose of the pipe. As a guide for the flow rate, the following specifications apply.

**Liquids**

v = 0.5 – 1.0 m/s for the suction side

v = 1.0 – 3.0 m/s for the pressure side

This method of calculation of pipe diameter does not allow for hydraulic losses. They must be calculated separately. The following sections serve that purpose.

Conversion table with units of flow rate.

| ($m^3$/h) | (l/min) | (l/s) | ($m^3$/s) |
|---|---|---|---|
| 1.0 | 16.67 | 0.278 | $2.78 \times 10^{-4}$ |
| 0.06 | 1.0 | 0.017 | $1.67 \times 10^{-5}$ |
| 3.6 | 60 | 1.0 | $1.00 \times 10^{-3}$ |
| 3'600 | 60'000 | 1'000 | 1.0 |

## Correlation of outer diameter - inner diameter

To determine the outer diameter based on the internal diameter and SDR, the following formula can be used:

$$d = d_i \cdot \frac{SDR}{SDR - 2}$$

## Correlation between pipe external and internal diameter

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| d (mm) | 32 | 40 | 50 | 63 | 75 | 90 | 110 | 140 |
| di SDR11 (mm) | 26.2 | 32.6 | 40.8 | 51.4 | 61.4 | 73.6 | 90 | 114.6 |
| di SDR17 (mm) | | | | | | | | |
| d (mm) | 160 | 225 | 250 | 280 | 315 | 355 | 400 | 450 |
| di SDR11 (mm) | 130.8 | 184 | 204.6 | 229.2 | 257.8 | 290.6 | 327.4 | 368.2 |
| di SDR17 (mm) | 141 | 198.2 | 220.4 | 246.8 | 277.6 | 312.8 | 352.6 | 396.6 |

# 1.4.6 Nomogram for easy calculation of diameter and pressure loss

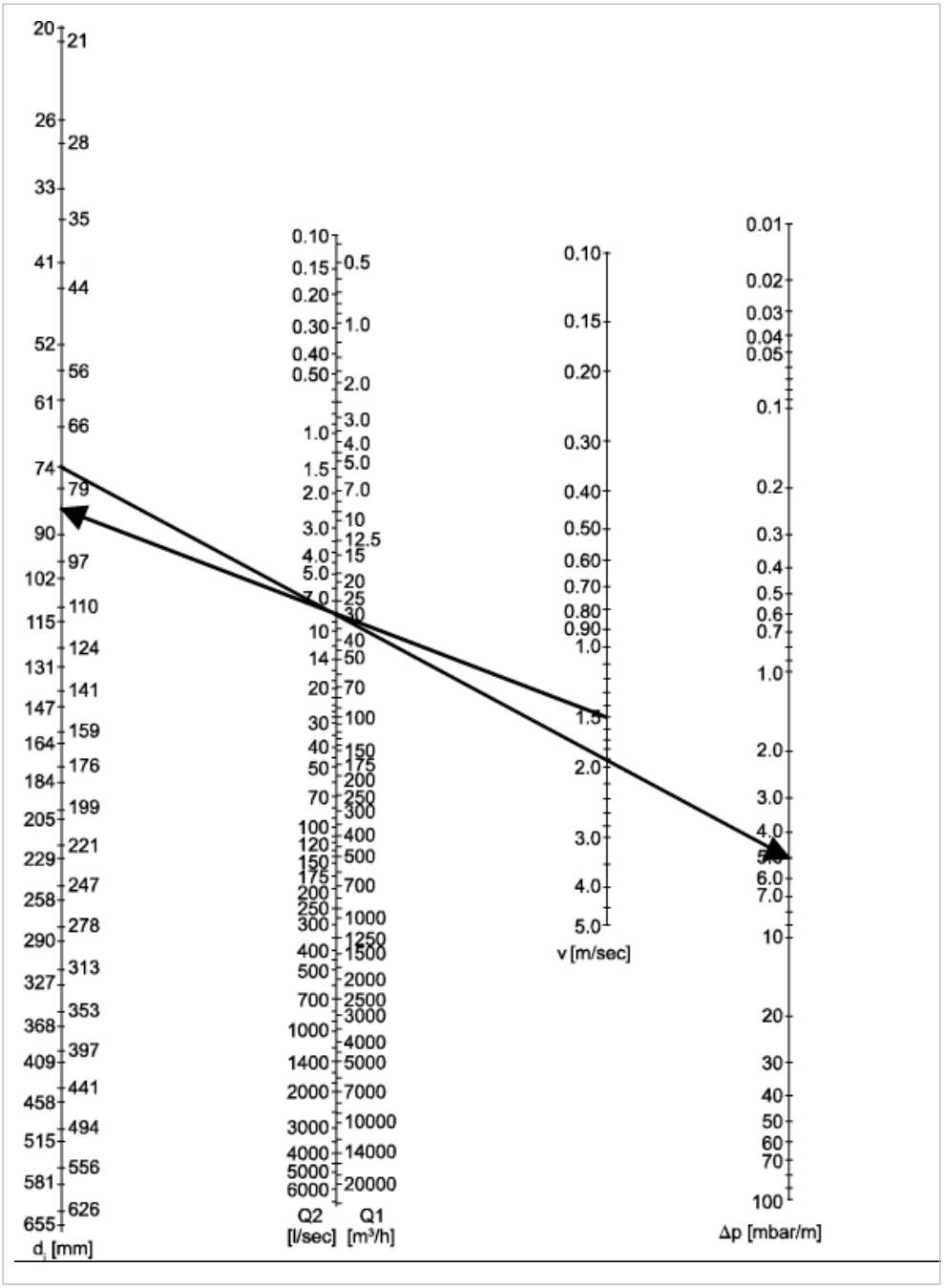
The nomogram below can be used to simplify the determination of the diameter required .The pressure loss in the pipe can be read off per meter of the pipe length.

⚠ The pressure loss calculated using the nomogram only applies to flows of substances with density 1000 kg/m³, i.e. water. Further pressure losses from fittings, valves, etc. also need to be considered using the instructions that follow.

## Using the nomogram

Based on a flow velocity of 1.5 m/s, a line is drawn through the desired flow rate (i.e. 30 m³/h) to the axis which shows an internal diameter di (≈ 84 mm). Here, a closely matching diameter (74 mm for SDR11) and a second line is drawn back through the desired flow rate to the pressure drop axis Δp (5 mbar per meter of pipe).

## Nomogram for COOL-FIT 4.0 pipe (PE100, SDR11) using the metric system




i For detailed information on the determination of diameter and pressure loss, see Planning Fundamentals "Hydraulic calculation and pressure losses of metric industrial piping systems".

# 1.4.7 Dimension comparison COOL-FIT 4.0 / 4.0F / 4.0 Push System vs. metal

| COOL-FIT 4.0 / 4.0F | | | Stainless steel | | Copper pipe |
|---|---|---|---|---|---|
| d (mm) | $d_i$ (mm) | DN | inch | da (mm) | da (mm) |
| 32 | 26.2 | 25 | 1 | 33.4 | 28 |
| 40 | 32.6 | 32 | 1 ¼ | 42.2 | 35 |
| 50 | 40.8 | 40 | 1 ½ | 48.3 | 42 |
| 63 | 51.4 | 50 | 2 | 60.3 | 54 |
| 75 | 61.4 | 65 | 2 ½ | 73.0 | 76.1 |
| 90 | 73.6 | 80 | 3 | 88.9 | 88.9 |
| 110 | 90.0 | 90 | 4 | 114.3 | 108 |
| 140 | 114.6 | 125 | 5 | 141.3 | 133 |
| 160 | 141.0 | 150 | 6 | 168.3 | 159 |
| 225 | 198.2 | 200 | 8 | 219.1 | 219 |
| 250 | 220.4 | 250 | 10 | 244.5 | |
| 280 | 246.8 | 250 | 10 | 273.1 | 267 |
| 315 | 277.6 | 300 | 12 | 323.9 | |
| 355 | 312.8 | 350 | 14 | 355.6 | |
| 400 | 352.6 | 400 | 16 | 406.4 | |
| 450 | 396.6 | 450 | 18 | 457.2 | |

d Nominal external diameter of PE pipe
$d_i$ Nominal internal diameter of pipe

| COOL-FIT Push System | | | Stainless steel | | Copper pipe |
|---|---|---|---|---|---|
| d (mm) | $d_i$ (mm) | DN | Inch | da (mm) | da (mm) |
| 25 | 20 | 20 | ¾ | 26.7 | 22 |
| 32 | 26 | 25 | 1 | 33.4 | 28 |

d Nominal external diameter of pipe
$d_i$ Nominal internal diameter of pipe

# 1.4.8 Pressure loss

## Pressure loss in straight pipe

In determining pressure losses in straight pipe sections, a distinction is made between laminar and turbulent flows. The Reynolds number (Re) determines this. The change from laminar to turbulent occurs at the critical Reynolds number $Re_{crit}$ = 2320.

In practice laminar flows occur particularly for the movement of viscous liquids such as lubricating oils. In most applications, thus including flows of aqueous materials, there is turbulent flow with a substantially more uniform velocity distribution over the pipe cross-section than in laminar flow.

The pressure loss in a straight pipe section is inversely proportional to the pipe diameter and is calculated as follows:

$$\Delta p_R = \lambda \cdot \frac{L}{d_i} \cdot \frac{\rho}{2 \cdot 10^2} \cdot v^2$$

| | |
|---|---|
| $\Delta p_R$ | Pressure loss in the straight pipe run (bar) |
| $\lambda$ | Pipe friction factor |
| L | Length of the straight pipe section (m) |
| $d_i$ | Inner diameter of the pipe (mm) |
| $\rho$ | Density of the flow material (kg/m³)<br>for water 20 °C = 998.2 kg/m³ |
| v | Flow velocity v (m/s) |

⚠ In practice, when making a rough calculation (i. e. smooth plastic pipe and turbulent flow) it is enough to use the value $\lambda$ = 0.02 to represent the hydraulic pressure loss.

## Pressure losses in fittings

**Coefficient of resistance**

The pressure losses depend upon the type of fitting as well as on the flow in the fitting. The so-called coefficient of resistance ($\zeta$ value) is used for calculations.

**Calculation of the pressure loss**

To calculate the total pressure loss in all fittings in a piping system, take the sum of the individual losses, i. e. the sum of all the $\zeta$-values. The pressure loss can then be calculated according to the following formula:

$$\Delta p_{Fi} = \Sigma\zeta \cdot \frac{v^2}{2 \cdot 10^5} \cdot \rho$$

| | |
|---|---|
| $\Delta p_{Fi}$ | Pressure loss of all fittings (bar) |
| $\Sigma\zeta$ | Sum of all individual losses |
| v | Flow velocity v (m/s) |
| $\rho$ | Density of the medium in kg/m³ (1 g/cm³ = 1000 kg/m³) |

**Ceta-values fittings COOL-FIT 4.0**

| Designation | Symbol | Coefficient of resistance ζ |
|---|---|---|
| Couplers |  | 0.1 |
| Elbow 90° |  | 1.2 |
| Elbow 45° |  | 0.3 |
| Tee [1] |  | 1.3 |
| Bend 90° | d250: 0.35<br>d280: 0.34<br>d315: 0.33 | d355: 0.33<br>d400: 0.32<br>d450: 0.31 |
| Bend 45° | d250: 0.25<br>d280: 0.24<br>d315: 0.23 | d355: 0.23<br>d400: 0.23<br>d450: 0.22 |
| Reducer (contraction) |  | 0.5 |
| Reducer (enlargement) |  | 1.0 |
| Flange joint, transition fitting | d32: 0.8<br>d40: 0.7<br>d50: 0.6 | d63: 0.4<br>d75: 0.3<br>d90-d225: 0.1 |
| Flexible hoses | ½": 2.0<br>¾": 1.8<br>1": 1.4 | 1 ¼": 1.1<br>1 ½": 1.0<br>2": 0.8 |
| Weld-in port with female thread |  | 0.2 |
| Weld-in port PE spigot |  | 0.1 |
| |  | 0.9 |
| |  | 1.4 |
| Weld-in port PE/iFIT |  | 0.1 |
| |  | 1.1 |
| |  | 3.3 |

[1] For a more detailed view, differentiate between coalescence and separation. Ceta values up to a maximum of 1.3 can be found in the respective literature.

| Designation | Symbol | Coefficient of resistance ζ |
|---|---|---|
| Weld-in port PE/ Sanipex MT |  | 0.1 |
| |  | 1 |
| |  | 1.3 |

**Ceta-values fittings COOL-FIT 4.0 Push System**

| Designation | | Symbol | Dimension | Coefficient of resistance ζ |
|---|---|---|---|---|
| Coupler | |  | d25 | 2.8 |
| | | | d32 | 6.7 |
| 90° angle | |  | d25 | 5.2 |
| | | | d32 | 11.0 |
| Pipe bend 90°, bent manually | |  | d25 | 0.1 |
| | | | d32 | 0.1 |
| Pipe bend 45°, bent manually | |  | d25 | 0.1 |
| | | | d32 | 0.1 |
| Tee | Main |  | d25 | 2.8 |
| | | | d32 | 6.4 |
| Tee | Branch |  | d25 | 5.5 |
| | | | d32 | 12.4 |
| Tee, reduced | Main |  | d32-d25 | 2.6 |
| Tee, reduced | Branch |  | d32-d25 | 4.9 |
| Reducer | |  | d32-d25 | 2.7 |

## Pressure losses in valves

The $k_v$ factor is a convenient means of calculating the hydraulic flow rates for valves. It allows for all internal resistances and for practical purposes is regarded as reliable. It is defined as the flow rate of water in liters per minute with a pressure drop of 1 bar across the valve. The technical data of the Georg Fischer Piping Systems valves contains the $k_v$ values as well as pressure loss charts. The latter make it possible to read off the pressure loss directly. But the pressure loss can also be calculated from the $k_v$ value according to the following formula:

$$\Delta p_{Ar} = \left(\frac{Q}{k_v}\right)^2 \cdot \frac{\rho}{1000}$$

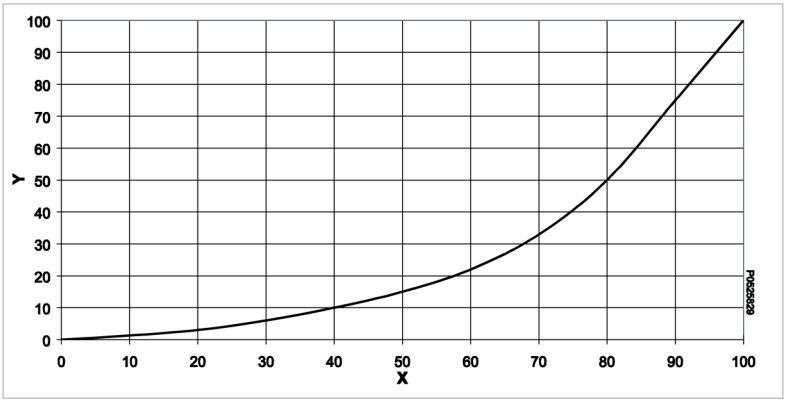
| | |
|---|---|
| $\Delta p_{Ar}$ | Pressure loss for the valve (bar) |
| $Q$ | Flow rate ($m^3/h$) |
| $\rho$ | Density of the conveyed medium ($kg/m^3$) (1 g/cc = 1000 $kg/m^3$) |
| $k_v$ | Valve characteristic value ($m^3/h$) |

### $k_v$ 100-Werte

| DN (mm) | Zoll (inch) | d (mm) | $k_v$ 100 (l/min) | Cv 100 (gal/min) | $k_v$ 100 ($m^3/h$) |
|---|---|---|---|---|---|
| 25[1] | 1 | 32 | 700 | 49.0 | 42 |
| 32[1] | 1 ¼ | 40 | 1'000 | 70.0 | 60 |
| 40[1] | 1 ½ | 50 | 1'600 | 112.0 | 96 |
| 50[1] | 2 | 63 | 3'100 | 217.1 | 186 |
| 65[1] | 2 ½ | 75 | 5'000 | 350.0 | 300 |
| 80[1] | 3 | 90 | 7'000 | 490.0 | 420 |
| 100[2] | 4 | 110 | 3'800 | 455 | 390 |
| 125[2] | 5 | 140 | 8'600 | 602 | 516 |
| 150[2] | 6 | 160 | 16'600 | 1'162 | 1'000 |
| 200[2] | 8 | 225 | 39'600 | 2'772 | 2'380 |

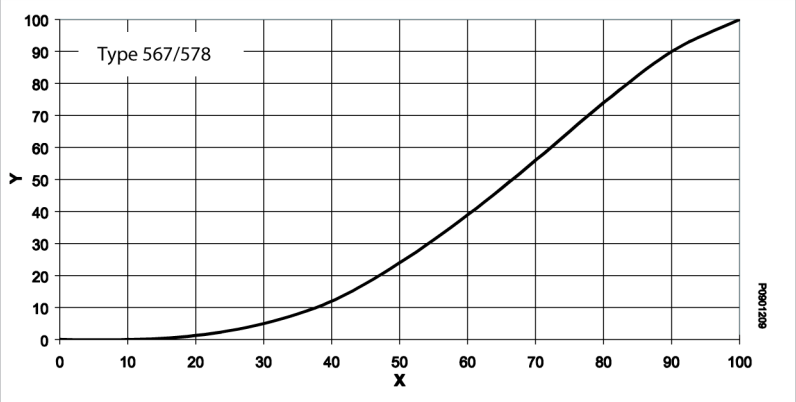
[1] COOL-FIT 4.0 Ball valve
[2] COOL-FIT 4.0 Butterfly valve

### Flow characteristic Ball valve




X Opening angle (%)
Y $k_v$, Cv value (%)

### Flow characteristic butterfly valve




X Opening angle (%)
Y $k_v$, Cv value (%)

**kv 100-values Ball valve COOL-FIT 4.0 Push System**

| DN (mm) | Inch (") | d (mm) | $k_v$ 100 (l/min) | Cv 100 (gal/min) | $k_v$ 100 ($m^3/h$) |
|---|---|---|---|---|---|
| 20 | ¾ | 25 | 29.5 | 7.8 | 1.8 |
| 25 | 1 | 32 | 29.5 | 7.8 | 1.8 |

**kv 100-values Flow control valve COOL-FIT 4.0 Push System**

| DN (mm) | Inch (") | d (mm) | $k_v$ 100 (l/min) | Cv 100 (gal/min) | $k_v$ 100 ($m^3/h$) |
|---|---|---|---|---|---|
| 20 | ¾ | 25 | 83.3 | 22.0 | 5.0 |
| 25 | 1 | 32 | 83.3 | 22.0 | 5.0 |

⚠ The use of antifreeze agents changes the viscosity and density of the medium. Depending on the proportion added, the actual flow rate therefore deviates from the displayed flow rate. Please contact GF Industry & Infrastructure Flow Solutions for further information.

### Pressure difference between the static pressure

If the piping system is installed vertically, then a geodetic pressure difference must be calculated for it. This pressure difference is calculated as follows:

$$\Delta p_{geod} = \Delta H_{geod} \cdot \rho \cdot 10^{-4}$$

| | |
|---|---|
| $\Delta p_{geod}$ | Geodetic pressure difference (bar) |
| $\Delta H_{geod}$ | Difference in elevation of the piping system (m) |
| $\rho$ | Density of the medium (kg/m³) (1 g/cm³ = 1000 kg/m³) |

⚠ At closed systems, the geodetic pressure difference does not need to be considered. This is typically the case for cooling systems.

## Sum of pressure losses

The sum of all pressure drops for a piping system is calculated as follows:

$$\Sigma\Delta p = \Delta p_R + \Delta p_{Fi} + \Delta p_{Ar}$$

√ Example for pressure drop calculations

The following example illustrates the calculation process for determining the pressure loss of a piping system.

| | | Number of Fittings |
|---|---|---|
| COOL-FIT 4.0 pipe | d40 mm | 12 x 90° angle |
| SDR11 - flow rate | 1.5 l/s | 4 x 45° angle |
| Medium | Water | 3 x T-piece |
| Density of the medium | 1.0 g/cm³ | 3 x screws |
| Length straight pipe | 15 m | 2 x flange connections |
| Height difference | 2.0 m | 1 x ball valve, 80 % opened |

The wall thickness of the piping system can be calculated as follows with the SDR:

$$e = \frac{d}{SDR} = \frac{40\ mm}{11} = 3.6\ mm$$

The inner diameter of the piping system is as follows:

$$d_i = d - 2 \cdot e = d - \frac{2 \cdot d}{SDR} = 32.8\ mm$$

With the desired flow rate of 1.5 l/s, the flow velocity is as follows:

$$v = 1275 \cdot \frac{Q_2}{d_i^2} = 1275 \cdot \frac{1.5}{32.8^2}\ \frac{m}{sec} = 1.78\ \frac{m}{sec}$$

| Pressure loss | Formula |
|---|---|
| Pressure loss for straight pipe sections | $\Delta p_R = 0.02 \cdot \frac{15}{32.8} \cdot \frac{1000}{2 \cdot 10^2}\ 1.78^2 = 0.14$ bar |
| Pressure loss for fittings incl. connections | $\Sigma\zeta = (12 \cdot 1.2) + (4 \cdot 0.3) + (3 \cdot 1.3) + (5 \cdot 0.7) = 23$ |
| | $\Delta p_{Fi} = 23 \cdot \frac{1.78^2}{2 \cdot 10^5} \cdot 1000 = 0.36$ bar |
| Pressure loss for the valve 80 % opened. With the flow characteristics diagram for ball valves type 546, from an 80 % opening angle a percentile $k_v$ value of 50 % can be read out,that means 50 % of the $k_v$ value 100: 0.5 * 60 m³/ H (flow rate 1.5 l/s = 5.4 m³/h) | $\Delta p_{Ar} = \left(\frac{5.4}{0.5 \cdot 60}\right)^2 \cdot \frac{1000}{1000} = 0.03$ bar |
| Whole pressure loss of the piping | $\Sigma\Delta p = 0.14\ bar + 0.36\ bar + 0.03\ bar = 0.53\ bar$ |

# 1.4.9 Z-dimension method

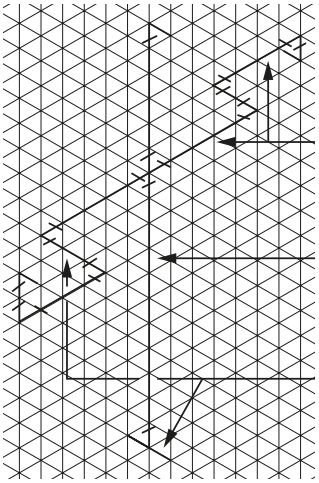
**Overview**

The pressure of competition and high wages makes it essential to install piping systems efficiently. The Georg Fischer Piping Systems method of assembly is highly suited to this task. It replaces the tedious and time-consuming cutting to size of one pipe at a time by a fast and precise way of preparing whole groups of pipe according to plans or jigs.

The respective pipe group with the corresponding design dimensions and cut lengths can be entered in the isometric paper of Georg Fischer Piping Systems, see Measuring SheetSeite 51.

Please adhere to the following guidelines for drawing:

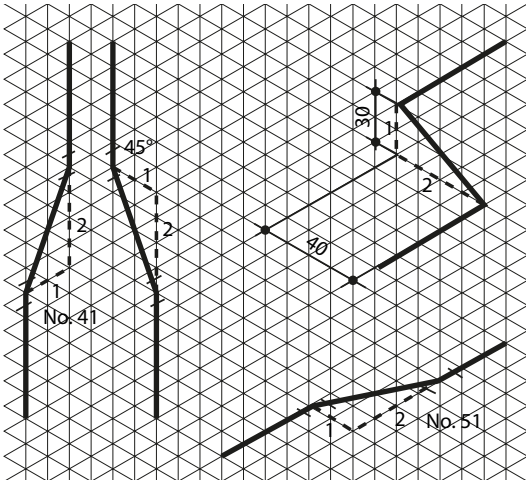
| Pipe running perpendicular to one another | Pipe running diagonally |
|---|---|



Horizontally:
left and right

Vertical

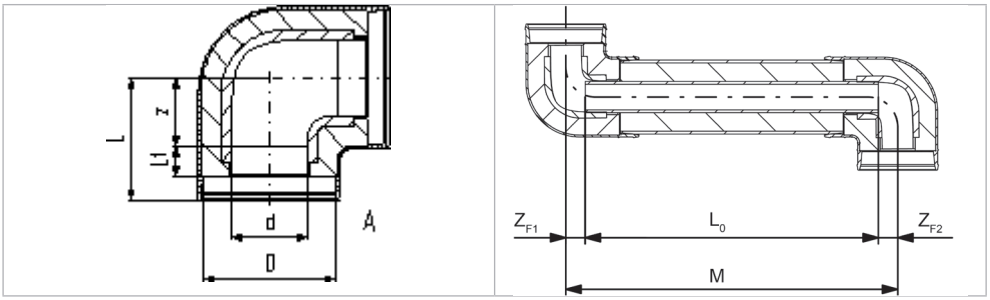
Horizontally:
front and rear




The z-dimensions of the fittings are needed for determining the actual cutting lengths of the pipe. The tables in our product ranges and in the online catalogues contain all the relevant data for the fittings. The length of pipe to be cut is given as in the following diagram by the distance between the center of adjoining fittings less the sum of the z-dimension of the fittings.

## Procedure

**Electrofusion**




**Formula for determining the required pipe length**

$L_0 = M - Z_{F1} - Z_{F2}$

$L_0$ Pipe length to be cut
M Center to center distance between fittings
$z_{F1}$ z measurement for fitting 1
$z_{F2}$ z measurement for fitting 2

Example

| | |
|---|---|
| Dimension | d32/D90 |
| Center to center distance M | 1'000 mm |
| z measurement for 90° elbow $z_{F1}$ | 20 mm |
| z measurement for 90° elbow $z_{F2}$ | 20 mm |

M = 1000 mm; $L_0$ = ?

$L_0$ = 1000 mm – 20 mm – 20 mm = 960 mm

## Measuring Sheet

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**GEORG FISCHER**
PIPING SYSTEMS

**Unterteilungsblatt 30°**
**Feuille de mesurage 30°**
**Foglio per misure 30°**

Firma
Firme
Ditta

Dat.

Bauobjekt
Bâtiment
Edificio

Blatt Nr.
Feuille No.
Foglio No.

| Pos. | M - M | – cm | L cm | Ø | |
|---|---|---|---|---|---|
| | | | | | |



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# 1.4.10 Length changes and flexible sections

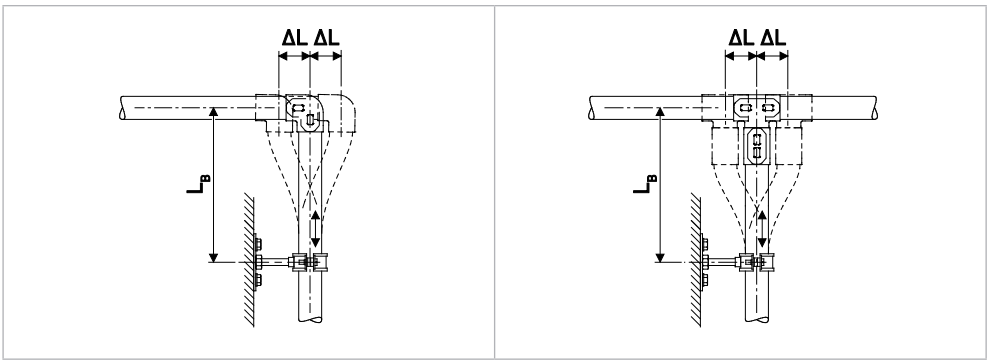
## Overview

**Length changes ΔL and expansion bend $L_B$ – General**

Thermoplastics are subject to higher thermal expansion and contraction than metallic materials. Pipe installed above ground, against walls or in ducts, require changes in length to be taken up in order to prevent any superimposed extra strain on the pipe. This applies especially to pipe exposed to operating temperature variations.

To accommodate a change in length, the following options can be considered:
A Flexible sections
B Flexible hoses
C Compensators

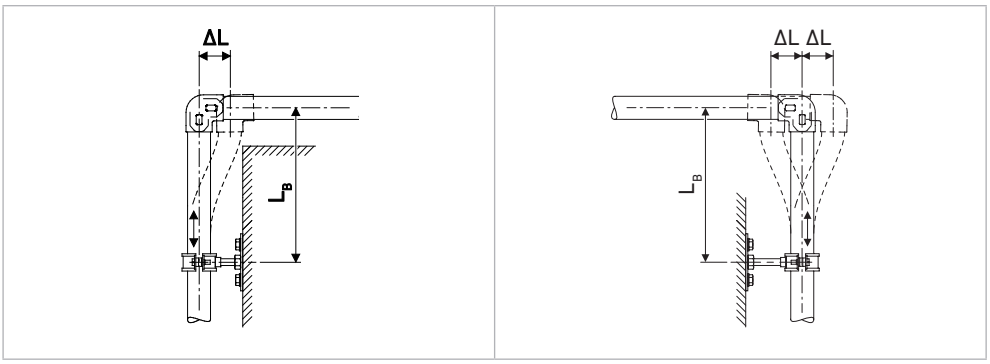
Flexible sections are the most common, the simplest and the most economical solution. The calculations for and the positioning of flexible sections are therefore described in detail.




ΔL Change in length
$L_B$ Flexible section

**Fundamentals**

The low elasticity of thermoplastics allows changes in length to be taken up by special pipe sections, where pipe supports are positioned so that they can take advantage of the natural flexibility of the material. The length of such sections is determined by the diameter of the piping system and the extent of the thermal expansion to be compensated.



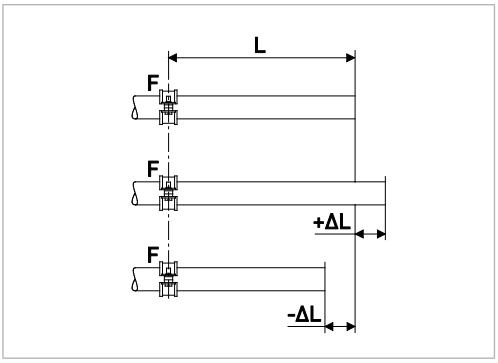

Flexible sections arise naturally at any branching or change in direction of the piping system. The movement $L_B$ of the flexible section as a result of a change ΔL in the length must not be restrained by fixed pipe brackets, wall protrusions, girders or the like.

## Calculation of length changes and flexible sections COOL-FIT 4.0 / 4.0F

To determine the **change in length due to temperature** ΔL (mm) of COOL-FIT 4.0 pipe, the following temperatures must be known:

**Installation temperature**

- Minimum flow temperature
- Maximum flow temperature
- Minimum ambient temperature
- Maximum ambient temperature




F Fixpoint
L Length of pipe section

**The following tables show changes in length at different media temperatures for certain conditions. To determine the change in length for other conditions, the COOLING Tool-Box can be used. Contact your local GF Industry & Infrastructure Flow Solutions representative or visit www.gfps.com**

**Example of use:**

| | |
|---|---|
| Installation temperature | 25 °C |
| Min. ambient temperature | 25 °C constant |
| Max. ambient temperature | 25 °C constant |
| Min. flow temperature | See table |
| Max. flow temperature | 25 °C |
| Pipe class | d32 - d140 SDR11 and d160 - d450 SDR17 |

**COOL-FIT 4.0**

| Length change ΔL (mm) at 20° C flow temperature | | | | | Length change ΔL (mm) at 15° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -4 | -9 | -18 | -27 | d32 | -9 | -18 | -37 | -55 |
| d40 | -5 | -10 | -19 | -29 | d40 | -10 | -20 | -40 | -59 |
| d50 | -6 | -13 | -26 | -38 | d50 | -13 | -26 | -52 | -78 |
| d63 | -7 | -15 | -29 | -44 | d63 | -15 | -30 | -60 | -90 |
| d75 | -8 | -16 | -32 | -48 | d75 | -16 | -33 | -65 | -98 |
| d90 | -9 | -18 | -36 | -54 | d90 | -18 | -36 | -73 | -109 |
| d110 | -10 | -20 | -41 | -61 | d110 | -21 | -41 | -82 | -124 |
| d140 | -10 | -21 | -41 | -62 | d140 | -21 | -42 | -84 | -126 |
| d160 | -9 | -18 | -37 | -55 | d160 | -19 | -37 | -75 | -112 |
| d225 | -11 | -21 | -43 | -64 | d225 | -22 | -43 | -86 | -129 |
| d250 | -11 | -23 | -45 | -68 | d250 | -23 | -46 | -91 | -137 |
| d280 | -11 | -22 | -44 | -66 | d280 | -22 | -44 | -89 | -133 |
| d315 | -11 | -22 | -45 | -67 | d315 | -23 | -45 | -91 | -136 |
| d355 | -11 | -23 | -45 | -68 | d355 | -23 | -46 | -91 | -137 |
| d400 | -11 | -23 | -45 | -68 | d400 | -23 | -46 | -92 | -137 |
| d450 | -12 | -24 | -48 | -72 | d450 | -24 | -48 | -96 | -144 |

L Laid pipe length

| Length change ΔL (mm) at 10° C flow temperature | | | | | Length change ΔL (mm) at 5° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -14 | -28 | -56 | -84 | d32 | -19 | -38 | -76 | -115 |
| d40 | -15 | -30 | -61 | -91 | d40 | -21 | -41 | -83 | -124 |
| d50 | -20 | -40 | -80 | -120 | d50 | -27 | -54 | -109 | -163 |
| d63 | -23 | -46 | -91 | -137 | d63 | -31 | -62 | -124 | -185 |
| d75 | -25 | -50 | -100 | -150 | d75 | -34 | -67 | -135 | -202 |
| d90 | -28 | -55 | -111 | -166 | d90 | -37 | -75 | -149 | -224 |
| d110 | -31 | -62 | -125 | -187 | d110 | -42 | -84 | -168 | -252 |

L Laid pipe length

| Length change ΔL (mm) at 10° C flow temperature | | | | | Length change ΔL (mm) at 5° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d140 | -32 | -64 | -127 | -191 | d140 | -43 | -86 | -171 | -257 |
| d160 | -28 | -57 | -114 | -171 | d160 | -38 | -77 | -154 | -230 |
| d225 | -33 | -65 | -130 | -196 | d225 | -44 | -88 | -175 | -263 |
| d250 | -34 | -69 | -138 | -207 | d250 | -46 | -93 | -185 | -278 |
| d280 | -34 | -67 | -134 | -201 | d280 | -45 | -90 | -180 | -270 |
| d315 | -34 | -69 | -138 | -206 | d315 | -46 | -92 | -185 | -277 |
| d355 | -35 | -69 | -138 | -207 | d355 | -46 | -93 | -186 | -278 |
| d400 | -35 | -69 | -139 | -208 | d400 | -46 | -93 | -186 | -279 |
| d450 | -36 | -73 | -145 | -218 | d450 | -49 | -97 | -195 | -292 |

| Length change ΔL (mm) at 0° C flow temperature | | | | | Length change ΔL (mm) at -5° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -24 | -49 | -97 | -146 | d32 | -30 | -59 | -119 | -178 |
| d40 | -26 | -53 | -105 | -158 | d40 | -32 | -64 | -128 | -192 |
| d50 | -34 | -69 | -138 | -207 | d50 | -42 | -84 | -168 | -252 |
| d63 | -39 | -78 | -157 | -235 | d63 | -48 | -95 | -190 | -286 |
| d75 | -43 | -85 | -171 | -256 | d75 | -52 | -104 | -207 | -311 |
| d90 | -47 | -94 | -189 | -283 | d90 | -57 | -114 | -228 | -342 |
| d110 | -53 | -106 | -212 | -318 | d110 | -64 | -128 | -256 | -384 |
| d140 | -54 | -108 | -215 | -323 | d140 | -65 | -130 | -260 | -390 |
| d160 | -48 | -97 | -194 | -291 | d160 | -59 | -117 | -234 | -352 |
| d225 | -55 | -110 | -221 | -331 | d225 | -67 | -133 | -266 | -399 |
| d250 | -58 | -116 | -233 | -349 | d250 | -70 | -140 | -280 | -420 |
| d280 | -57 | -113 | -226 | -340 | d280 | -68 | -136 | -273 | -409 |
| d315 | -58 | -116 | -232 | -348 | d315 | -70 | -140 | -279 | -419 |
| d355 | -58 | -117 | -233 | -350 | d355 | -70 | -140 | -281 | -421 |
| d400 | -58 | -117 | -234 | -350 | d400 | -70 | -141 | -281 | -422 |
| d450 | -61 | -122 | -244 | -367 | d450 | -73 | -147 | -294 | -441 |

L Laid pipe length

| Length change ΔL (mm) at -10° C flow temperature | | | | | Length change ΔL (mm) at -15° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -35 | -71 | -141 | -212 | d32 | -41 | -82 | -163 | -245 |
| d40 | -38 | -76 | -152 | -228 | d40 | -44 | -88 | -176 | -264 |
| d50 | -50 | -99 | -198 | -297 | d50 | -57 | -115 | -229 | -344 |
| d63 | -56 | -112 | -225 | -337 | d63 | -65 | -130 | -259 | -389 |
| d75 | -61 | -122 | -244 | -366 | d75 | -70 | -140 | -281 | -421 |
| d90 | -67 | -134 | -268 | -402 | d90 | -77 | -154 | -308 | -463 |
| d110 | -75 | -150 | -300 | -450 | d110 | -86 | -172 | -344 | -516 |
| d140 | -76 | -152 | -305 | -457 | d140 | -87 | -175 | -349 | -524 |
| d160 | -69 | -138 | -275 | -413 | d160 | -79 | -158 | -316 | -475 |
| d225 | -78 | -156 | -312 | -467 | d225 | -89 | -178 | -357 | -535 |
| d250 | -82 | -164 | -328 | -491 | d250 | -94 | -187 | -375 | -562 |
| d280 | -80 | -160 | -319 | -479 | d280 | -91 | -183 | -366 | -549 |
| d315 | -82 | -163 | -327 | -490 | d315 | -93 | -187 | -374 | -561 |
| d355 | -82 | -164 | -328 | -492 | d355 | -94 | -188 | -376 | -563 |
| d400 | -82 | -164 | -329 | -493 | d400 | -94 | -188 | -376 | -564 |
| d450 | -86 | -172 | -343 | -515 | d450 | -98 | -196 | -392 | -588 |

L Laid pipe length

### COOL-FIT 4.0F SDR17

| Length change ΔL (mm) at 20° C flow temperature | | | | | Length change ΔL (mm) at 15° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d160 | -6 | -12 | -25 | -37 | d160 | -13 | -25 | -51 | -76 |
| d225 | -7 | -15 | -30 | -45 | d225 | -15 | -30 | -61 | -91 |

| Length change ΔL (mm) at 10° C flow temperature | | | | | Length change ΔL (mm) at 5° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d160 | -19 | -39 | -77 | -116 | d160 | -26 | -53 | -105 | -158 |
| d225 | -23 | -47 | -93 | -140 | d225 | -32 | -63 | -126 | -189 |

L Laid pipe length

### COOL-FIT 4.0F SDR11

| Length change ΔL (mm) at 20° C flow temperature | | | | | Length change ΔL (mm) at 15° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -3 | -5 | -10 | -15 | d32 | -5 | -11 | -21 | -32 |
| d40 | -3 | -6 | -12 | -18 | d40 | -6 | -13 | -25 | -38 |
| d50 | -4 | -8 | -17 | -25 | d50 | -9 | -17 | -34 | -51 |
| d63 | -5 | -10 | -21 | -31 | d63 | -11 | -21 | -43 | -64 |
| d75 | -5 | -10 | -20 | -30 | d75 | -10 | -20 | -41 | -61 |
| d90 | -6 | -11 | -23 | -34 | d90 | -12 | -24 | -47 | -71 |
| d110 | -6 | -13 | -26 | -39 | d110 | -13 | -26 | -53 | -79 |
| d140 | -7 | -15 | -30 | -44 | d140 | -15 | -30 | -60 | -91 |
| d160 | -8 | -16 | -31 | -47 | d160 | -16 | -32 | -64 | -96 |
| d225 | -9 | -18 | -37 | -55 | d225 | -19 | -38 | -75 | -113 |

L Laid pipe length

| Length change ΔL (mm) at 10° C flow temperature | | | | | Length change ΔL (mm) at 5° C flow temperature | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 | L (m) | 25 | 50 | 100 | 150 |
| d32 | -8 | -16 | -32 | -49 | d32 | -11 | -22 | -44 | -66 |
| d40 | -10 | -19 | -39 | -58 | d40 | -13 | -27 | -53 | -80 |
| d50 | -13 | -26 | -53 | -79 | d50 | -18 | -36 | -72 | -108 |
| d63 | -16 | -33 | -66 | -99 | d63 | -22 | -45 | -89 | -134 |
| d75 | -16 | -31 | -62 | -93 | d75 | -21 | -42 | -85 | -127 |
| d90 | -18 | -36 | -72 | -108 | d90 | -25 | -49 | -98 | -147 |
| d110 | -20 | -40 | -81 | -121 | d110 | -27 | -55 | -110 | -164 |
| d140 | -23 | -46 | -92 | -138 | d140 | -31 | -63 | -125 | -188 |
| d160 | -24 | -49 | -97 | -146 | d160 | -33 | -66 | -132 | -198 |
| d225 | -29 | -57 | -114 | -171 | d225 | -39 | -77 | -154 | -231 |

L Laid pipe length

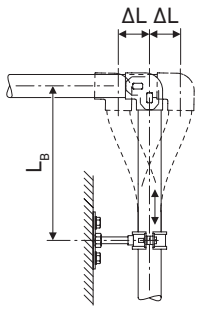
| Length change ΔL (mm) at 0° C flow temperature | | | | |
|---|---|---|---|---|
| L (m) | 25 | 50 | 100 | 150 |
| d32 | -14 | -28 | -57 | -85 |
| d40 | -17 | -34 | -68 | -102 |
| d50 | -23 | -46 | -92 | -138 |
| d63 | -28 | -57 | -114 | -171 |
| d75 | -27 | -54 | -108 | -163 |
| d90 | -31 | -63 | -125 | -188 |
| d110 | -35 | -70 | -139 | -209 |
| d140 | -40 | -79 | -159 | -238 |
| d160 | -42 | -84 | -167 | -251 |
| d225 | -49 | -97 | -195 | -292 |

## Flexible sections for COOL-FIT 4.0

**Flexible Section $L_B$**

Valid for SDR11 and SDR17. The values for $L_B$ (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

| Flexible section $L_B$ (cm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ΔL (mm) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 150 | 200 | 300 |
| d32 | 78 | 110 | 135 | 156 | 174 | 191 | 206 | 221 | 234 | 247 | 302 | 349 | 427 |
| d40 | 86 | 122 | 149 | 172 | 193 | 211 | 228 | 244 | 259 | 273 | 334 | 386 | 472 |
| d50 | 86 | 122 | 149 | 172 | 193 | 211 | 228 | 244 | 259 | 273 | 334 | 386 | 472 |
| d63 | 92 | 130 | 159 | 184 | 206 | 225 | 243 | 260 | 276 | 291 | 356 | 411 | 503 |
| d75 | 97 | 138 | 168 | 195 | 218 | 238 | 257 | 275 | 292 | 308 | 377 | 435 | 533 |
| d90 | 104 | 147 | 180 | 208 | 233 | 255 | 275 | 294 | 312 | 329 | 403 | 465 | 570 |
| d110 | 110 | 156 | 191 | 221 | 247 | 270 | 292 | 312 | 331 | 349 | 427 | 493 | 604 |
| d140 | 123 | 174 | 214 | 247 | 276 | 302 | 326 | 349 | 370 | 390 | 478 | 552 | 675 |
| d160 | 130 | 184 | 225 | 260 | 291 | 318 | 344 | 368 | 390 | 411 | 503 | 581 | 712 |
| d225 | 146 | 206 | 253 | 292 | 326 | 357 | 386 | 413 | 438 | 461 | 565 | 653 | 799 |
| d250 | 155 | 219 | 268 | 310 | 346 | 379 | 410 | 438 | 465 | 490 | 600 | 693 | 848 |
| d280 | 164 | 233 | 285 | 329 | 368 | 403 | 435 | 465 | 493 | 520 | 637 | 735 | 901 |
| d315 | 174 | 247 | 302 | 349 | 390 | 427 | 461 | 493 | 523 | 552 | 675 | 780 | 955 |
| d355 | 184 | 260 | 318 | 368 | 411 | 450 | 486 | 520 | 552 | 581 | 712 | 822 | 1'007 |
| d400 | 195 | 275 | 337 | 389 | 435 | 477 | 515 | 550 | 584 | 615 | 754 | 870 | 1'066 |
| d450 | 206 | 292 | 357 | 413 | 461 | 505 | 546 | 584 | 619 | 653 | 799 | 923 | 1'130 |

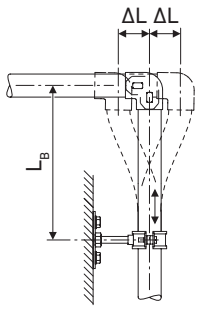



## Flexible sections for COOL-FIT 4.0F

**Flexible Section $L_B$**

Valid for SDR11 and SDR17. The values for $L_B$ (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

| Flexible section $L_B$ (cm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ΔL (mm) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 150 | 200 | 300 |
| d32 | 101 | 142 | 174 | 201 | 225 | 246 | 266 | 284 | 302 | 318 | 389 | 449 | 550 |
| d40 | 111 | 157 | 192 | 222 | 248 | 272 | 294 | 314 | 333 | 351 | 430 | 497 | 609 |
| d50 | 111 | 157 | 192 | 222 | 248 | 272 | 294 | 314 | 333 | 351 | 430 | 497 | 609 |
| d63 | 118 | 168 | 205 | 237 | 265 | 290 | 313 | 335 | 355 | 375 | 459 | 530 | 649 |
| d75 | 125 | 177 | 217 | 251 | 280 | 307 | 332 | 355 | 376 | 396 | 485 | 561 | 687 |
| d90 | 134 | 190 | 232 | 268 | 300 | 328 | 355 | 379 | 402 | 424 | 519 | 599 | 734 |
| d110 | 142 | 201 | 246 | 284 | 318 | 348 | 376 | 402 | 426 | 449 | 550 | 636 | 778 |
| d140 | 159 | 225 | 275 | 318 | 355 | 389 | 420 | 449 | 477 | 503 | 615 | 711 | 870 |
| d160 | 168 | 237 | 290 | 335 | 375 | 410 | 443 | 474 | 503 | 530 | 649 | 749 | 917 |
| d225 | 188 | 266 | 326 | 376 | 420 | 461 | 497 | 532 | 564 | 595 | 728 | 841 | 1030 |



## Reduction of the flexible sections

The specified flexible section lengths are based on the maximum permissible operating pressure according to the pressure-temperature diagram (SDR11/17, C = 1.6).

**$P_{perm}$ for dimensions d32-d225**

Maximum permissible operating pressure according to the pressure-temperature diagram for SDR11, considering medium-specific derating factors.

**$P_{perm}$ for dimensions d250-d450**

Maximum permissible operating pressure according to the pressure-temperature diagram for the respective SDR, considering medium-specific derating factors.

For lower operating pressures, the flexible section lengths may be reduced as follows:

| Operating Pressure | Permissible Reduction |
|---|---|
| ≤ 25% of $P_{perm}$ | 30% |
| > 25% to 60% of $P_{perm}$ | 15% |
| > 60% of $P_{perm}$ | No reduction |

**Example:**

For a COOL-FIT d110 pipe, the permissible operating pressure according to the pressure-temperature diagram at 10°C is 15 bar. When using a water-glycol mixture with a derating factor of 1.1, the permissible operating pressure is $P_{perm}$ = 15/1.1 = 13.6 bar.

If the actual system operating pressure is 5 bar, this corresponds to 36.7% of $P_{perm}$. Since this value is between 25% and 60% of $P_{perm}$, the tabulated flexible section length may be reduced by 15%. A possible flexible section length of 2.0 m may therefore be reduced to 1.7 m.

## Calculation of length changes and flexible section COOL-FIT 4.0 Push System

As a first approximation, the change of the pipe length can be calculated using the following formula.

$$\Delta L = \alpha \cdot L \cdot \Delta T$$

| | |
|---|---|
| $\Delta L$ | Length difference in mm |
| $\Delta T$ | Temperature difference in K |
| $L$ | Length of pipeline in m |
| $\alpha$ | Linear coefficent of thermal expansion; 0.024 mm/(mK) |

**Change in length**

| Pipe length [m] | Temperature difference ΔT [K] | | | | | |
|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 |
| | Change in length [mm] | | | | | |
| 1 | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.4 |
| 2 | 0.5 | 1.0 | 1.4 | 1.9 | 2.4 | 2.9 |
| 3 | 0.7 | 1.4 | 2.2 | 2.9 | 3.6 | 4.3 |
| 4 | 1.0 | 1.9 | 2.9 | 3.8 | 4.8 | 5.8 |
| 5 | 1.2 | 2.4 | 3.6 | 4.8 | 6.0 | 7.2 |
| 6 | 1.4 | 2.9 | 4.3 | 5.8 | 7.2 | 8.6 |
| 7 | 1.7 | 3.4 | 5.0 | 6.7 | 8.4 | 10.1 |
| 8 | 1.9 | 3.8 | 5.8 | 7.7 | 9.6 | 11.5 |
| 9 | 2.2 | 4.3 | 6.5 | 8.6 | 10.8 | 13.0 |
| 10 | 2.4 | 4.8 | 7.2 | 9.6 | 12.0 | 14.4 |
| 20 | 4.8 | 9.6 | 14.4 | 19.2 | 24.0 | 28.8 |
| 30 | 7.2 | 14.4 | 21.6 | 28.8 | 36.0 | 43.2 |
| 40 | 9.6 | 19.2 | 28.8 | 38.4 | 48.0 | 57.6 |
| 50 | 12.0 | 24.0 | 36.0 | 48.0 | 60.0 | 72.0 |

## Flexible section

### Sample calculation

The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K.

**Example: COOL-FIT 4.0 Push System**

| | |
|---|---|
| PE-RT pipe, dimension | d25 |
| Material constant C | 33 |
| Change in length $\Delta l$ | 10.08 mm |

**Calculation of the length of the flexible pipe leg**

$$L_B = C \cdot \sqrt{d \cdot \Delta l}$$

$$L_B = 33 \cdot \sqrt{(25\ mm \cdot 10.08\ mm)}$$

$$L_B = 523.9\ mm$$

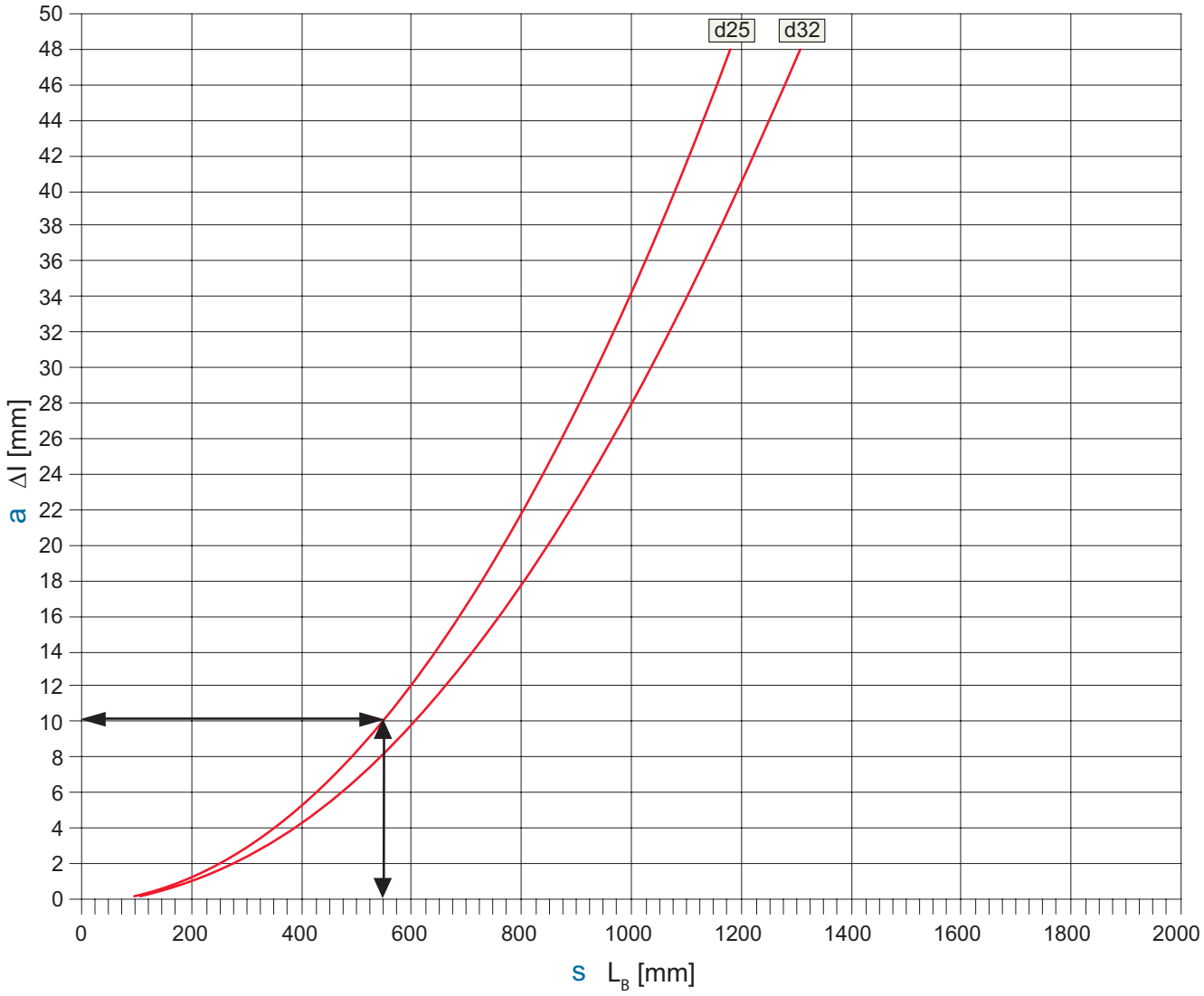
The length of the flexible pipe leg is derived from the pipe's change in length:

### Graph reading example

| | |
|---|---|
| PE-RT pipe, dimension | d25 |
| Material constant C | 33 |
| Change in length Δl | 10.08 mm |

$L_B$ = 523.9 mm

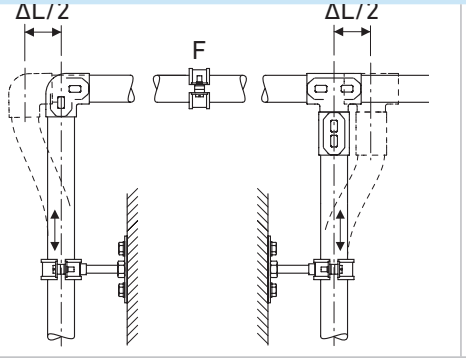
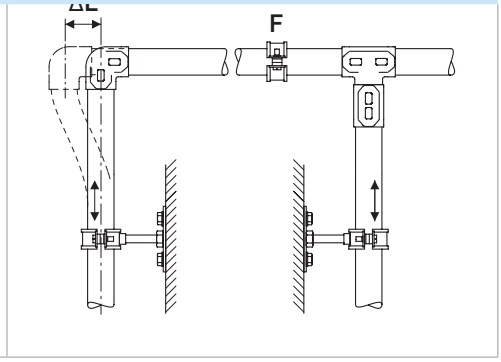
**Length of flexible pipe leg**
- **a** Change in length of the pipe
- **s** Length of flexible pipe leg



# 1.4.11 Handling expansion and contraction

## Recommendations for installation

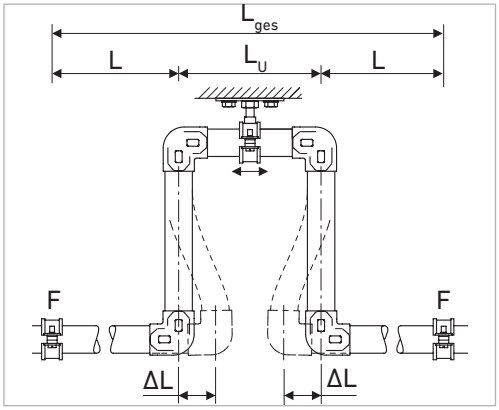
Length changes in pipe sections should always be accommodated through the arrangement of fixed brackets. The following examples show how the changes can be distributed in pipe sections by suitable positioning of fixed brackets:

| Recommended installation | Not recommended installation |
|---|---|
|  |  |





Expansion loops can be installed to take up changes in length when flexible sections cannot be included at a change in direction or branch in the piping system or if substantial changes in the length of a straight section need to be taken up. In such a case the compensation for changes in length is distributed over two flexible sections.





⚠ Bending stress can lead to leaks in mechanical joints.

Do not use any unions or flanged connections close to expansion bends and loops.

## Pre-tensioning

In particularly difficult situations with large changes in one direction only, it is possible to pre-tensioning the flexible section during installation and thereby shorten its length LB, as illustrated in the next example:

Example

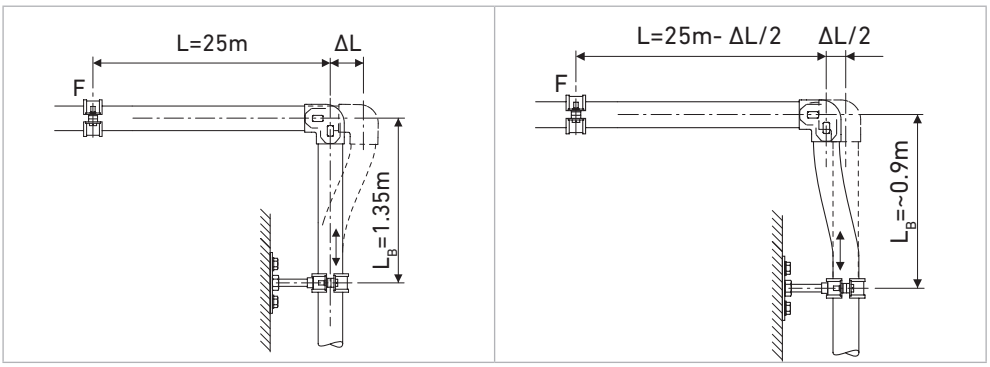
| | |
|---|---|
| Pipe length L | 25 m |
| Diameter | d225/D315 mm |
| Installation temperature | 25 °C |
| Min ambient temperature | 25 °C constant |
| Max ambient temperature | 25 °C constant |
| Min flow temperature | 10 °C |
| Max flow temperature | 25 °C |

Change in length from the table or COOLING Tool-Box:
-ΔL = 39 mm

A flexible section to take up a change in length of +/- ΔL = 40 mm needs to be $L_B$ (mm) = 2920 mm long according to the table.

If the flexible section is pre-tensioned to ΔL/2, the flexible section required is reduced to ~2060 mm. The change in length starting from the 0 position is then +/- ΔL/2 = 39/2 = 19.5 mm.

By pre-tensioning the flexible section makes it possible to reduce its required length in installations where space is restricted. Pre-stressing also reduces the bending of the flexible section in service, improving the appearance of the piping system.



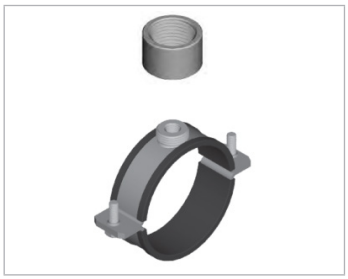
# 1.4.12 Pipe bracket spacing and support of piping systems

## Overview

**Installation of plastic pipe**

COOL-FIT 4.0 pipe should be installed using supports designed for use with plastics and should then be installed taking care not to damage or overstress the pipe. Specifically COOL-FIT 4.0 must be installed in order to allow stress-free operation.

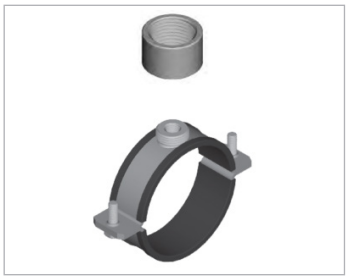
Thanks to the excellent insulating properties of the COOL-FIT 4.0 pipe and its hard, impact resistant outer jacket, standard pipe clamps with hard plastic inlay may be used. Special insulation pipe clamps or cold clamps are not necessary.



**Installation of COOL-FIT 4.0 Push System**

COOL-FIT 4.0 Push System tubes must be installed using suitable tube supports. In doing so, the pipes must not be under too much tension.

The COOL-FIT 4.0 Push System, pipes can be inserted into standard sliding pipe clamps with the COOL-FIT 4.0 Push System, support carrier. Special insulation pipe clamps or cold clamps are not necessary.



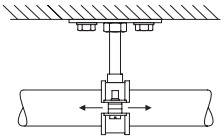
A retaining clamp must be placed next to each fitting.



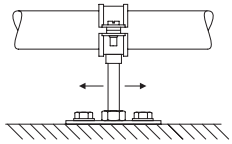
## Arranging loose brackets

**What is a loose bracket?**

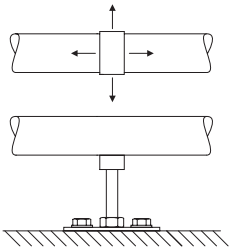
A loose bracket is a pipe bracket which allows axial movement of the pipe. This allows stress-free compensation of temperature changes and compensation of any other operating condition changes.



Axial displacement of the pipe in the clamp.



Pipe clamp fitted rigidly to the pipe, axial displacement in the suspension of the pipe clamp.



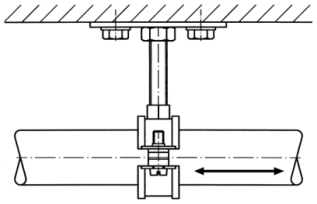
Displacement of the pipe in 2 axes.

The inner diameter of the bracket must be larger than the outer diameter of the pipe to allow free movement of the pipe. The inner edges of the brackets should be free from any sharp contours to avoid damaging the pipe surface.

Another method is to use brackets with spacers in the bolts which also avoids clamping the bracket on the pipe

The axial movement of the piping may not be hindered by fittings arranged next to the pipe bracket or other diameter changes.

Sliding brackets and hanging brackets permit the pipe to move in different directions. Attaching a sliding block to the base of the pipe bracket permits free movement of the pipe along a flat supporting surface. Sliding and hanging brackets are needed in situations where the piping system changes direction and free movement of the pipe must be allowed.

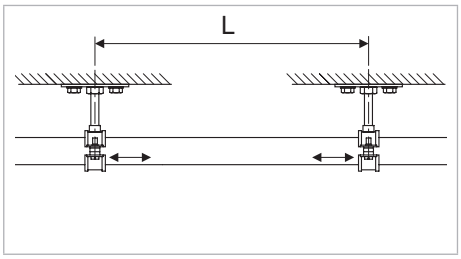


Spacers prevent pinching the pipe

## Maximum pipe support distance

The maximum pipe support distances have been determined for conveying water on the basis of a specific deflection of the pipe between two clamps considered acceptable.

The maximum pipe support distance for COOL-FIT 4.0 pipes is always consistent independent of pressure and temperature.




L Pipe bracket spacing

**Maximum pipe support distance L for COOL-FIT 4.0**

| d/D (mm) | d32/ D90 | d40/ D110 | d50/ D110 | d63/ D125 | d75/ D140 | d90/ D160 | d110/ D180 | d140/ D225 | d160/ D250 | d225/ D315 | d250/ D355 | d280/ D400 | d315/ D450 | d355/ D500 | d400/ D560 | d450/ D630 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L (mm) | 1'800 | 1'950 | 1'950 | 2'000 | 2'100 | 2'150 | 2'300 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |

**Maximum pipe support distance L for COOL-FIT 4.0F**

| d/D (mm) | d32/ D90 | d40/ D110 | d50/ D110 | d63/ D125 | d75/ D140 | d90/ D160 | d110/ D180 | d140/ D225 | d160/ D250 | d225/ D315 |
|---|---|---|---|---|---|---|---|---|---|---|
| L (mm) | 2'350 | 2'550 | 2'550 | 2'600 | 2'750 | 2'800 | 3'000 | 3'200 | 3'400 | 3'700 |

**Maximum pipe support distance L for COOL-FIT 4.0 Push System**

| d/D (mm) | 25/75 | 32/85 |
|---|---|---|
| L (mm) | 1'700 | 2'200 |

The pipe support distances from the table can be increased by 30% for vertical pipe. Multiply the values given by 1.3 in this case.

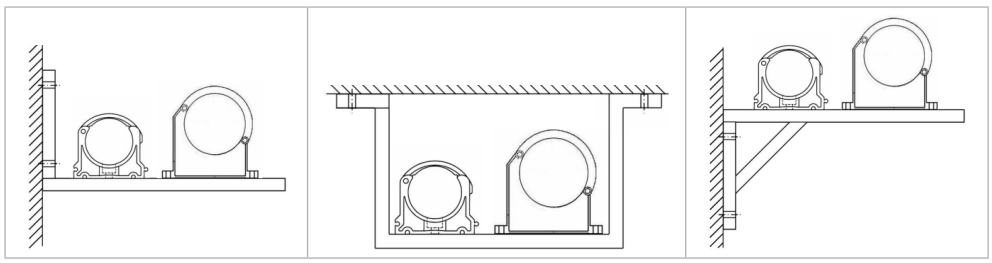
Valid for SDR11 and SDR17.

### KLIP-IT pipe brackets

These robust plastic pipe brackets can be used not only under rigorous operating conditions, but also where the pipework is subject to aggressive media or atmospheric conditions. Pipe brackets and pipe clamps from Georg Fischer Piping Systems are suitable for all pipe materials used.

Do not use KLIP-IT pipe brackets as fixed points!

From d90 upwards KLIP-IT pipe clamps must be mounted upright, as in the installation examples below.



## Arranging fixed points

A fixed point is a bracket which prevents the pipe from moving in any direction. The purpose of a fixed point is to control tension caused by temperature changes and guide elongation in a certain direction.

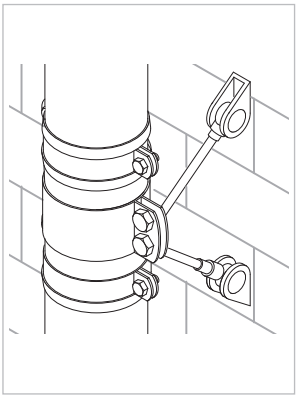
⚠ Fixpoint design

The pipe must not be fixed by clamping it in the pipe bracket. This can cause deformation and physical damage to the pipe, damage that sometimes does not appear until very much later.

⚠ Pipe brackets must be robust and mounted firmly to be able to take up the forces arising from changes in length in the piping system. Hanging brackets or KLIP-IT pipe brackets are unsuitable for use as fixed points.

## COOL-FIT 4.0 Fixed points

Fixed points for COOL-FIT are established with the special COOL-FIT fixed points. The product consists of fusion tapes and pipe brackets. Electrofusion bands as permanent joints transmit the forces that occur in the pipe to the fixed point. The supplied pipe brackets serve to build up the fusion pressure during installation of the fusion bands and provide stability during operation. For fusion, use an MSA 2.x, MSA 4.x, MSA 250, 300, 350, 400 or commercially available 220-V electrofusion unit. If you use an MSA electrofusion unit by Georg Fischer Piping Systems, use the y-cable kit with code 790.156.032.



Please take note of the maximum allowed forces in the table below.

| **Diameter** (mm) | d32/ D90 | d40/ D110 | d50/ D110 | d63/ D125 | d75/ D140 | d90/ D160 | d110/ D180 | d140/ D225 | d160/ D250 | d225/ D315 | d250/ D355 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum force F (kN)** | 2.0 | 3.0 | 5.0 | 8.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |

⚠ COOL-FIT 4.0 / 4.0F fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.

⚠ The COOL-FIT Fixed points must not be used on non-insulated PE pressure pipes (e.g. SDR11 + SDR17).

**Scope of delivery**



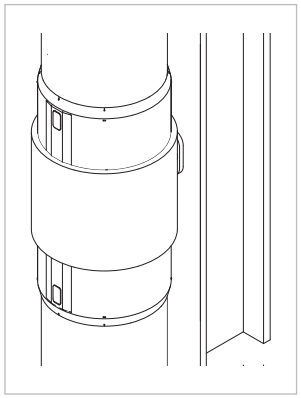

**1** Clamps to maintain fusion pressure
**2** Electrofusion band

**Y-cable kit for COOL-FIT fixed points**

The COOL-FIT Y-cables can be used for a faster installation of COOL-FIT fix points. Since electrofusion tapes always come in pairs, Y-cables allow for a simultaneous fusion process, cutting fusion time in half.

**COOL-FIT 4.0 fixed point for higher forces**

For applications with higher forces, such as long risers, fixed points must be planned specifically for the application. Attachment to the beam is via a weld-on plate on the metal pipe clamp. The clamp is positioned between two COOL-FIT electrofusion fittings and is subsequently insulated. Please take note of the maximum allowed forces in the table below.



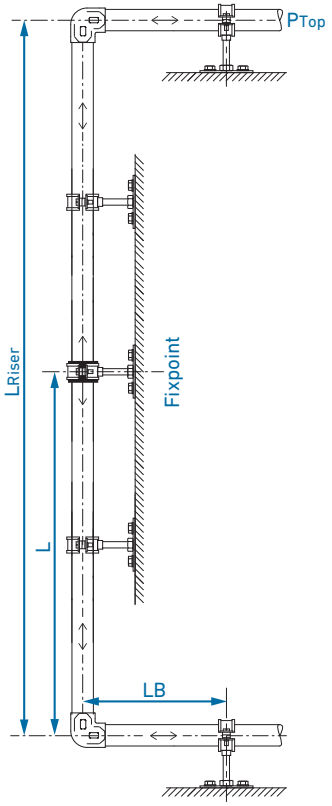
| **Diameter** (mm) | d140/D225 | d160/D250 | d225/D315 | d250/D355 | d280/D400 | d315/D450 | d355/D500 | d400/D560 | d450/D630 |
|---|---|---|---|---|---|---|---|---|---|
| **Maximum force F (kN)** | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |

⚠ COOL-FIT fixed points for higher forces must be calculated according to the application. The pipeline, support, weld seam type and other influencing factors must be taken into account in the force analysis. Please contact GF Advanced Engineering.

**Example of maximal achievable riser length:**

| | |
|---|---|
| Installation temperature | -5 to +40°C |
| Ambient temperature | -5 to +45°C |
| Flow temperature | -33 to +47°C |
| Fixpoint position | Middle of the riser pipe |
| Pressure on top level | 3 bar ($P_{Top}$) |
| Support distance vertical | Equal to horizontal |
| Pipe class | d32 - d450 SDR11 |

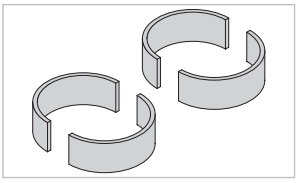
| | Pipe support distance reduced for long riser | | Fixpoint at jacket pipe | | Fixpoint at media pipe | |
|---|---|---|---|---|---|---|
| | Horizontal [m] | Vertical [m] | Max. riser length (LRiser) [m] | Fixpoint force [kN] | Max. riser length (LRiser) [m] | Fixpoint force [kN] |
| d32/90 | 1.8 | 1.8 | 43 | 0.9 | | |
| d40/110 | 2.0 | 2.0 | 54 | 1.7 | | |
| d50/110 | 2.0 | 2.0 | 44 | 1.7 | | |
| d63/125 | 2.0 | 2.0 | 49 | 2.7 | | |
| d75/140 | 2.1 | 2.1 | 52 | 3.8 | | |
| d90/160 | 2.2 | 2.2 | 54 | 5.4 | | |
| d110/180 | 2.3 | 2.3 | 54 | 7.5 | | |
| d140/225 | 2.5 | 2.5 | 45 | 10 | 55 | 12 |
| d160/250 | 2.6 | 2.6 | 35 | 10 | 55 | 16 |
| d225/315 | 2.9 | 2.9 | 17 | 10 | 54 | 29 |
| d250/355 | 3.3 | 3.3 | 14 | 10 | 54 | 35 |
| d280/400 | 3.5 | 3.5 | | | 41 | 35 |
| d315/450 | 3.7 | 3.7 | | | 32 | 35 |
| d355/500 | 3.9 | 3.9 | | | 24 | 35 |
| d400/560 | 4.1 | 4.1 | | | 18 | 35 |
| d450/630 | 4.3 | 4.3 | | | 14 | 35 |




⚠ Following sections are recommended to be proofed by GF Advanced Engineering before installation: Riser pipe dimension >d160; Riser pipe with multiple dimensions; Installation differ from normal installation with fixpoint in the middle

**COOL-FIT 4.0F Fixed points**

Four half shells which are cemented on both sides to the fixed point pipe clamp.



| Diameter (mm) | d32/ D90 | d40/ D110 | d50/ D110 | d63/ D125 | d75/ D140 | d90/ D160 | d110/ D180 | d140/ D225 | d160/ D250 | d225/ D315 |
|---|---|---|---|---|---|---|---|---|---|---|
| Maximum force F (kN) | 3.0 | 5.0 | 8.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |

⚠ COOL-FIT 4.0 fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.

## Rigidly fixed installations

⚠ Pipe which are axially clamped and rigidly fixed must be tested for their resistance to kinking. In most cases, this test results in a reduction of the maximum internal pressure and more tightly spaced supports. The forces acting on the fixed points should be considered.

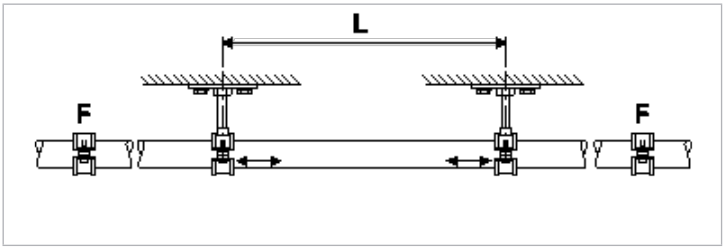
COOL-FIT 4.0 pipe and fittings are suitable for a rigidly fixed installation

Values for forces acting on fixed points as well as the resulting pipe bracket spacing are listed in following tables.

**Example of use:**

| | |
|---|---|
| Installation temperature | 25 °C |
| Min. ambient temperature | 25 °C constant |
| Max. ambient temperature | 25 °C constant |
| Min. flow temperature | See table |
| Max. flow temperature | 25 °C |

Pipe class d32 - d140 SDR11 and d160 - d450 SDR17




| Fixpoint forces F and maximal pipe bracket spacing L at 15 °C flow temperature | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 0.4 | 0.6 | 0.9 | 1.4 | 2.0 | 2.8 | 4.1 | 6.7 | 6.0 | 11.6* | 14.3* | 18.0* | 22.8* | 29.0* | 36.6* | 46.4* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |
| Fixpoint forces F and maximal pipe bracket spacing L at 10 °C flow temperature | | | | | | | | | | | | | | | | |
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 0.6 | 1.0 | 1.4 | 2.2 | 3.0 | 4.4 | 6.4* | 10.4 | 9.3* | 18.1* | 22.3* | 28.1* | 36.6* | 45.1* | 57.1* | 72.5* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |
| Fixpoint forces F and maximal pipe bracket spacing L at 5 °C flow temperature | | | | | | | | | | | | | | | | |
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 0.9 | 1.4 | 2.0 | 3.1 | 4.2 | 6.1 | 8.9* | 14.4 | 12.9* | 25.1* | 30.9* | 38.9* | 49.3* | 62.5* | 79.0* | 100.2* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |
| Fixpoint forces F and maximal pipe bracket spacing L at 0 °C flow temperature | | | | | | | | | | | | | | | | |
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 1.1 | 1.8 | 2.5 | 3.9 | 5.5 | 7.8 | 11.5* | 18.6 | 16.7* | 32.4* | 40.0* | 50.3* | 63.7* | 80.8* | 102.2* | 130.0* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |
| Fixpoint forces F and maximal pipe bracket spacing L at -5 °C flow temperature | | | | | | | | | | | | | | | | |
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 1.4 | 2.2 | 3.1 | 4.9 | 6.8 | 9.7* | 14.3* | 23.0 | 20.7* | 40.2* | 49.5* | 62.2* | 79.0* | 100.0* | 126.6* | 160.6* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |
| Fixpoint forces F and maximal pipe bracket spacing L at -10 °C flow temperature | | | | | | | | | | | | | | | | |
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 1.6 | 2.6 | 3.8 | 5.9 | 8.1 | 11.6* | 17.2* | 27.7 | 24.8* | 48.3* | 59.3* | 74.8* | 94.9* | 120.3* | 152.1* | 193.0* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |

| Fixpoint forces F and maximal pipe bracket spacing L at -15 °C flow temperature | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 | 250/355 | 280/400 | 315/450 | 355/500 | 400/560 | 450/630 |
| F (kN) | 1.9 | 3.0 | 4.4 | 6.9 | 9.5 | 13.7* | 20.2* | 32.5 | 29.2* | 56.8* | 70.0* | 87.9 | 111.5* | 141.4* | 178.8* | 226.8* |
| L (mm) | 1'800 | 1'950 | 1'900 | 2'000 | 2'100 | 2'150 | 2'200 | 2'450 | 2'600 | 2'850 | 3'300 | 3'500 | 3'700 | 3'900 | 4'100 | 4'300 |

* max allowed force for COOL-FIT fixed point exceeded

### COOL-FIT 4.0F

| Fixpoint forces F and maximal pipe bracket spacing L at 15 °C flow temperature | | |
|---|---|---|
| d/D (mm) | d160/250 | d225/315 |
| F (kN) | 6.01 | 11.65* |
| L (mm) | 3'400 | 3'700 |

| Fixpoint forces F and maximal pipe bracket spacing L at 10 °C flow temperature | | |
|---|---|---|
| d/D (mm) | d160/250 | d225/315 |
| F (kN) | 9.37 | 18.18* |
| L (mm) | 3'400 | 3'700 |

| Fixpoint forces F and maximal pipe bracket spacing L at 5°C flow temperature | | |
|---|---|---|
| d/D (mm) | d160/250 | d225/315 |
| F (kN) | 12.95* | 25.14* |
| L (mm) | 3'400 | 3'700 |

* max allowed force for COOL-FIT fixed point exceeded

⚠ Please contact GF Industry & Infrastructure Flow Solutions for rigidly fixed installations that contain ball valves and mechanical joints as well as if the max. allowed force on the fixed points are exceeded

## 1.4.13 Bending of COOL-FIT 4.0 Push System pipes

**Manual bending**

COOL-FIT 4.0 Push System pipes can be bent by hand without the use of bending tools. Ensure the pipes do not kink when bending them.

**Hydraulic cylinders or bending springs**

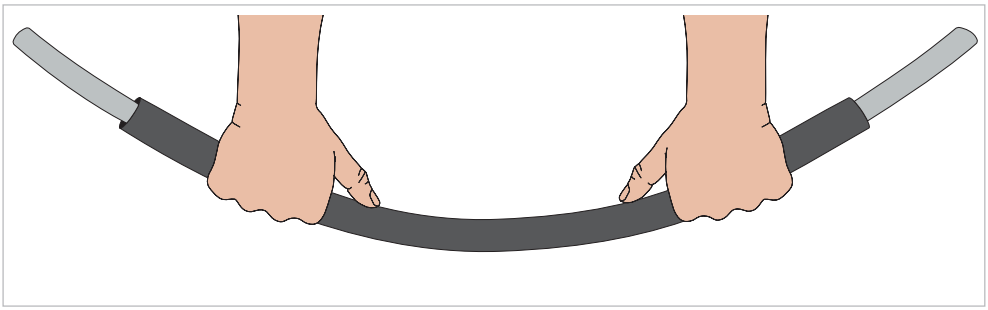
Commercially available hydraulic cylinders can be used, considering the following aspects:

☑ The shape of the bending gauge must correspond with the outside diameter of the media pipe.

☑ Do not use internal bending springs.

☑ Ensure the bending radius is not less then 3.5 · d.

COOL-FIT 4.0 Push System pipes can be easily shaped into the desired angle with the outside pipe bending tool.
Consider the removal of the insulation before bending with hydrailic cylinders or bending springs.



**Bending the COOL-FIT 4.0 Push System multilayer composite pipe**

| Bending radius R | COOL-FIT 4.0 Push System | |
|---|---|---|
| d [mm] | 25 | 32 |
| Bending radius R, with bending spring: 5 · d [mm] | 200 | - |
| Bending radius R, with tool: 3.5 · d [mm] | 98 | 112 |

**Minimum bending radius of the COOL-FIT 4.0 Push System pipe**

⚠ NOTE! Risk of damaging the pipes due to improper bending!
→ Ensure the pipes do not kink when bending them.
→ Do not use internal bending springs.

## 1.4.14 Hoses

**Installation of elastomer hoses**

To ensure the usability of hose lines and to avoid shortening their service life through additional stresses, please note the following:

- Hose lines must be installed so that their natural position and movement is not hindered.
- During operation, hose loines must in principle not be subjected to external forces such as tension, torsion and compression, unless they have been specially made for the purpose.
- The minimum radius of curvature specified by the manufacturer must be observed.
- Buckling is to be avoided, particularly by the joint.
- Before putting the system into operation, check that the mechanical connections are properly tightened.
- If there is visible external damage, the hose line must not be put into operation.
- The connection fittings should be firmly screwed together.

**Proper use of the hose line**

- Pressure: do not exceed maximum permitted working pressure and operating vacuum
- Temperature: do not exceed maximum permitted temperature for the medium

**Storage**

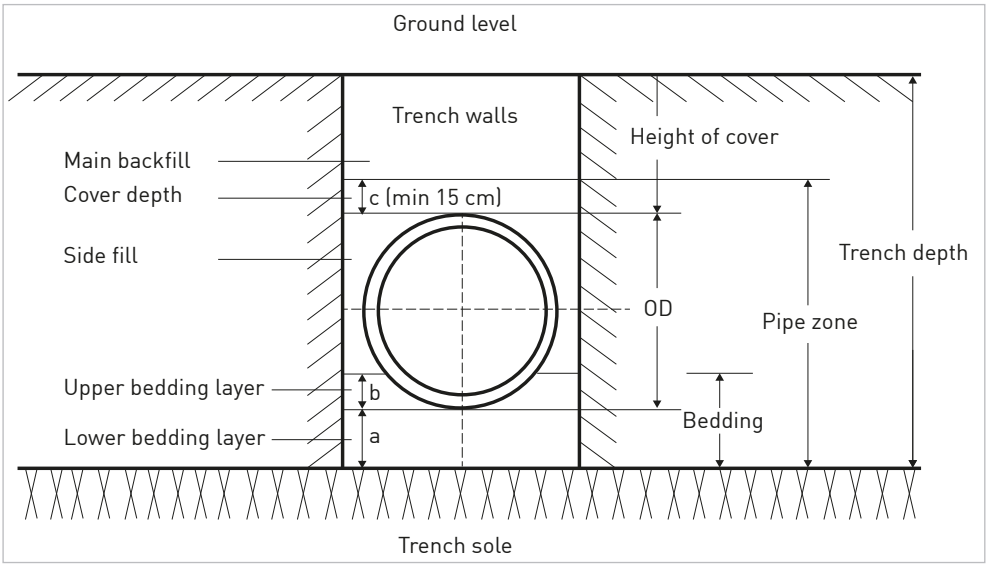
- Store in a cool, dry and dust-free area; avoid direct sunlight or ultraviolet irradiation; protect from nearby heat sources. Piping must not come into contact with substances that can cause damage.
- Hoses and hose assemblies must be stored horizontally, free of tension or bending forces.

**Maintenance**

We recommend a regular visual inspection of the hose line in case of high temperature fluctuations.

## 1.4.15 Underground installation

COOL-FIT 4.0 can be used underground. The corresponding national installation guidelines apply to building the pipe trenches and installing the pipe. In general, trenches should not be less than 1 meter deep, deeper if there is a risk of frost. The sand bed must be built in such a way that the pipe is evenly supported. The pipe must be laid in a sand bed and protected against sharp stones and debris. The sand must be well compacted.




The pipe zone has to be designed according to planning requirements and static calculations. The area between trench sole and side fill is referred to as bedding. A load-carrying bedding must be created by using soil replacement. For regular soil conditions, EN 1610 specifies a minimum thickness of a = 150 mm for the lower bedding. In addition to the minimum thickness, corresponding requirements are also imposed on the building materials that must be used for the bedding.

No building materials with components exceeding the following ranges may be used:

- 22 mm for DN ≤ 200

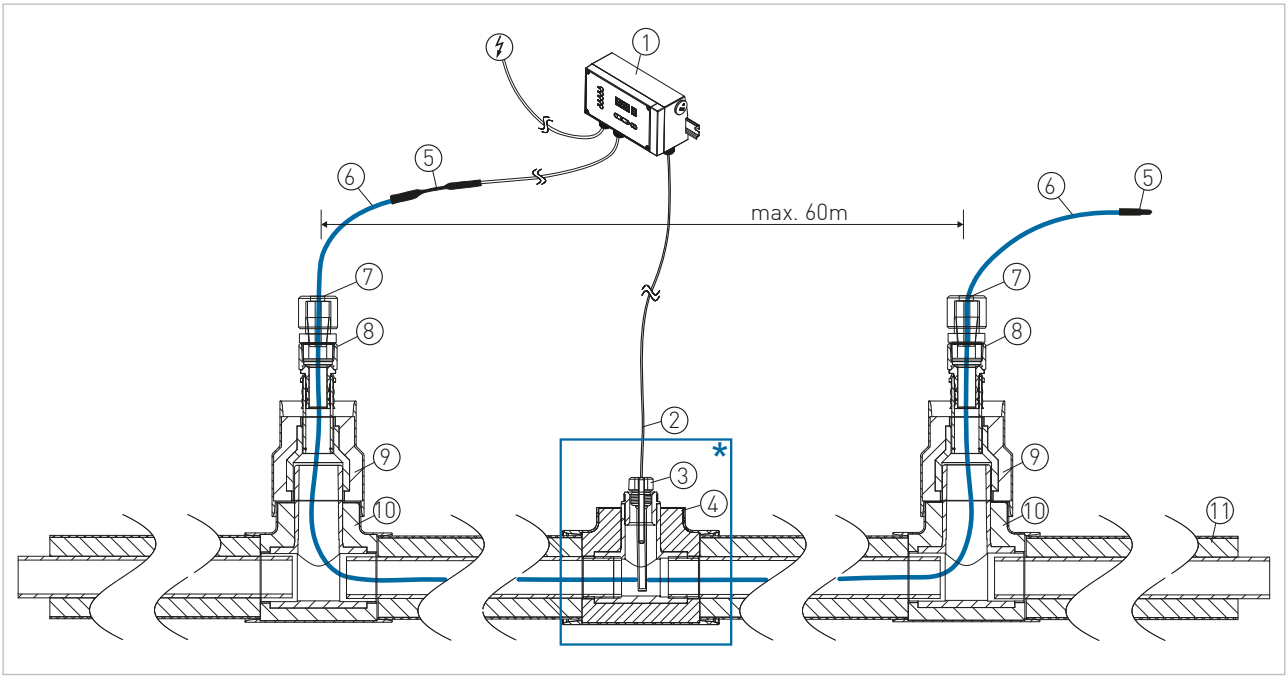
The upper bedding layer b is derived from static calculations. It is also important to ensure that no cavities are created below the pipe. The bedding dissipates all loads from the pipe securely and evenly into the ground. For this reason, the COOL-FIT 4.0 pipe has to rest solidly on the bedding across its entire length. The upper end of the pipe zone is defined according to EN 1610 as 150 mm above the pipe apex or 100 mm above the pipe connection. Ensure that the pipe is not damaged when the cover and main backfill are filled and compacted.

COOL-FIT 4.0 pipe have a higher degree of stiffness and a higher weight than non-insulated pipe. For this reason, the pipe should always be connected in the trench. Unnecessary stress on the COOL-FIT 4.0 jointing elements is thus avoided. Under normal circumstances, it is not necessary to install expansion loops in the system.

⚠ A movement of the pipe before filling the pipe trench should be avoided. Please contact Georg Fischer Piping Systems concerning recommendations for underground installations.

⚠ Installation in water is not permitted; any water that occurs must be able to drain off.

# 1.4.16 COOL-FIT 4.0 Heat Tracing Installation




| No. | Designation | No. | Designation |
|---|---|---|---|
| 1 | Thermostat | 7 | Cable glands ¾“ male thread R |
| 2 | Temperature sensor | 8 | Adaptor fitting d32-¾“ female thread Rp |
| 3 | Immersion sleeve for sensor* | 9 | COOL-FIT 4.0 Reducer to d32 |
| 4 | COOL-FIT 4.0 Installation fitting ½“ Rp* | 10 | COOL-FIT 4.0 T90° |
| 5 | Cold lead connection and end seal kit | 11 | COOL-FIT 4.0 pipe |
| 6 | Heating cable | | |

## Components installation

**General notes:**

Installation instructions included in the kit must be followed, including those for preparation of the heating cable conductors for connections. Before assembly, use the guide given in the instructions to ensure that the kit is correct for the heating cable and environment.

► Self-regulating and power-limiting heating cables are parallel circuit design. Do not twist the conductors together as this will result in a short circuit.

**Components required**

For the installation of all components refer to the relevant component installation instructions.
Required for each heating cable run:

- Cold lead connection and end seal kit
- Cable entry and exit
- Fittings for inlet and outlet

Required for the installation of the temperature sensor of each thermostat (for control via the media temperature):

- COOL-FIT 4.0 Installation fitting ½“ Rp
- Immersion sleeve for PT sensor

**Procedure**

- ► Insert the heat tracing cable into the inner pipe during installation of the piping components and out again at the end of the heating circuit. If there are more than 2 changes in the direction of the pipe equipped with the heating tape, the use of a suitable lubricant is recommended for simpler installation.
- ► Note that the heating cable must not be routed through the inside of valves. If using COOL-FIT valves, the cable must be routed outwards on both sides of the valve end.

**Thermostats and control systems**

- ► Follow the installation instructions supplied with the thermostat or control. Use the proper wiring diagram for for the heating cable layout and control method desired.
- ► After switching on the heating cable, the cable ends must be warm after 5 to 10 minutes.

* For the freezer protection on pipe sections, for each pipe dimension a separate heating circle with temperature sensor is recommended.

## 1.4.17 COOLING Tool-Box

The Georg Fischer Piping Systems COOLING Tool-Box is used to help in the dimensioning and design of cooling systems.

The COOLING Tool-Box handles:

- Expansion, contraction
- Flexible section design
- Energy savings
- Pipe exterior temperature
- Pipe dimensioning
- Pressure loss
- Dew point/ insulation thickness
- Pipe bracket spacing
- Freezing time
- Weight comparison
- $CO_2$ footprint




Data for the most commonly used secondary refrigerants are already stored in the calculation tool. It calculates all system components such as pipe, fittings and valves. The menu is available in several different languages. It allows system design to be efficient and optimized. With the function "comparison" a COOL-FIT system can be compared to a black steel, stainless steel or copper system.

**COOLING Tool-Box: Get in contact with your GF Industry & Infrastructure Flow Solutions representative or visit www.g com**

# 1.5 Jointing and Installation

## 1.5.1 Jointing of COOL-FIT 4.0

For general information on electrofusion, see Planning Fundamentals chapter "Jointing technology", section "Electrofusion joints".

### General advice

The quality of a weld is largely determined by careful preparation. The welding surface must be protected from adverse weather conditions such as rain, snow or wind. The permissible temperature range for fusion is -10 °C to 45 °C. National regulations must be observed. In direct sunlight, shielding of the welding area can help to create an even temperature profile around the whole circumference of the pipe. It is particularly important to ensure that the climate conditions are the same for both the electrofusion machine and the welding area.

### Executing electrofusion

**Protect the welding area**

The surfaces to be welded on the pipe and the fitting must be carefully protected from dirt, grease, oils and lubricants. Only Tangit PE cleaner must be used for cleaning.

No fats (i.e. hand cream, oily rags, silicone, etc.) must be introduced into the fusion zone!

### Jointing d32 – d225 (plus coupler d250)

1 Without touching the surface, remove product immediately before the installation from packaging

Prepare pipe with stripping and peeling tool for electrofusion welding connection (stripping, peeling and sheath cutting) and check pipe spigot with circumferential measuring tape for compliance with minimum permissible pipe outer diameter.

**Minimum permitted pipe external diameter after peeling for COOL-FIT 4.0**

| | d nominal diameter (mm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tempera-ture (°C) | 32 | 40 | 50 | 63 | 75 | 90 | 110 | 140 | 160 | 225 | 250 |
| | dmin after peeling (mm)* | | | | | | | | | | |
| 40 | 31.4 | 39.4 | 49.4 | 62.5 | 74.5 | 89.6 | 109.6 | 139.7 | 159.8 | 225.0 | 250.0 |
| 30 | 31.3 | 39.4 | 49.4 | 62.4 | 74.4 | 89.4 | 109.5 | 139.5 | 159.5 | 224.6 | 249.7 |
| 20 | 31.3 | 39.3 | 49.3 | 62.3 | 74.3 | 89.3 | 109.3 | 139.3 | 159.3 | 224.3 | 249.3 |
| 10 | 31.3 | 39.2 | 49.2 | 62.2 | 74.2 | 89.2 | 109.1 | 139.1 | 159.1 | 224.0 | 248.9 |
| 0 | 31.2 | 39.2 | 49.2 | 62.1 | 74.1 | 89.0 | 109.0 | 138.9 | 158.8 | 223.6 | 248.6 |
| -10 | 31.2 | 39.1 | 49.1 | 62.0 | 74.0 | 88.9 | 108.8 | 138.7 | 158.6 | 223.3 | 248.2 |

* Minimum diameters do not comply with the pipe tolerance specifications for GF electrofusion fittings. COOL-FIT minimum diameters are verified by release tests.

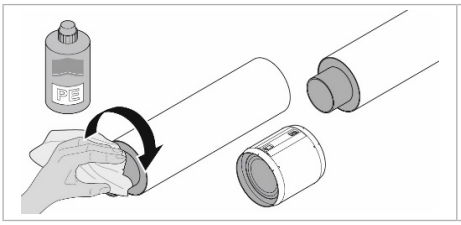
If the pipe outside diameter falls below the min. permissible value, cut off the spigot and check the blade quality by measuring the chip thickness with a caliper gauge: the reference dimension over the entire length is between 0.2 - 0.4 mm. Replace blade in case of deviation.

COOL-FIT 4.0 already factory-set free pipe ends (5 m lengths), COOL-FIT 4.0 Valves and COOL-FIT 4.0 Fittings d32 – d225 (Type B, barrel nipple and transition fittings) need not to be peeled.

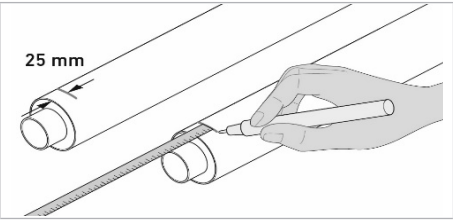
Pipe dimensions d160 to 225 in lengths 11.9 m are stripped, however need to be peeled upfront jointing.

Factory-set free pipe ends at pipe and fittings type B for dimension d250 have to be peeled for jointing before.

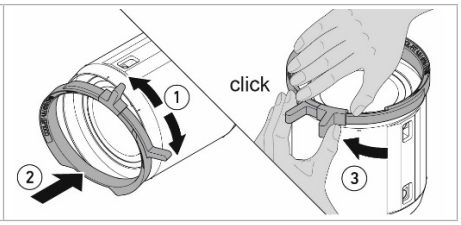
## 2 Cleaning and installation for welding preparation



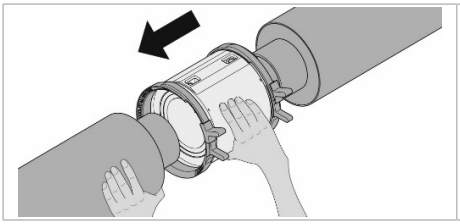

**Step 1**
Clean the fusion area of the components with Henkel Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.



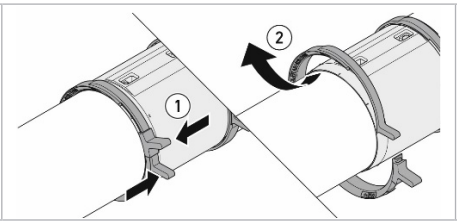

**Step 2**
Mark the jacket pipe at a distance of 25 mm



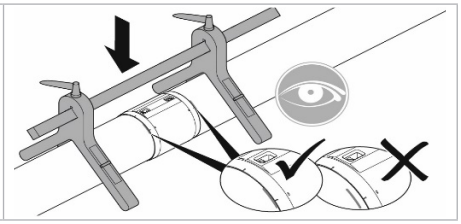

**Step 3**
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting



**Step 4**
Insert pipe in pipe brackets and align free of stress. Push fitting up to the limit stop on the pipe.

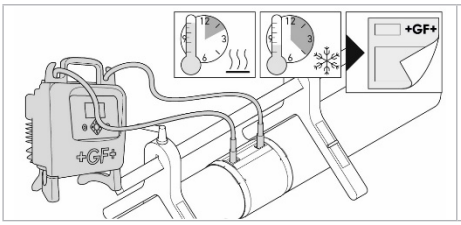



**Step 5**
Remove the assembly aids

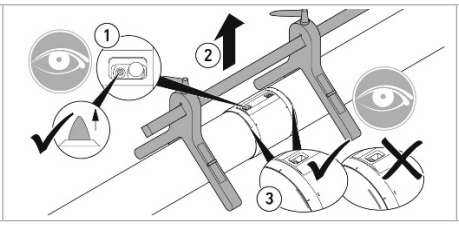


**Step 6**
Take care for low stress installation and secure the pipe and fitting against dislocation. Check insertions depths of both pipe into the fitting

## 3 Fusion process

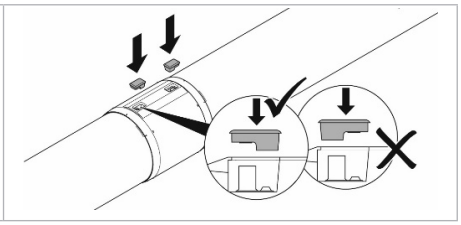



**Step 1**
Fuse in accordance to the operating instructions of the fusion unit. Use long fusion adaptors (790128035). Pay attention to fusion and cooling time.

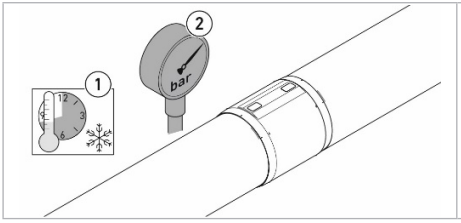



**Step 2**
After fusion, check fusion indicators on the electrofusion fitting and note the messages on the display of the electrofusion machine.
Mark the fitting with following information
- Date
- Welder/ Weld number
- Time at the end of cooling time

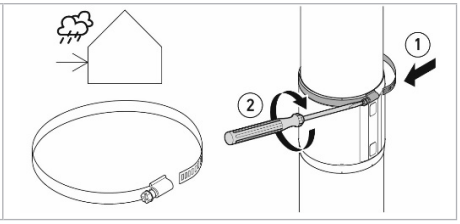
Remove the clamping tool after cooling time



**Step 3**
Fit the insulation of the weld pins onto the fusion contacts




**Step 4**
After cooling perform pressure tests as per table.




**Step 5 (optional)**
For vertical installations outside, mount sealing clamps tightly at the top lip of the fitting.
Alternatively to sealing clamps, sealing tapes, 25 mm width can be mounted underneath the top lip of the fittings.

## Jointing d250 – d450

**Hint: Factory-set free pipe ends at pipe and fittings type B have to be peeled for jointing before.**

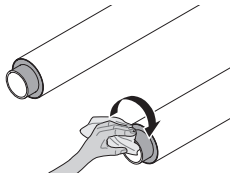
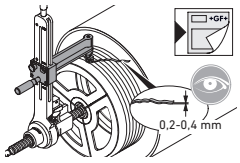
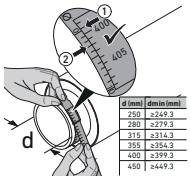
### 1 Preparation

Prepare pipe with stripping and peeling tool for electrofusion welding connection (stripping, peeling and sheath cutting) and check pipe spigot with circumferential measuring tape for compliance with minimum permissible pipe outer diameter.

**Minimum permitted pipe external diameter after peeling for COOL-FIT 4.0**

| Temperature (°C) | d nominal diameter (mm) | | | | | |
|---|---|---|---|---|---|---|
| | 250 | 280 | 315 | 355 | 400 | 450 |
| | dmin after peeling (mm)* | | | | | |
| 40 | 250.0 | 280.1 | 315.2 | 355.4 | 400.5 | 450.6 |
| 30 | 249.7 | 279.7 | 314.8 | 354.8 | 399.9 | 450.0 |
| 20 | 249.3 | 279.3 | 314.3 | 354.3 | 399.3 | 449.3 |
| 10 | 248.9 | 278.9 | 313.8 | 353.8 | 398.7 | 448.6 |
| 0 | 248.6 | 278.5 | 313.4 | 353.2 | 398.1 | 448.0 |
| -10 | 248.2 | 278.0 | 312.9 | 352.7 | 397.5 | 447.3 |

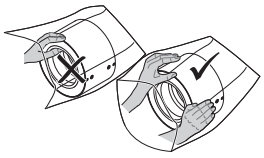
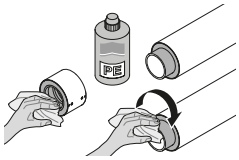
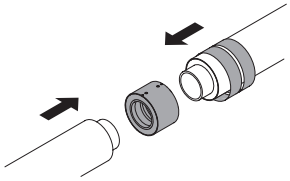
* Minimum diameters do not comply with the pipe tolerance specifications for GF electrofusion fittings. COOL-FIT minimum diameters are verified by release tests.

| Step 1 | Step 2 | Step 3 |
|---|---|---|
|  |  |  |
| Perform a preliminary cleaning of the media pipe, deburr at a right angle using the pipe cutter, if necessary. | Peel the media pipe as well as the fittings type B with the peeler, if not already done with foam removal. Observe min. peel removal of 0.2 to 0.4mm. | Check minimum permissible pipe outside diameter after peeling with a circumferential measuring tape. |

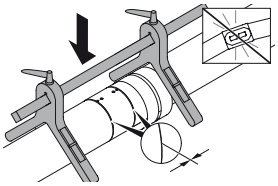
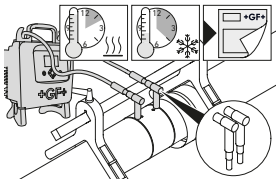
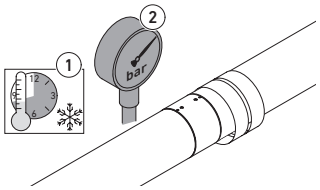
## Overview of pipe outer diameter and open spigot length

| Dimension (mm) | Factory-set spigot length (mm) |
|---|---|
| d250 | 120-126 |
| d280 | 123-129 |
| d315 | 129-137 |
| d355 | 144-152 |
| d400 | 145-155 |
| d450 | 160-170 |

## 2 Cleaning and installation

| Step 1 | Step 2 | Step 3 |
|---|---|---|
|  |  |  |
| Unpack the coupler. Pay attention that you don't touch the inner surface of the coupler. | Clean fusion area of the electrofusion coupler, the pipe and as well of the fittings type B with Tangit PE cleaner and lint-free cloth and allow to air out. | Slide on the shrink sockets and afterwards the electrofusion coupler up to the insulation without touching the fusion area. |

## 3 Fusion process

| Step 1 | Step 2 | Step 3 |
|---|---|---|
|  |  |  |
| Take care for low stress installation and secure the pipe and fitting against dislocation. There must be no gap between coupler and pipes. | Fuse in accordance to the operating instructions of the fusion unit. Use long fusion adaptors (790128035). Pay attention to fusion and cooling time. | After cooling perform pressure tests as per table. |

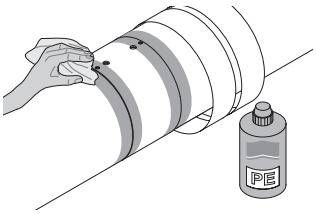
**Cooling times before removing clamping tool and pressure/leak testing**

| d (mm) | Cooling time before Remove clamping tool (min.) | Cooling time before internal pressure test at ≤ 6 bar (min.) | Cooling time before internal pressure test at ≤ 18 bar (hours) | Cooling time before internal pressure test at ≤ 11 bar (hours) |
|---|---|---|---|---|
| 32 | 10 | 15 | 3 | |
| 40 | 10 | 20 | 5 | |
| 50 | 10 | 20 | 5 | |
| 63 | 10 | 20 | 5 | |
| 75 | 15 | 25 | 6 | |
| 90 | 20 | 35 | 8 | |
| 110 | 30 | 50 | 8 | |
| 140 | 45 | 90 | 12 | |
| 160 | 45 | 90 | 12 | 8 |
| 225 | 45 | 90 | 12 | 9.5 |
| 250 | 30 | 90 | 12 | 9.5 |
| 280 | 30 | 90 | 12 | 9.5 |
| 315 | 30 | 90 | 12 | 9.5 |
| 355 | 60 | 100 | 12 | 9.5 |
| 400 | 75 | 110 | 12 | 9.5 |
| 450 | 75 | 125 | 12 | 9.5 |

The values are valid for pressure tests using a liquid at ≤ 20 ° C. For testing with gas a cooling time of 12 hours is recommended.

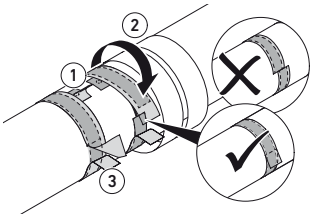
## 4 Sealing

### Step 1



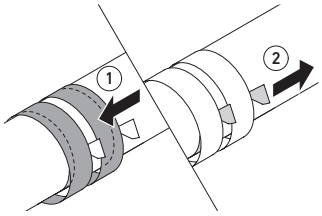

Clean the pipe/fitting type B and partially the coupler over the gap with Tangit PE cleaner.

### Step 2



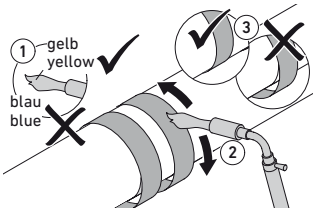

Affix the sealing tape centered over the gap and overlap it at the end. Press it on well and smooth out folds.

### Step 3



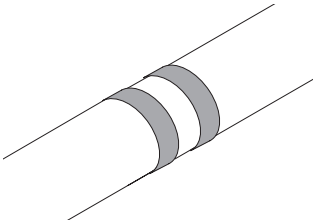

Position the shrink socket centered over the sealing tape, than remove the white separating tape.

### Step 4




The yellow flame of the gas burner or hot-air stream must strike the shrink socket as vertically as possible. Avoid applying unnecessary heat to the fitting.

### Step 5

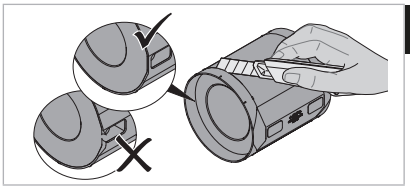


The jointing is now finished.

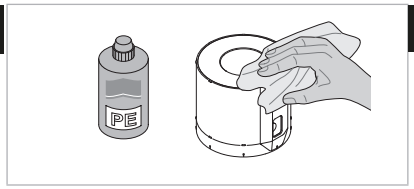
## Valves and flange joints

**1** Preparation of fitting – remove sealing lip on one side, clean the sealing surfaces

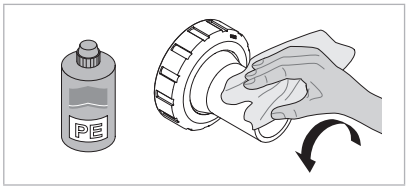
1



2




3

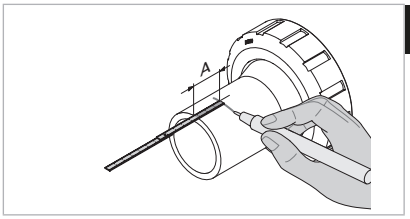



For the jointing to a valve or flange adaptor, the sealing lip of the fitting has to be removed at the valve or flange adaptor side and sealing and fusion surfaces have to be cleaned.

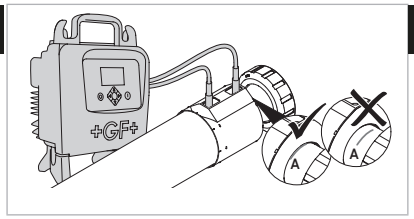
**2** Standard fusion

Fuse both valve ends without valve mounted.

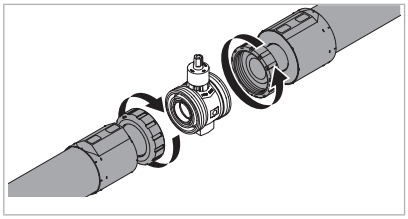
4




5



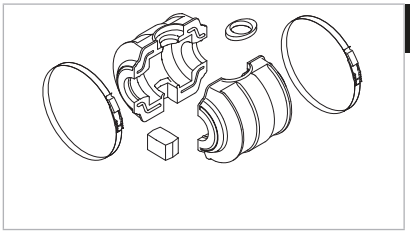

6



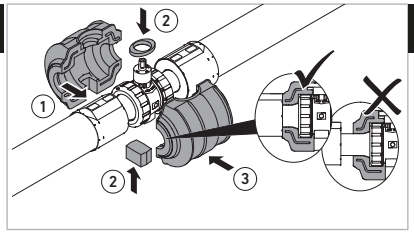
Following insertion depths A are valid for COOL-FIT 4.0 components:

| d/D (mm) | 32/90 | 40/110 | 50/110 | 63/125 | 75/140 | 90/160 | 110/180 | 140/225 | 160/250 | 225/315 |
|---|---|---|---|---|---|---|---|---|---|---|
| L1 (mm) | 36 | 40 | 44 | 48 | 55 | 62 | 72 | 84 | 90 | 110 |

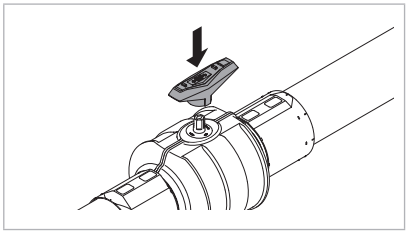
**3** **Mounting the valve/flange insulation**



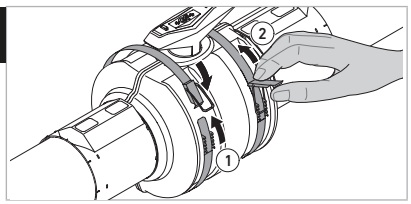
7




8



9




Further information can be found in the assembly instructions "COOL-FIT 2.0 / COOL-FIT 4.0 insulation for Ball Valve and Butterfly Valve".

It's recommended to re-tighten the bolts of COOL-FIT 4.0 butterfly valves and flange joints at operating temperature.

## Compact connection fitting-to-fitting

When there is enough space, Fitting-to-Pipe-to-Fitting connections can be realized using a short COOL-FIT 4.0 pipe. The foam removal tool enables the foam removal of pipe lengths of ~110 mm for the dimensions d32-d90, or respectively ~170 mm for the dimensions d110-d225.

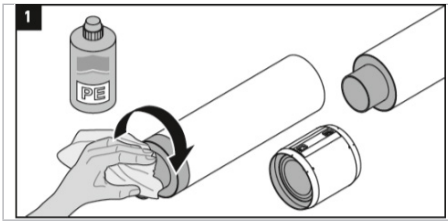
For compact fitting-to-fitting joints, COOL-FIT 4.0 barrel nipple can be used.

**Shorter connections Fitting-to-Pipe-to-Fitting as of sizes d75mm can be realized using an un-insulated PE100 SDR11 pipe in combination with a piece of insulation that results of an foam removal process of the foam removal tool. After the peeling of the oxid layer of the un-insulated PE pipe, the insulation ring is pulled over the pipe and the pipe is welded with the fitting.**

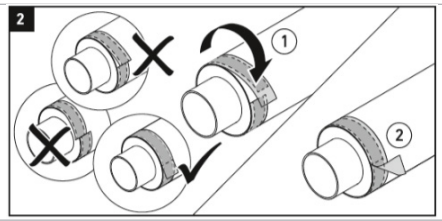
| d | d75 | d90 | d110 | d140 | d160 | d225 |
|---|---|---|---|---|---|---|
| L (mm) | 165 | 186 | 216 | 252 | 270 | 330 |

L: Length of un-insulated PE100 SDR11 pipe needed

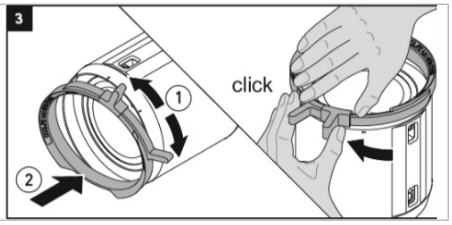
## Mounting of sealing tape and transition of insulation



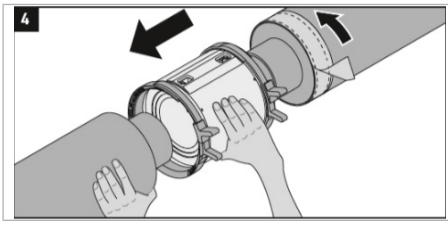

**Step 1**
In addition to the fusion zone, also clean the jacket of the pipe



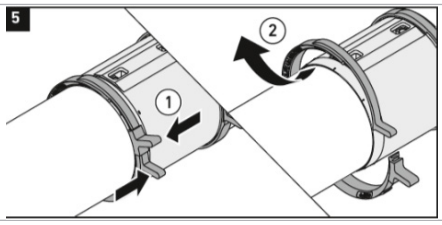

**Step 2**
Mount sealing tape/ transition of insulation, end to end without offset and fold down liner



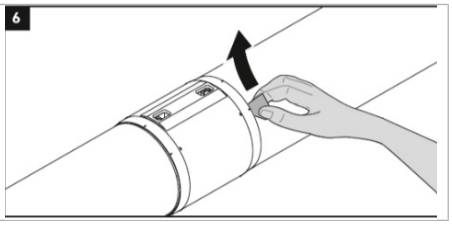

**Step 3**
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting




**Step 4**
On pushing together, slightly turn either fitting or pipe assembled with sealing tape/ transition of insulation



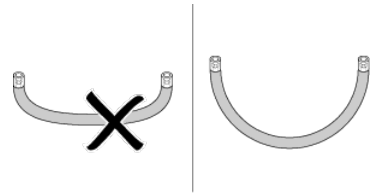
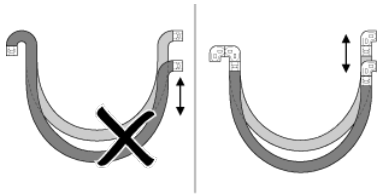
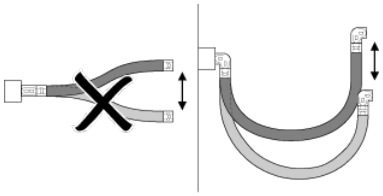
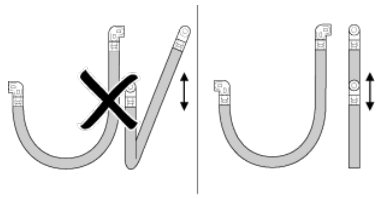
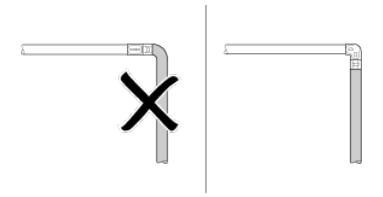
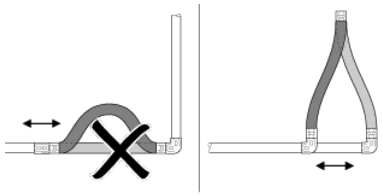
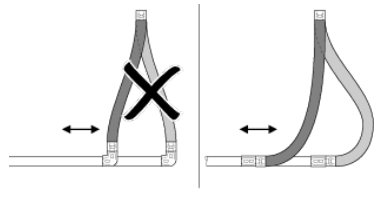
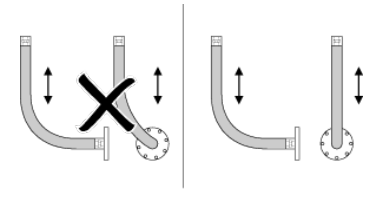

**Step 5**
Remove the assembly aids

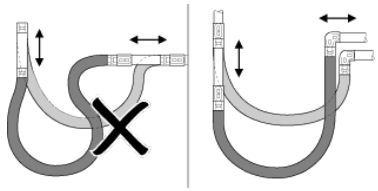



**Step 6**
Pull off the liner after removal of assembly aids

## COOL-FIT Hoses

In order to ensure the functionality of flexible hose joints following installation and handling instructions have to be considered.

| Installation and handling instructions (false/correct) | Description |
|---|---|
|  | Ensure hose is long enough to observe the minimum radius of curvature. |
|  | Avoid excessive bending of hoses, use elbows. |
|  | Avoid fluctuating bending stress and excessive curvature behind the fitting, use elbows. |
|  | Where there is significant axial expansion, the direction of movement and hose axis must lie in the same plane in order to avoid torsion. |
|  | Avoid excessive bending stress by using elbows. |
|  | If the hose absorbs expansion, it must be installed transversally to the direction of expansion. |
|  | For large lateral movements, a 90° angle should be allowed. |
|  | Expansion take-up must be in the plane of the pipe; torsion should be avoided. |

| Installation and handling instructions (false/correct) | Description |
|---|---|
|  | For major axial expansion, the pipe must be installed in a U-shape to avoid kinking. |

## Transition Fittings

The Georg Fischer Piping Systems range of fittings provides a variety of transitions and threaded fittings to connect plastic piping components to pipe, fittings or valves in metal (or vice versa). The metal threads Rp, R or NPT can be sealed with hemp or PTFE tape as long as the counterpart is not made of plastic. Male and female G threads must be sealed with flat gaskets. The advantage of a threaded G connection is radial and torsion-free possibility for installing and uninstalling.

Next to the traditional transition to metal piping, these fittings can also be used to connect a manometers.

⚠ To prevent electrochemical corrosion, stainless steel connecting elements should preferably be used for steel transitions.

**Combining G and R threads**

The connection of an external parallel pipe thread G in accordance with EN ISO 228-1, with an internal parallel pipe thread Rp in accordance with ISO 7-1 is not intended according to standards. A tight connection is possible under favorable conditions, but cannot be established reliably.

## Mounting the insulaton half shells of Transition Fittings

Following the jointing of the COOL-FIT 4.0 Transition Fittings with the COOL-FIT 4.0 Fitting Typ A, and the mechanical jointing of the threaded components, the insulation half shells can be mounted. Assembling of the shells can be done in the same way like for the COOL-FIT 4.0 valves. With the exception of COOL-FIT unions, the sealing lip of the type A fitting must not be cut off on mounting the insulation half shells of transition fittings.

i Further information can be found in the assembly instructions "COOL-FIT 4.0 insulation for transition fittings".

## Connecting the insulations of flexible hoses

The length of the insulation of flexible hoses enabels a direct jointing at the face of the electrofusion fitting.

The radial jointing of the jointing face of the EPDM insulation of flexible hoses to the insulation of transition fittings can be applied either by adhesive cement of by adhesive tape.

**Jointing Instructions for the adhesive cement**

The adhesive should be thoroughly stirred before use. A thin film is applied by means of the brush to both surfaces to be bonded. Doing this, the consumption is ~0.2 – 0.25 kg/m$^2$.

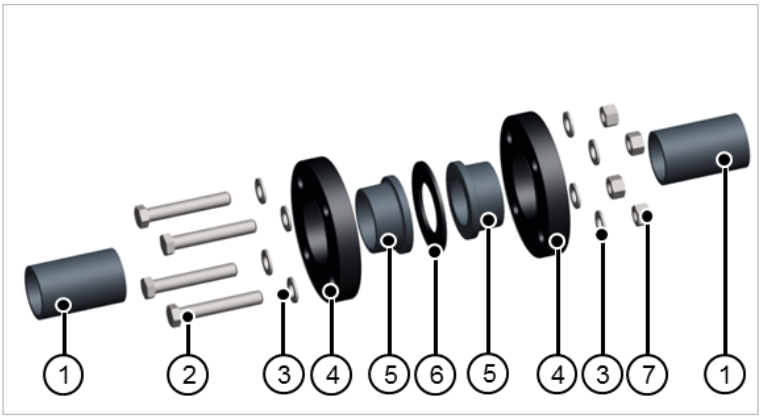
The open joint time is about 3 to 15 minutes depending on temperature and humidity of air.

Before the coated surfaces are brought together the, the adhesive must still be tacky but should not transfer to the skin when finger-tested. The surfaces should be brought together quickly and firmly and should be held together for a few seconds.

The recommended temperature and for storage and processing is in the range between +15 °C and 25 °C.The adhesive should not be used below +10 °C.

## Flange joints

Flanges with sufficient thermal and mechanical stability must be used. The different flange types by Georg Fischer Piping Systems fulfill these requirements. The gasket dimensions must match the outer and inner diameter of the flange adapter or valve end. Differences between the inner diameters of gasket and flange that are higher than 10 mm may result in malfunctioning flange connections.




**Recommended backing flange of COOL-FIT 4.0 flange joints**

1 Pipe
2 Bolt
3 Washer
4 Backing Flange
5 Flange Adapter/Valve end
6 Flange gasket
7 Nut

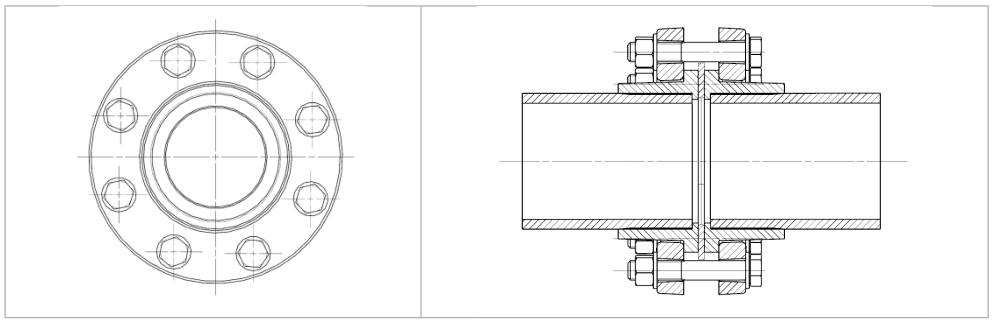
| Flange | Properties |
|---|---|
| **PP-steel flange** | • Very robust and stiff due to the steel inlay<br>• Corrosion-free plastic flange made of polypropylene PP-GF30 (fiber-glass reinforced) with steel inlay<br>• High chemical resistance (hydrolysis-resistant)<br>• UV-stabilized |

### Creating flange joints

When executing flange joints, the following points should be noted:

**Orientation of bolts beyond the two main axes**

- For horizontal piping systems, the orientation shown of the bolts beyond the main axes (see the following figure) is preferred since possible leaks at the flange connection do not cause the medium to run directly onto the bolts.



**Flange with main axes (centered crosswise)**

- Flange adaptor, valve end or fixed flange, seal and loose flange must be aligned centrally on the pipe axis.
- Before tightening the screws, the sealing surfaces must be aligned parallel and snug against the seal. Tightening misaligned flanges with the resulting tensile stress is to be avoided at all costs.

**Selecting and handling bolts**

- The length of the bolts should be in such a way that the bolt thread does not protrude more than 2-3 turns of the thread at the nut. Washers must be used at the bolts as well as the nut. If too long bolts are used it's not possible to mount the insulation half shells afterwards.
- To ensure that the connecting bolts can be easily tightened and removed after a lengthy period of use, the thread should be lubricated, e.g. with molybdenum sulphide.
- Tightening the bolts by using a torque wrench.
- The bolts must be tightened diagonally and evenly: First, tighten the bolts by hand so that the gasket is evenly contacting the jointing faces. Then tighten all bolts diagonally to 50 % of the required torque, followed by 100 % of the required torque. The recommended bolt tightening torques are listed in the table.
- However, deviations may occur in practice, e. g. through the use of stiff bolts or pipe axes that are not aligned. The Shore hardness of the gasket can also influence the necessary tightening torque.
- We recommend checking the tightening torques 24 hours after assembly according to the specified values and, if necessary, retighten them. Always tighten diagonally here, as well.
- After the pressure test, the tightening torques must be checked in any case and, if necessary, retightened.

i For more information on flanges, see DVS 2210-1 supplement 3.

i In the area of flexible sections and expansion loops, no mechanical joints should be used since the bending stress may cause leaks.

**Bolt tightening torque guidelines for metric (ISO) flange connections with PP- steel flanges**

The indicated torques are recommended by Georg Fischer Piping systems. These torques already ensure a sufficient tightness of the flange connection. They deviate from the data in the DVS 2210-1 Supplement 3, which are to be understood as upper limits. The individual components of the flange connection (valve ends, flange adapters, flanges) by Georg Fischer Piping systems are dimensioned for these upper limits.

| Pipe outside diameter d (mm) | Nominal Diameter DN (mm) | Tightening torque MD (Nm) | | |
|---|---|---|---|---|
| | | Flat ring maximum pressure 10 bar / 40 °C | Profile seal maximum pressure 16 bar | O-ring maximum pressure 16 bar |
| d32 | DN25 | 15 | 10 | 10 |
| d40 | DN32 | 20 | 15 | 15 |
| d50 | DN40 | 25 | 15 | 15 |
| d63 | DN50 | 35 | 20 | 20 |
| d75 | DN65 | 50 | 25 | 25 |
| d90 | DN80 | 30 | 15 | 15 |
| d110 | DN100 | 35 | 20 | 20 |
| d140 | DN125 | 45 | 25 | 25 |
| d160 | DN150 | 45 | 25 | 25 |
| d225 | DN200 | 70[1)] | 45 | 35 |
| d250 | DN250 | 65 | 35 | |
| d280 | DN250 | 65 | 35 | |
| d315 | DN300 | 90 | 50 | |
| d355 | DN350 | 90 | 50 | |
| d400 | DN400 | 100 | 60 | |
| d450 | DN450 | 190 | 70 | |

1) Maximum operating pressure 6 bar

Bolt tightening torque guidelines for ISO flange connections

**Length of bolts**

In practice, it is often difficult to determine the correct bolt length for flange joints. It can be derived from the following parameters:

- Thickness of the washer (2x)
- Thickness of the nut (1x)
- Thickness of the gasket (1x)
- Flange thickness (2x)
- Thickness of flange collar (valve end or flange adaptor) (2x)
- Valve installation length, if applicable (1x)

In order to ensure the fitting of the insulation half shells of the COOL-FIT 4.0 flange adaptors the used bolts must not be too long.

The following table is useful in determining the necessary bolt length.

Under DVS 2210-1, the screw length should be such that it extends 2 to 3 threads beyond the nut.

**Online "screw lengths and tightening torques" tool on www.gfps.com/tools**

For COOL-FIT 4.0 Flange adaptors used together with PP-Steel backing flanges, the following bolt lengths can be used:

| Dimension | d32 | d40 | d50 | d63 | d75 | d90 | d110 | d140 | d160 | d225 |
|---|---|---|---|---|---|---|---|---|---|---|
| Screws | M12x80 | M16x80 | M16x90 | M16x90 or M16x100 | M16x100 | M16x100 | M16x100 | M16x130 | M16x200 | M20x220 |

## Installation fittings (for sensors)

Transitions and threaded plastic fittings should first be screwed finger tight. The fittings are then screwed in using an appropriate tool until 1 or 2 threads remain visible.

Georg Fischer Piping Systems recommends using PTFE tape to seal transitions and threaded plastic fittings. Alternatively, Henkel Tangit Uni-Lock or Loctite 55 thread seal or Loctite 5331 thread sealant gel can be used. Follow the manufacturer's instructions. When using other sealants, you must check compatibility with the plastic used.

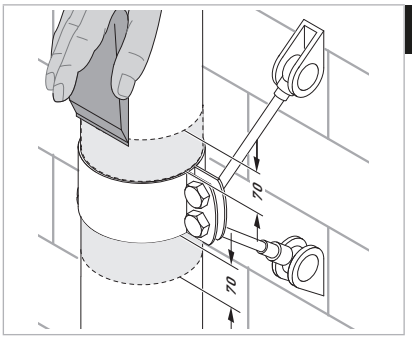
On installing Installation fittings in horizontal piping systems, the sensors should be in 1 – 5 or 7 – 11 clock position.

⚠ Do not use hemp! It may swell up, putting force on the plastic fittings and damaging plastic threads. Hemp is also not resistant to chemicals used in some media.

## COOL-FIT 4.0 Installation of fixed points

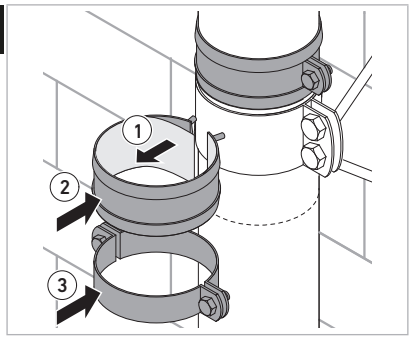
The COOL-FIT pipe shall be intstalled with a standard fix point as shown below.

1




**Step 1**
Remove the outer layer of the PE jacket with a pipe scraper

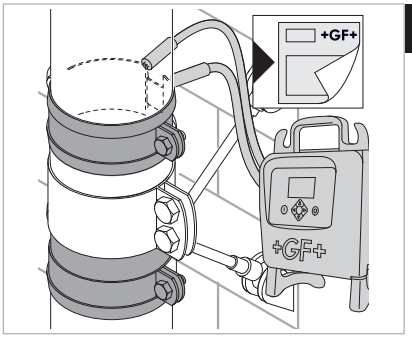
2




**Step 2**
Remove the yellow protection band from the welding bands and place them on the COOL-FIT pipe. Fix the welding bands with the pipe clips provided.

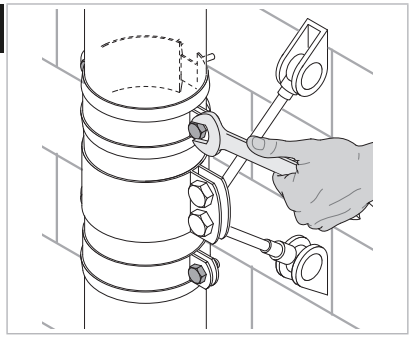
**Note:** The necessary welding pressure on the clean and dry COOL-FIT pipe is achieved by tightening the pipe clips. Take care that between fixed point clip and weld band there are no visible holes.

3




**Step 3**
Bond the welding band with the COOL-FIT pipe in accordance with the operating instructions of the electrofusion machine. Use welding adaptors of the y-cable with integrated welding adaptors for the bonding.

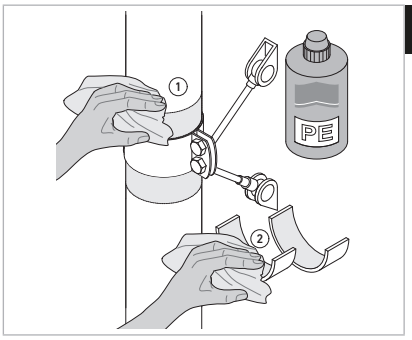
4



**Step 4**
Retighten the pipe clips after 10 minutes.

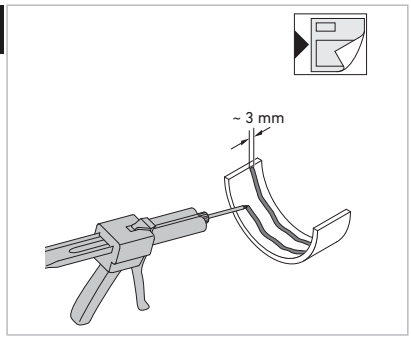
## Installation of COOL-FIT 4.0F fixed points

1



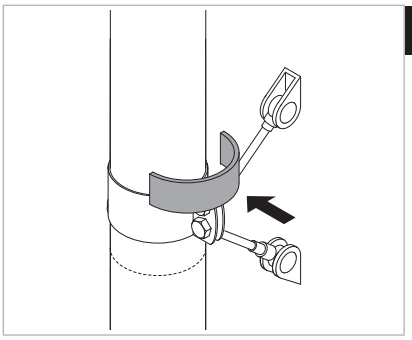

**Step 1**
Clean the cementing area on the pipe and the components with Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.

2



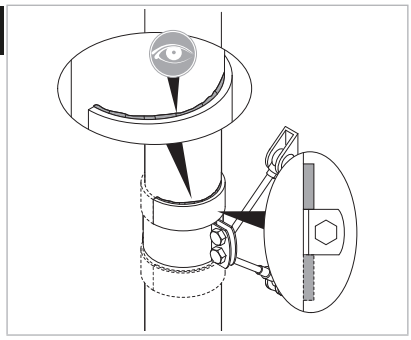

**Step 2**
Place the Tagit RAPID in about 3mm stripes on the inner side of the fixed point set half shells.

3



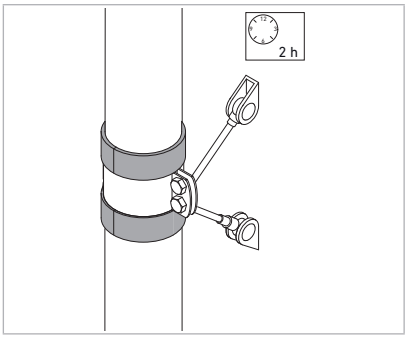
**Step 3**
Cement the half shelfs on the pipe next to the pipe clamp.

4



**Step 4**
Check the cementing and ensure the fixed point half shells are next to the pipe clamp.

5




**Step 5**
Let the fixed point dry for minimum 2hours.

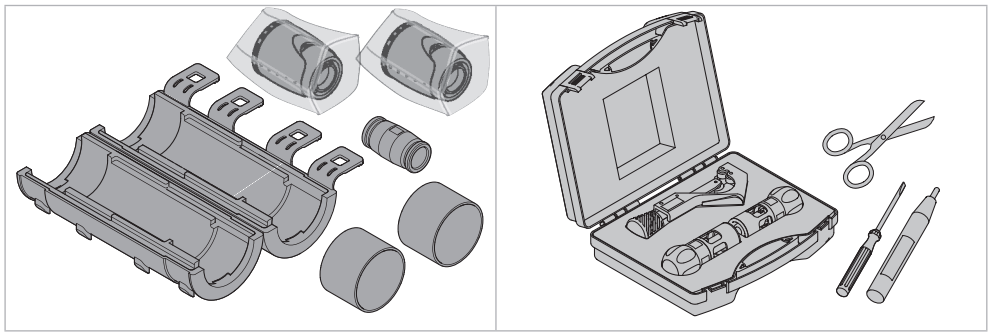
# 1.5.2 Jointing of COOL-FIT 4.0 Push System

## General advice

The push-in fittings may only be installed by skilled personnel who have been regularly instructed in work safety and environmental protection on pressurized pipes. The quality of the mechanical connection is largely determined by the careful execution of the preparatory work. The mating area must be protected from adverse weather conditions such as rain, snow or wind. Permissible temperature range for processing is -10 °C to +45 °C. The national guidelines must be observed.

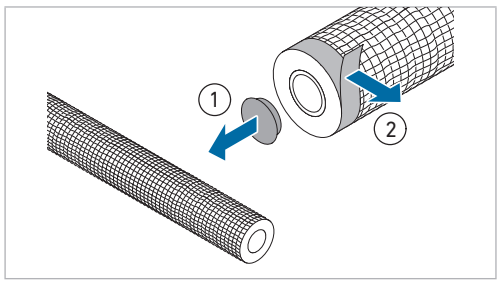
The surfaces to be welded on the pipe and fitting must be carefully protected from dirt, any grease, oil and lubricants. Only cleaning agents suitable for PE may be used.

## Work preparation



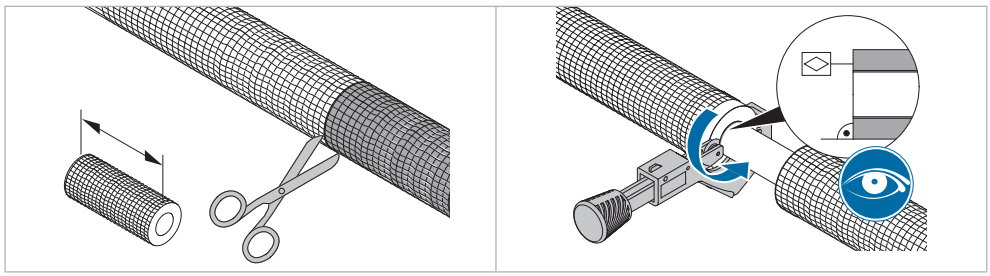
Remove products from packaging immediately before assembly and have necessary tools ready.

## Prepare pipe




**Step A**

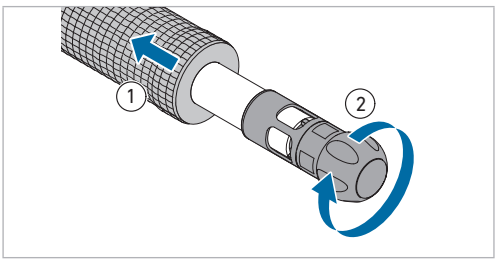
For new pipe start: Remove cap from pipe end and remove tape from insulation.



**Step B**

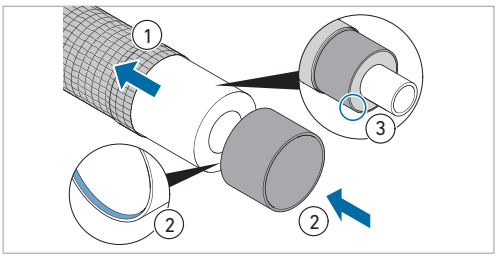
Pipe lengths: Cut the insulation at right angles at the interface using scissors. Push the insulation aside and cut the pipe flush with the insulation using a pipe cutter.

## Joint




**Step 1**

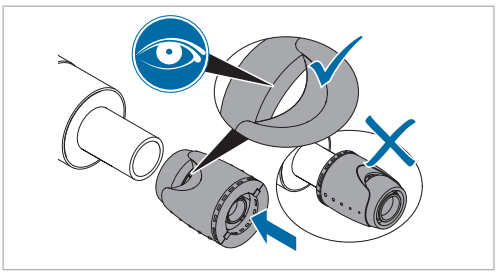
Push back the insulation and chamfer and calibrate the tube end with the chamfering tool. Visually check the chamfering. Remove any chips that may be adhering, also inside the tube.




**Step 2**

Pull the net of the insulation to the rear. Push the ring over the insulation with the chamfered side first. The surface of the insulation must lie flush in the ring.

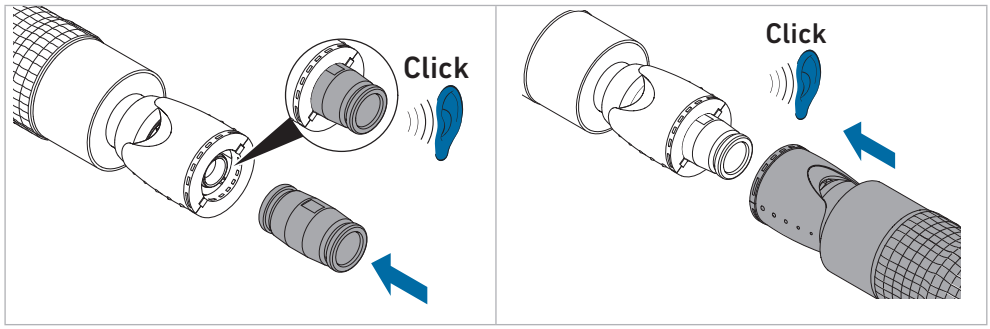
i It is easier to attach the ring if the insulation is first pulled off the pipe, then the ring is slid over the insulation. Then both are pushed back over the pipe.



**Step 3**

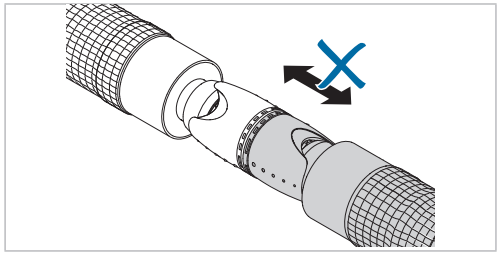
The adapters are packaged individually. The packaging is only opened immediately before use.

Push the adapter onto the tube end as far as it will go. Visually check that the viewing window of the adapter is completely filled by the tube.




**Step 4- 5**

Insert the module into the adapter and push it in until an audible click is heard (acoustic check). Prepare the second tube end and also push it onto the module until an audible click is heard.

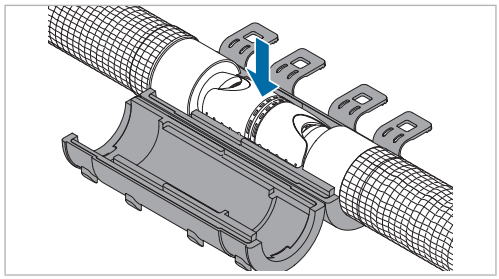


**Step 6**

Check by counter-tensioning whether the tube adapter and module are firmly connected to each other.

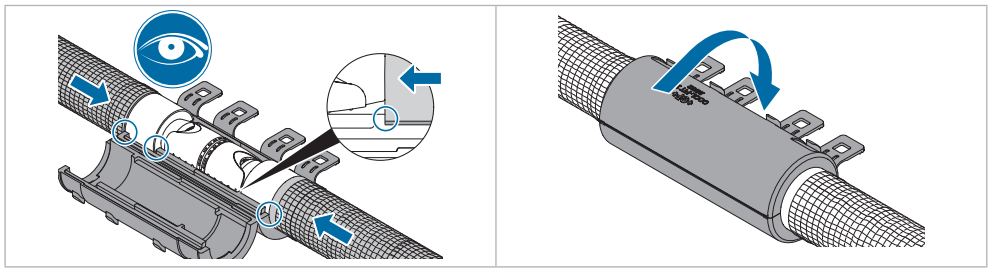
During the counter-tension test, the adapter and module may slide apart by up to 5 mm. Due to the dynamic holding mechanism, the pipe moves back slightly during operation or during the pressure test. This is not a defect of the assembly from a technical point of view.

## Insert joint into shell



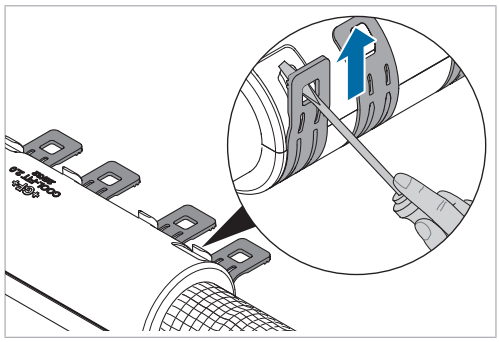
**Step 7**

Insulation with ring is pushed to butt against the adapter. The net must be outside the shell.



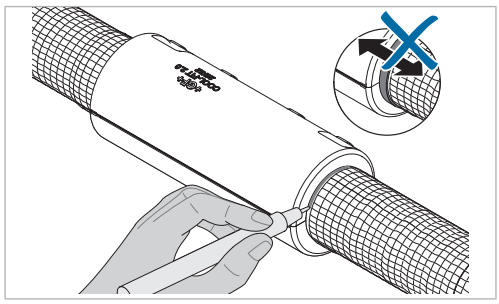
**Step 8 - 9**

Visually check that the insulation is butted in the shell and, if necessary, push the adapter into place. The ring must be completely in the shell. Then close the shell.



**Step 10**

Close the tabs with a screwdriver.



**Step 11**

After closing the shell, a mark is placed along the edge of the shell. The mark indicates whether the insulation has shifted during the further installation process. If the mark is no longer visible along the shell, the shell must be reopened and checked.

## Disassembly

### Fitting

The fitting can be opened and released again.

> NOTE! Loss of warranty if adapters are opened!
> If adapters have been opened, e.g. during disassembly, the warranty is no longer valid.
> → Do not reuse opened adapters.

### Shell

The shell can be opened at the tabs and reused.

### Plug connection

It is possible to loosen the connection, but the adapter will be destroyed in the process.

> NOTE! Destruction of the adapter by loosening the connection.
> Loosening the connection is possible, but the adapter will be destroyed in the process.
> → For the next assembly: Use a new adapter.

1. Use water pump pliers to fix the collar of the half shells. Use a second pair of water pump pliers to loosen the adapter housing in an anticlockwise direction.
2. This destroys the housing and it must not be used again.
3. Unscrew the adapter housing completely.
4. Pull the tube off the support nipple.
5. Remove the adapter housing, support ring and toothed ring from the tube.
6. Remove the half shells of the adapter from the support nipple of the module.
7. Pull the support nipple of the adapter out of the module.
8. Loosen the clamping ring by squeezing it lightly with pliers and remove it from the tube.
9. Dispose of all parts of the dismantled adapter properly.

### Module

The module can be reused.

The tube end must be shortened by 6 mm (this complies with the insertion depth of the toothed ring) and recalibrated.

# 1.5.3 Pressure test

## Internal pressure test

For internal pressure testing and commissioning, the same conditions apply for COOL-FIT 4.0 as for the non-insulated ecoFIT system (PE).

# 1.5.4 Internal pressure and leak testing

## Introduction to the pressure test

**Overview of the various test methods**

| Test methods | Inner Pressure test | | | Leakage test |
|---|---|---|---|---|
| Medium | Water | Gas[1] | Compressed air[1] | Gas/air (oil-free) |
| Type | Incompressible | Compressible | Compressible | Compressible |
| Test pressure (overpressure) | $P_{p\,(perm)}$ or $0.85 \bullet P_{p\,(perm)}$ | Operating pressure + 2 bar | Operating pressure + 2 bar | 0.5 bar |
| Potential risk during the pressure test | Low | Hoch | High | Low |
| Significance | High: Proof of pressure resistance incl. impermeability to test medium | High: Proof of pressure resistance incl. impermeability to test medium | High: Proof of pressure resistance incl. impermeability to test medium | Low |

[1] Observe the applicable safety precautions. More information is available in DVS 2210-1 addendum 2.

A number of international and national standards and guidelines are available for leak and pressure tests. Therefore, it is often not easy to find the applicable test procedure and for example the test pressure.

The purpose of a pressure test is:

- Ensure the resistance to pressure of the piping system, and
- Show the leak-tightness against the test medium

Usually, the internal pressure test is done as a water pressure test and only in exceptional cases (under consideration of special safety precautions) as a gas pressure test with air or nitrogen.

Water is an incompressible medium. In case of a leakage during the pressure test relative low energy is set free. Therefore the hazard potential is significantly lower compared to testing with a compressible medium like e.g. compressed air.

## Internal pressure test with water or similar incompressible test medium

The internal pressure test is done when installation work has been completed and presupposes an operational piping system or operational test sections. The test pressure load is intended to furnish experimental proof of operational safety. The test pressure is not based on the operating pressure, but rather on the internal pressure load capacity, based on the pipe wall thickness.

Addendum 2 of DVS 2210-1 forms the basis for the following information. This replaces the data in DVS 2210-1 entirely. The modifications became necessary because the reference value "nominal pressure (PN)" is being used less and less to determine the test pressure (1.5 x PN, or 1.3 x PN) and is being replaced by SDR. In addition, a short-term overload or even a reduction in the service life can occur if the pipe wall temperature TR = 20 °C is exceeded by more than 5 °C in the course of the internal pressure test based on the nominal pressure.

Test pressures are, therefore, determined in relation to SDR and the pipe wall temperature. The 100-h value from the long-term behavior diagram is used for the test pressure.

**Test parameters**

The following table provides recommendations on the performance of the internal pressure test

| Purpose | Preliminary Review | Main examination |
|---|---|---|
| Test pressure pp (depends on the pipe wall temperature and the permitted test pressure of the installed components, see "determination of the test pressure") | ≤ $P_{p\,(perm)}$ | ≤ 0.85 $P_{p\,(perm)}$ |
| Test duration (depends on the length of the pipe sections) | L ≤ 100 m: 3 h<br>100 m < L ≤ 500 m: 6 h | L ≤ 100 m: 3 h<br>100 m <L ≤ 500 m: 6 h |
| Checks during the test (test pressure and temperature curves must be recorded) | At least 3 checks distributed across the test period with test pressure restored | At least 3 checks distributed across the test period without restoring the test pressure |

**Pre-test**

The pre-test serves to prepare the piping system for the actual test (main test). In the course of pre-testing, a tension-expansion equilibrium in relation to an increase in volume will develop in the piping system. A material related drop in pressure will occur which will require repeated pumping to restore the test pressure and also frequently a re-tightening of the flange connection bolts.

The guidelines for an expansion-related pressure decrease in pipe are:

| Material | Pressure drop (bar/h) |
|---|---|
| COOL-FIT 4.0 | 1.2 |

**Main test**

In the context of the main test, a much smaller drop in pressure can be expected at constant pipe wall temperatures so that it is not necessary to pump again. The checks can focus primarily on leak detection at the flange joints and any position changes of the pipe.

**Observe if using compensators**

If the piping system to be tested contains compensators, it has an influence on the expected axial forces on the fixed points of the piping system. Because the test pressure is higher than the operating pressure, the axial forces on the fixed points increase proportionately. This has to be taken into account when designing the fixed points.

**Observe if using valves**

When using a valve at the end of a piping system (end or final valve), the valve and the pipe end should be closed by a dummy flange or cap. This prevents an inadvertent opening of the valve and release of the medium.

**Filling the pipe**

Before starting the pressure test, the following points should be checked:

1. The installation has been carried out in accordance with its plans.
2. All pressure relief and check valves are fitted in the direction of flow.
3. All end valves have been closed.
4. All valves for devices have been closed to secure against pressure.
5. A visual inspection has been made of all connections, pumps, measurement devices and tanks.
6. The waiting time after the last weld or bond has been observed

Now the piping system can be filled from the geodetic lowest point. Special attention should be given to the air vent. If possible, vents should be provided at all the high points of the piping system and these should be open when filling the system. Flushing velocity should be at least 1 m/s.

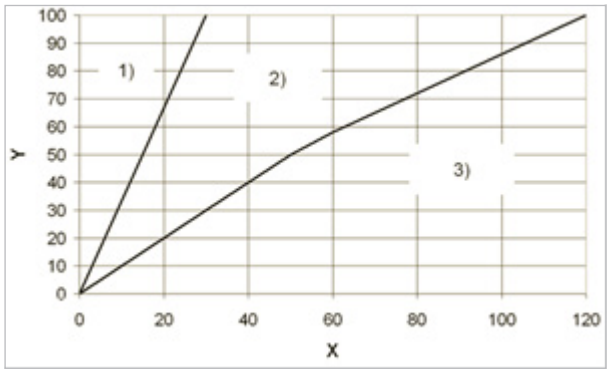
Reference values for the filling volume are given in the table below:

| d (mm) | V (l/s) |
|---|---|
| ≤ 90 | 0.15 |
| 110 | 0.3 |
| 160 | 0.7 |
| 225 | 1.5 |
| 250 | 2.0 |
| 315 | 3.0 |
| 400 | 6.0 |

Allow sufficient time to pass between filling and testing the pipe for the air in the piping system to escape through the vents: about 6 to 12 hours, depending on nominal diameter.

**Applying the test pressure**

The test pressure is applied in accordance with this diagram. It is important to ensure that the rate of pressure increase does not cause any water hammers.




Y Test pressure (%)
X Time of test pressure increase (min)
1) Rate of pressure increase up to DN100 mm
2) Range of pressure increase rates between DN100 and DN400 mm
3) Guideline rate of pressure increase for DN500 and higher: 500/DN (bar/10 min)

**Determination of the test pressure**

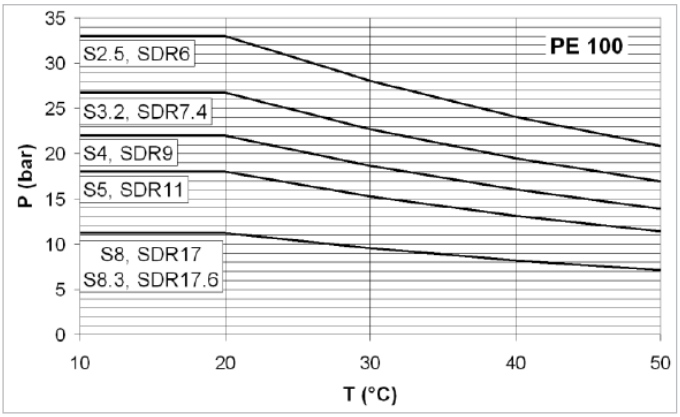
The permissible test pressure is calculated using the following formula:

$$P_{p(zul)} = \frac{1}{SDR} \cdot \frac{20 \cdot \sigma_{v(T,\,100\,h)}}{S_p \cdot A_G}$$

$\sigma_{v(T,\,100\,h)}$ Creep strength for the pipe wall temperature (at t= 100h)
$S_p$ Minimum safety factor for creep strength
$A_G$ Processing method or geometry specific factor which reduces the permissible test pressure
$T_R$ Pipe metal temperature: mean temperature of test medium and pipe surface

| Material | Sp minimum safety factor |
|---|---|
| COOL-FIT 4.0 Pipe and Fittings (PE100) | 1.25 |
| COOL-FIT 4.0 Valves (ABS) | 1.6 |

**To make things easier, the permissible test pressures can be taken directly from the following diagrams.**




P permitted test pressure (bar)
T pipe wall temperature (°C)

**Checks during testing**

The following measurement values must be recorded consistently during testing:

1. Internal pressure at the absolute lowest point of the piping system
2. Medium and ambient temperature
3. Water volume input
4. Water volume output
5. Pressure drop rates

## 1.5.5 Start-up with secondary refrigerants

Secondary refrigerants such as glycol solutions must only introduced in liquid, pre-mixed form into COOL-FIT 4.0 piping systems. Filling should be performed slowly from the lowest point of the system to allow the piping system to vent at its highest point.

**Filling and de-aeration**

It is important to vent air from all piping systems. This is particularly important with saline solutions, because of their corrosive properties. Venting process:

- The system must be filled slowly.
- Manual or automatic venting devices must be fitted at the highest point of the system.
- Long horizontal lines should be installed at a slight gradient.
- The piping layout should be chosen in such a way as to prevent the formation of air pockets.
- Installation of an air vent with a medium column as a reserve.
- Follow the specific manufacturer instructions for the liquids as regards filling

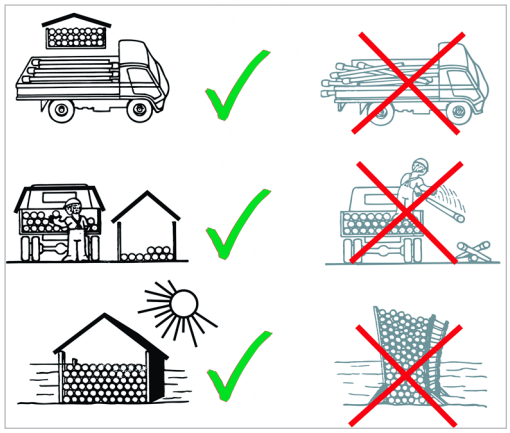
# 1.6 Transport, Handling and Storage

## 1.6.1 Transport

On trucks/in crates, manual transport

## 1.6.2 Storage

All plastic pipe including pre-insulated plastic pipe such as COOL-FIT 4.0 must be stacked on a flat surface with no sharp edges. During handling, care must be taken to avoid damage to the external surface of the pipe, i.e. by dragging along the ground). Pipe should not cross over each other in storage as this is likely to cause bending.



# 1.7 Environment

The materials used for COOL-FIT 4.0 are suitable for recycling. Georg Fischer Piping Systems aims to satisfy its customer's wishes concerning environmental aspects.

For more information at www.coolfit.georgfischer.com

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