COOL-FIT 4.0
Planning Fundamentals

Plan, Build, Operate

Design and Installation

COOL-FIT 4.0

2055120
Planning Fundamentals COOL-FIT 4.0 (11/2024)

Pre-Insulated Solutions

COOL-FIT 4.0

Content

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.

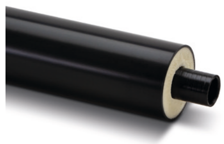
All components are pre-insulated or supplied with mountable insulation shells.
The COOL-FIT 4.0 tools allow for fast and safe installation of the system.

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 Fitting: XPE foam
	Outer jacket	Pipe HDPE	Flame retardant - GF-FR	Stainless steel polyester fabric
		Fitting GF-HE		TPE
Size		d32DN25 – d450DN450	d160DN150 + d225DN200	d25DN20 - d32DN25
Connection technology		Electrofusion	Electrofusion	Push-in connector
Nominal pressure[2)]	16 bar, SDR 11 10 bar, SDR17	d32DN25-d450DN450 d160DN150-d450DN450	- d160DN150 + d225DN200	16 bar
Temperature	Medium	-50 °C to +60 °C	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 HE Foam PE jacket GF-FR jacket Multilayer composite pipe EPDM Foam	 0.38 W/mK 0.022 W/mK (d32-d110); 0.026 W/mK (d140-d450) 0.38 W/mK	 0.38 W/mK 0.026 W/mK 0.15 W/mK	 0.43 W/mK 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)	≤ 0.32 mg/(m² d)	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 UV resistant		For indoor use
	Ozone Depletion Potential	Zero	Zero	Zero

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)		
	ISO 7	Threaded Joints		
	 EN ISO 16135 EN ISO 16136 EN ISO 16137 EN ISO 16138	Industrial valves ... – Ball valves made of thermoplastics – Butterfly valves made of thermoplastics – Backflow protection made of thermoplastics – 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		
Product declarations Green buildings		BNB BN 2015 BREEAM Int 2016 DGNB 2015 DGNB 2018 LEED V3 LEED V4 WELL V1 2019		
eco-bau	(BKP 240, 244, 250)	eco 1	eco 2	

[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] 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 3.5×10^{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 empty	Weight with water	Volume	Insulation thickness	Heat transfer coefficient (U)	Fire load
(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 6.3	24.67	72.51	47.84	53.7	0.47	277.80
d315/450	315 x 18.7	277.6	17	450 x 6.4	30.42	90.95	60.52	61.1	0.47	341.40
d355/500	355 x 21.1	312.8	17	500 x 7.4	38.35	115.20	76.85	65.1	0.49	432.43
d400/560	400 x 23.7	352.6	17	560 x 8.4	48.40	146.05	97.65	71.6	0.50	546.74
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 empty	Weight with water	Volume	Insulation thickness	Heat transfer coefficient (U)	Fire load
(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 6.3	30.93	72.18	41.26	53.7	0.46	354.06
d315/450	315 x 28.6	257.8	11	450 x 6.4	38.33	90.53	52.2	61.1	0.46	437.89
d355/500	355 x 32.2	290.6	11	500 x 7.4	48.34	114.67	66.33	65.1	0.48	554.36
d400/560	400 x 36.3	327.4	11	560 x 8.4	61.19	145.37	84.19	71.6	0.49	702.72
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

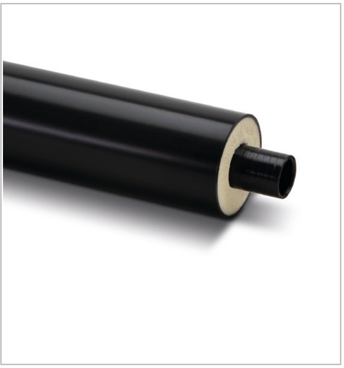
d	Nominal outer diameter of the PE pipe
d_i	Nominal inside diameter of the pipe
D	Nominal outside diameter of the outer PE jacket
e, e1	Nominal wall thickness

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

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 and reducer 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

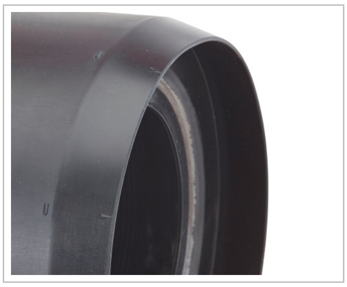
Fusion indicators

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

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.

373603063 160120 76701000325 Traceability

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

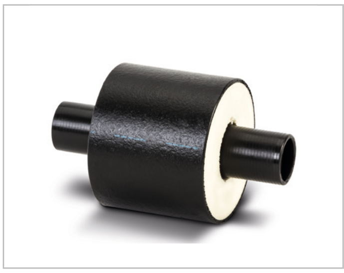
If a reducer in a system is fitted behind a tee, either a COOL-FIT 4.0 T90° reduced or a COOL-FIT 4.0 T90° reduced/equal connected to a reducer should be used.

Run 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 - d225

Insulation for fusion contacts

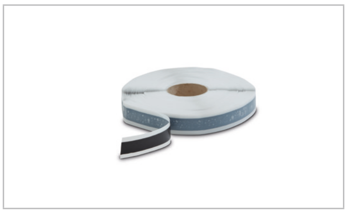
Supplied with each fitting. Prevent formation of a cold bridge at the fusion contacts. Insulation parts can also serve as an indicator that a connection has been welded. Install insulation after welding to show that the welding has been completed.

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 ½" – 2"	PE – stainless steel	male thread (R, NPT), female thread (Rp, NPT), loose nut (G)
Adaptor Fitting to iFIT or Sanipex MT	d32	Stainless steel / Brass	iFIT, Sanipex MT
Unions	d32 – d63 d32 – d110	PE – PE, PE – ABS	Welding spigots cementing sockets
Flange Adaptor (flange joints)	d32 – d225	PE	Suitable for Bolt circle PN 16/10

COOL-FIT 4.0 flex hoses

The flexible hoses in EPDM permit mobile access to devices such as chillers and fan coils. In addition to this the flex hose are compensating expansion or contraction within the system. The tear-resistant protective jacket and EPDM insulation ($\lambda_{0°C}$ ≤ 0.036 W/mK) ensure the temperature of the cooling medium remains unchanged. Versatile connectivity options mean that system connection is ensured: G thread (male thread + loose nut including gasket)

d (mm)	DN (mm)	Thread	Length (mm)	Max. compensation ΔL (mm)	Rmin (min. bending radius) (mm)
d20	DN15	½"	1'000	276	119
d25	DN20	¾"	1'000	161	156
d32	DN25	1"	1'000	68	192
d40	DN32	1 ¼"	1'500	233	252
d50	DN40	1 ½"	2'000	396	312
d63	DN50	2"	2'000	233	372

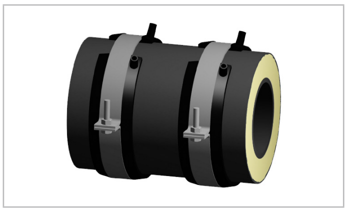
COOL-FIT 4.0 Installation fittings type 313

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.

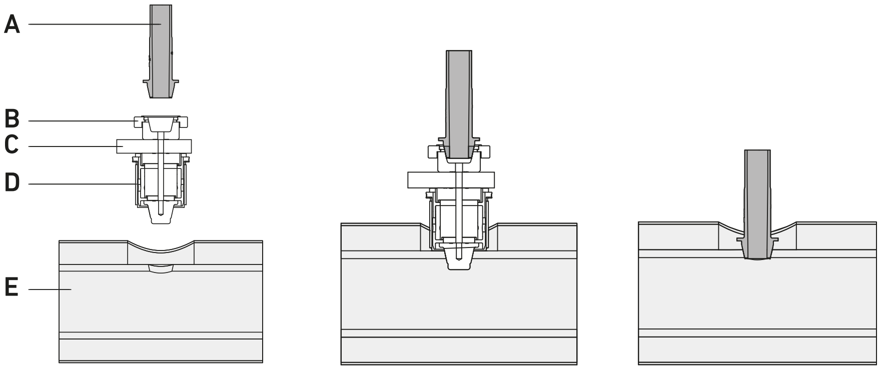
In the cone welding process used here, a modified version of heating element socket welding, the inner pipe of the COOL-FIT pipe and the Weld-in port are welded in an overlapping material-to-material bond without the use of additional filler materials.

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



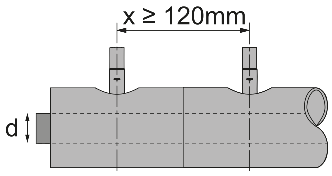
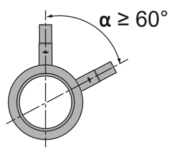
A Weld-in port
B Heating bush
C Fusion tool
D Heating spigot
E COOL-FIT Pipe

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:

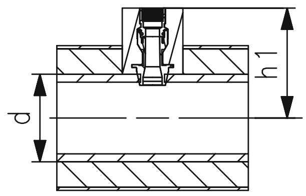
- Distances between Weld-in ports along the pipe axis.
- Arrangement around the circumference of the pipe.

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

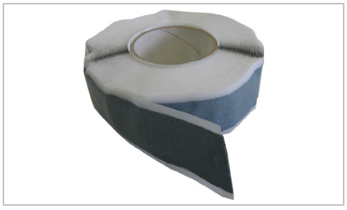
Heigth h1 [mm]/d [mm]	d63	d75	d90	d110	d140	d160	d225
½" Rp	117	123	130	140	155	165	198
½" NPT	120	126	134	144	159	169	201
¾" RP + NPT	117	123	130	140	155	165	198
1" Rp + NPT	118	124	131	141	156	166	199



1.3.3 Accessories for dimensions d250 - 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

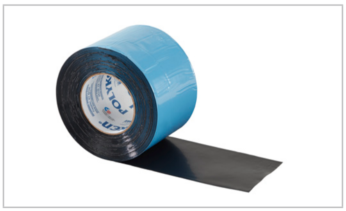
The shrink socket is used to water and vapor seal the respective welded joints on the outer jacket and can seal only components with the same outside diameter. Functionality is ensured only in combination with the butylene-rubber sealing tape. This version provides additional mechanical strength with 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.

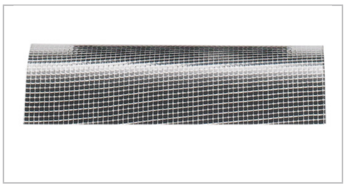


Hot shrink tape

The heat shrink tape is used on the respective welded joints for the water and vapor tight sealing of the outer jacket. The adhesive-coated tape must be glued with a sealing patch and shrunk under the influence of heat.

Sealing patch

The sealing patch is used to close the heat-shrink tape. One patch must be used per sealing.



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 Weight empty	 Weight with water	Volume	Insu-lation thick-ness	Heat transfer coeffi-cient (U)	Fire load	Bending radius R with bending spring	Ben-ding radius R with tool
(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

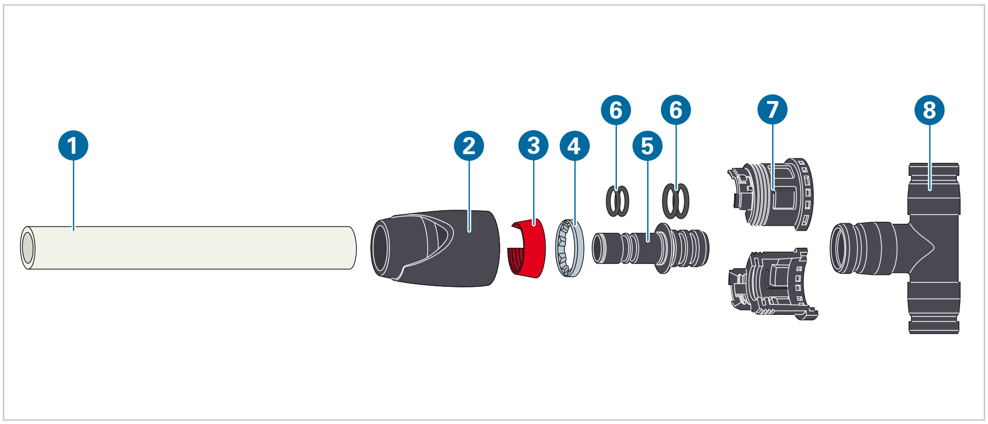
The connection is made using adapter module technology, a push system that requires few tools and no electrical power. It is possible to work across dimensions via the module.

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

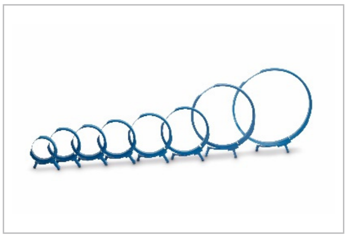
Long Fusion adaptors serve as an extension of the fusion plugs of electrofusion machines. Compared to standard adaptors, the longer adaptor length matches the insulation of the COOL-FIT 4.0 electrofusion Fittings. The long fusion adapters are needed for electrofusion of fittings
d ≥ d160/D250

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 Piping Systems representative. Additional information is available on the official GF Piping Systems website.

1.4.2 COOL-FIT 4.0 pressure-temperature diagram

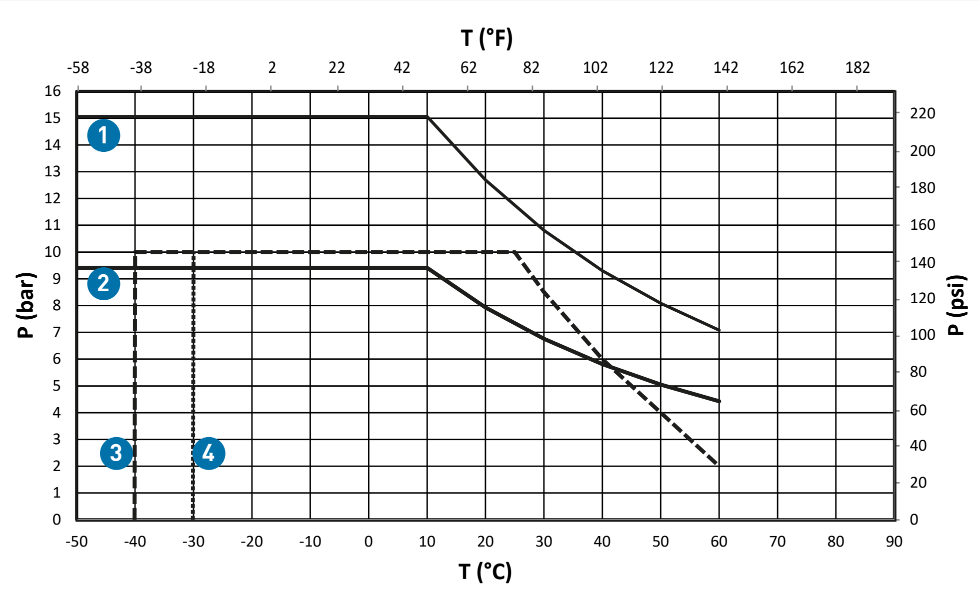
The pressure resistance for thermoplastic pipe for water is always specified at +20 °C. At higher temperatures allowance must be made for a lower maximum operating pressure.

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 Piping Systems representative.

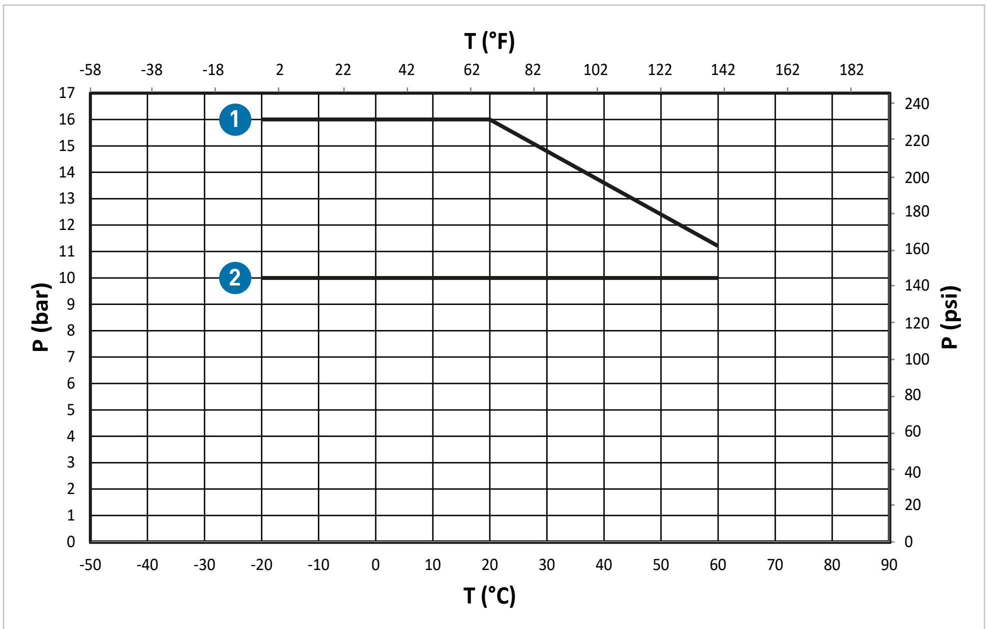


P Allowable pressure (bar, psi)
T Temperature (°C, °F)
C Safety factor

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".

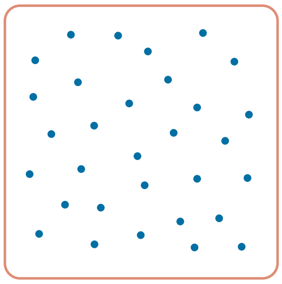
1.4.3 Condensation assessment and prevention

Introduction

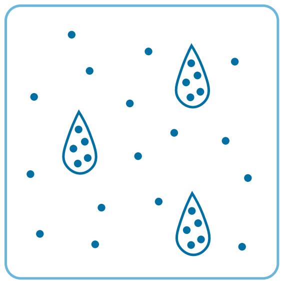
Piping in cooling applications is funeral to condensation due to its chilled media and therefore may need to contain preventive measures. Various factors influence the occurrence of condensation which, therefore, need to be considered during the planning stage.

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



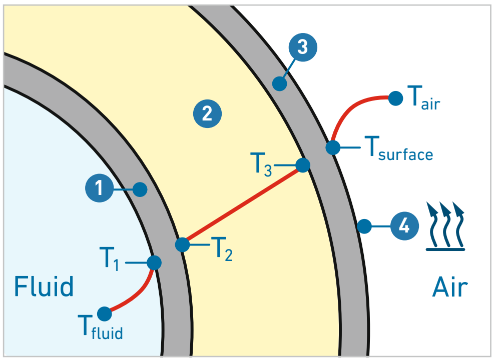
Molecules of water in cold air.
Excess water condenses into droplets.

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 λ_{jacket}
4 ε_{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 69. 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:

Dew point

- $T_{dp} > T_{surface}$ = 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 Piping Systems 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).

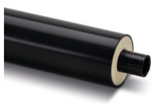
Smoke release:

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

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	277.8	341.4	432.4	546.7	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	354.1	437.9	554.4	702.7	850.7

d/D (mm)	160/250	225/315
Thermal load COOL-FIT 4.0F 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).

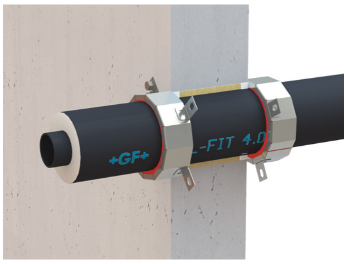
Abbreviation	Criterion	Rating
E – Étanchéité	Flame protection or integrity	Measurement of an element's capacity of preventing the passage of gases and flames in case of fire.
I – Insulation	Insulation or thermal insulation	Measurement of the insulation capacity of an element, i.e. the duration in which 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:

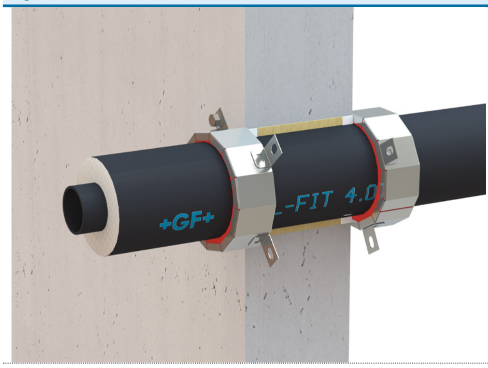
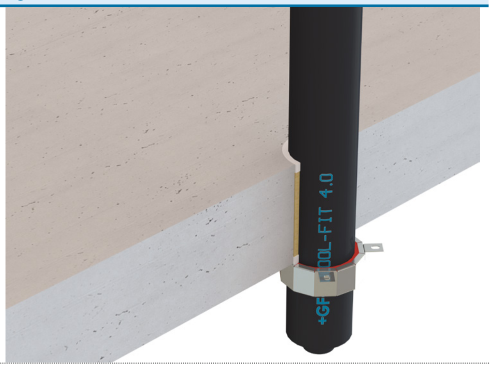
Product	Proof of applicability	Countries
Hilti firestop collar CP 644	Allgemeine Bauartgenehmigung (aBg) Z-19.53-2330	DE
Hilti firestop collar CP 644	VKF Technische Auskunft 14108	CH
Hilti firestop collar CFS-C P	ETA-10/0404	EU

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	Hilti CFS-C P
Info | Shop qr.hilti.com/r3069	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

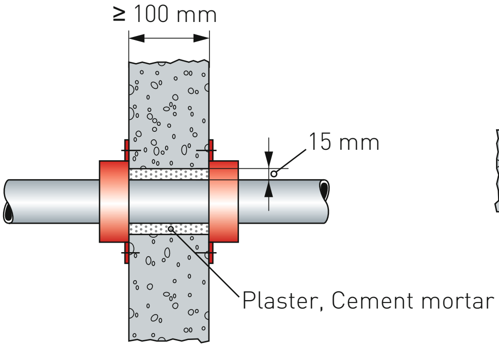
* For bigger dimensions see chapter "Additional approved fire retarding sealing".

Gap sealing

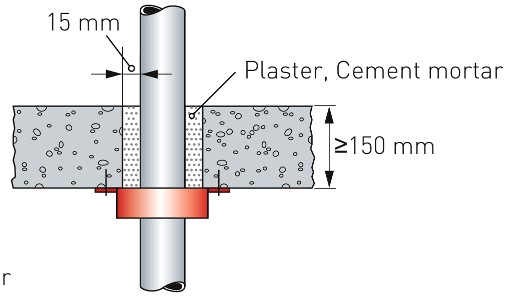
For the installation situations there are several options for sealing gaps against smoke gas.

Gap sealing with non-combustible construction materials:

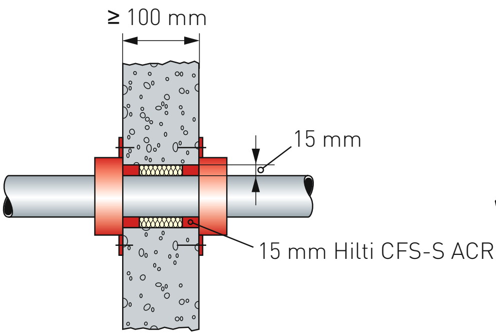
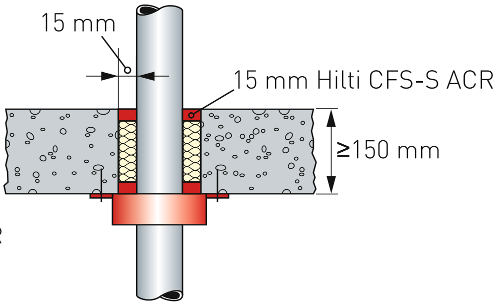
Rigid wall



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.

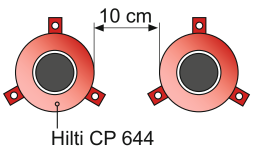
Rigid wall	Rigid floor
	

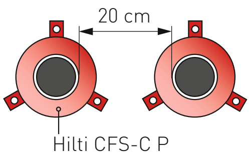
Distance regulations

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	

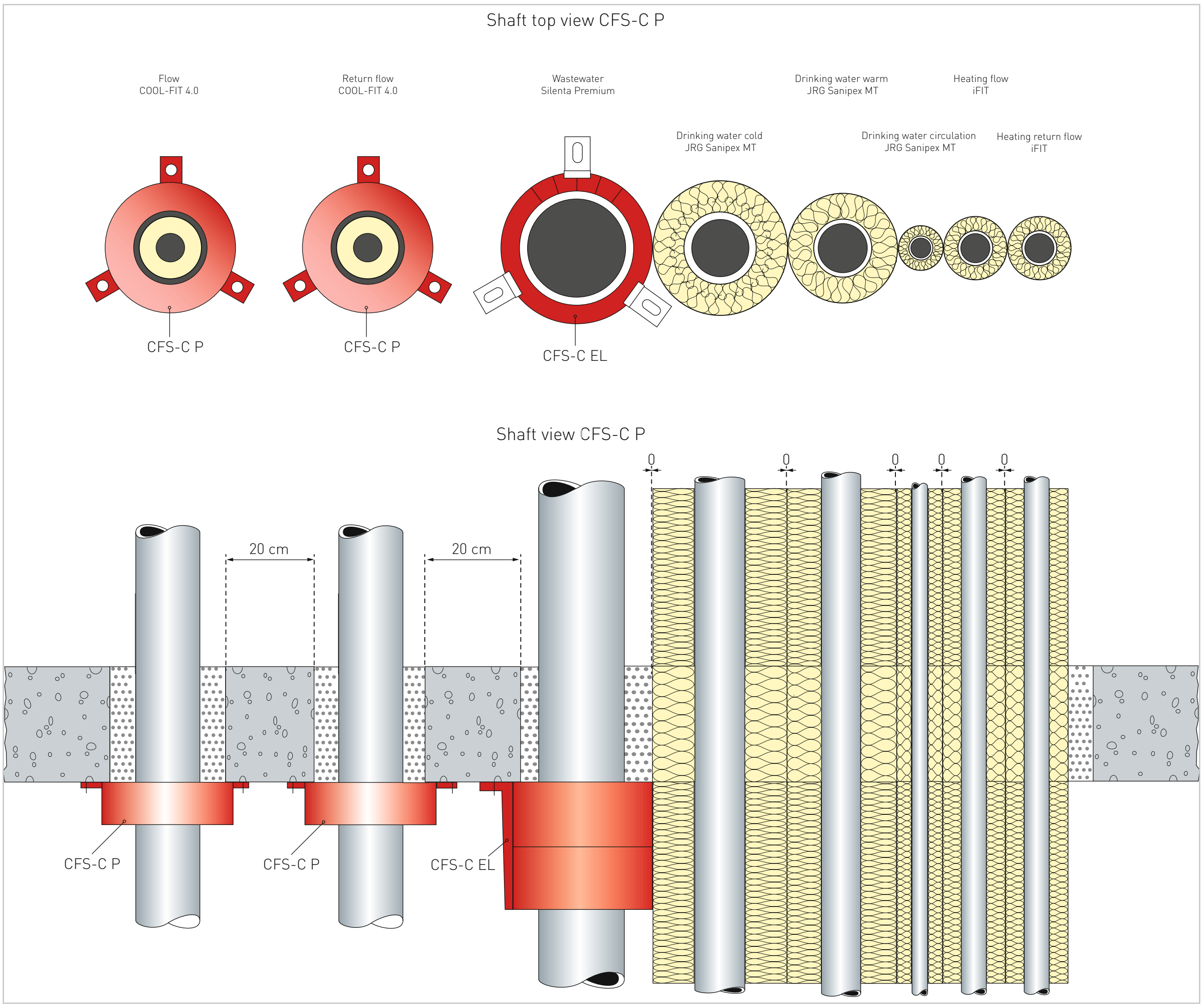
The following pipe distances between the openings of the pipe lead through are derived from this for pipe sealing with the Hilti firestop collar for COOL-FIT 4.0:

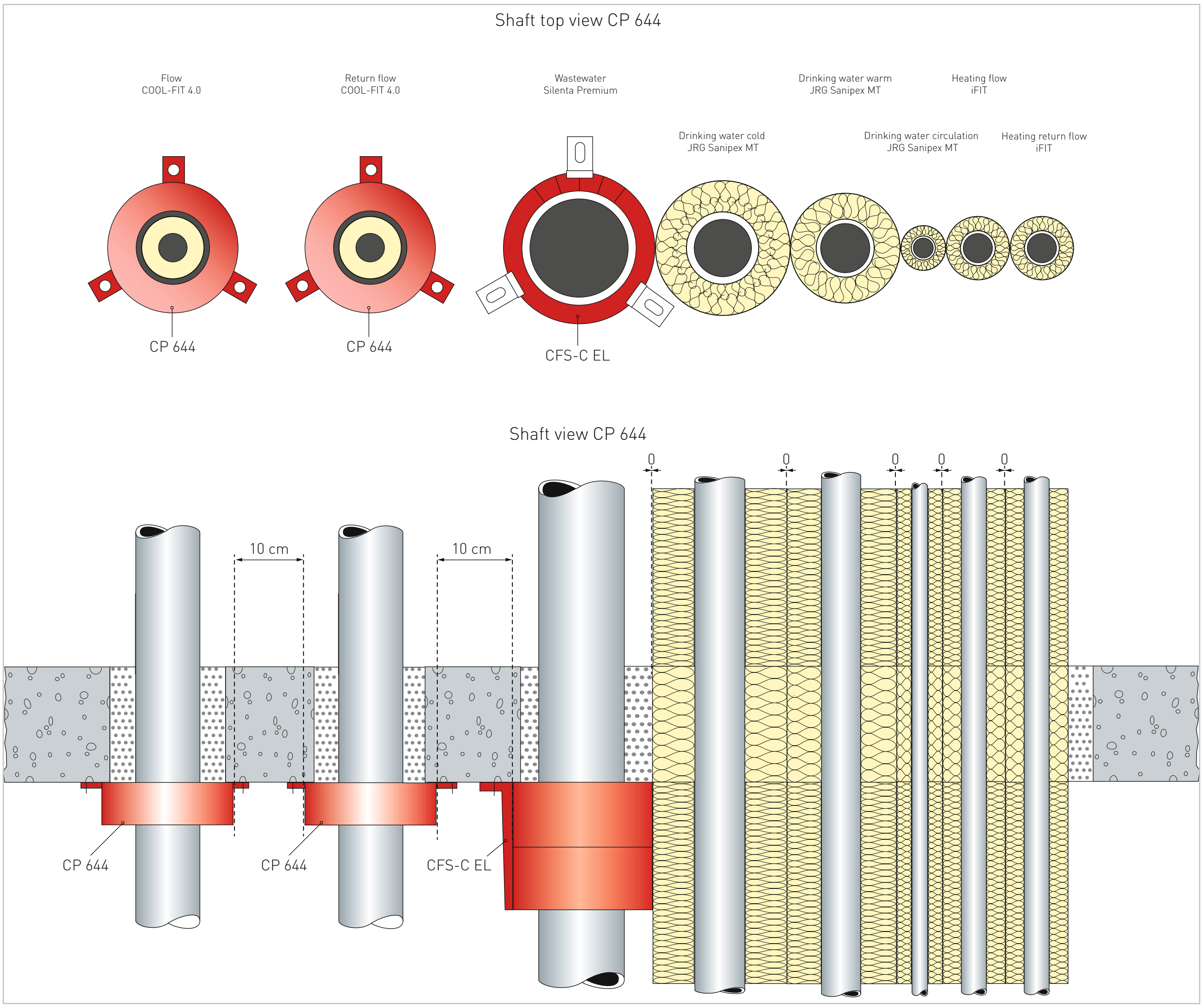




Shaft installation

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 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
ΔT	Temperature difference supply - return (K)
c	Specific heat capacity (kW*s/(kg*K))
ρ	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	2.78×10^{-4}
0.06	1.0	0.017	1.67×10^{-5}
3.6	60	1.0	1.00×10^{-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

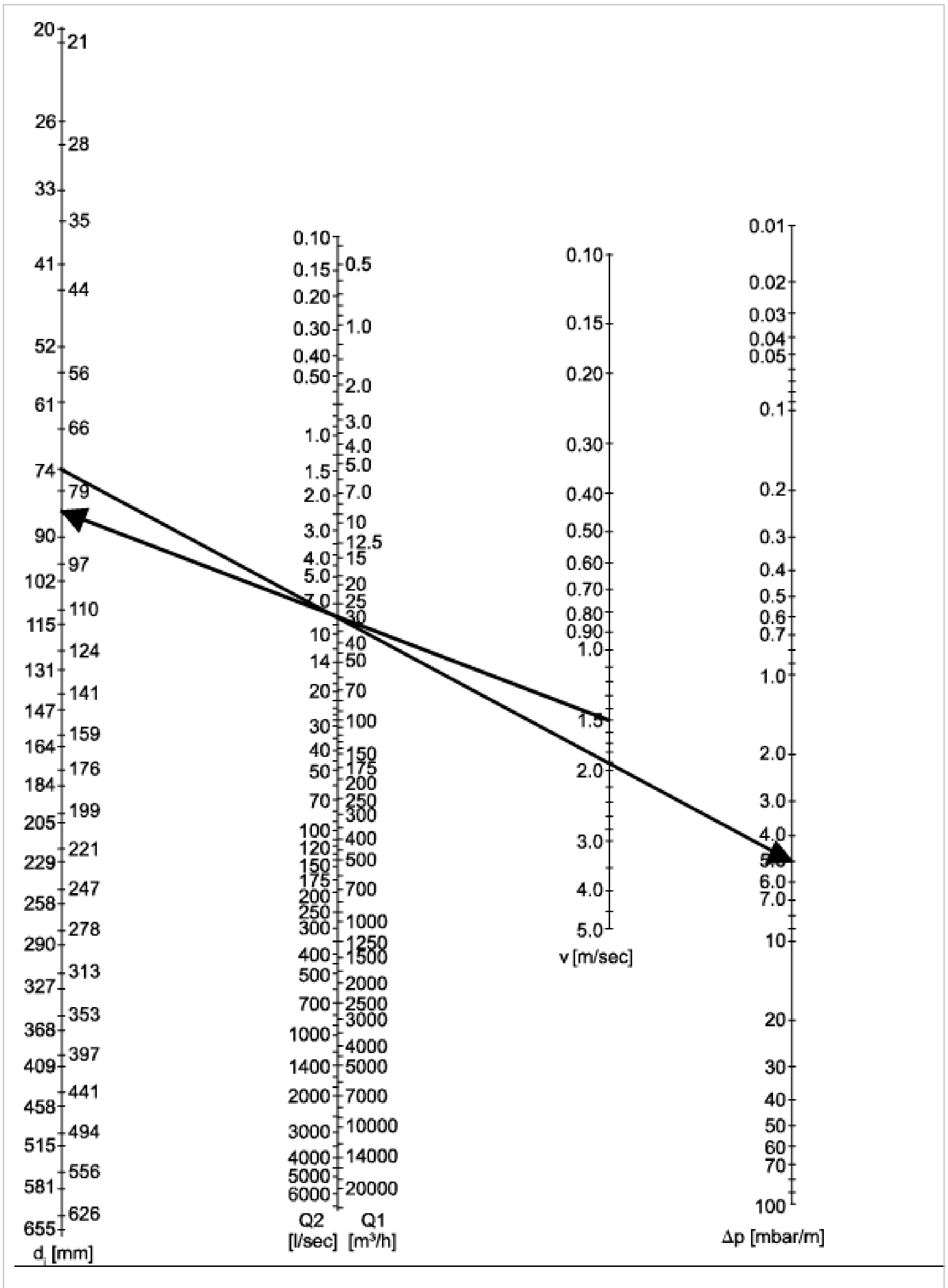
The nomogram below can be used to simplify the determination of the diameter required .The pressure loss in the pipe can be read off per meter of the pipe length.

> ⚠ The pressure loss calculated using the nomogram only applies to flows of substances with density 1000 kg/m^3, 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 m^3/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



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:

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

Δp_R	Pressure loss in the straight pipe run (bar)
λ	Pipe friction factor
L	Length of the straight pipe section (m)
d_i	Inner diameter of the pipe (mm)
ρ	Density of the flow material (kg/m^3)
	for water 20 °C = 998.2 kg/m^3
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 λ = 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 (ζ value) is used for calculations.

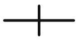
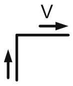
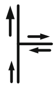
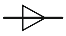
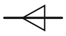
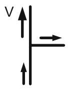
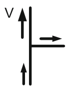
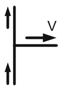
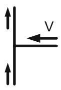
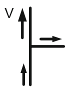
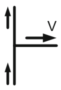
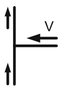
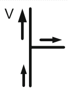
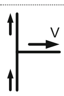
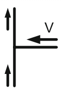
Calculation of the pressure loss

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 ζ-values. The pressure loss can then be calculated according to the following formula:

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

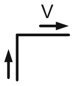
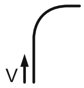
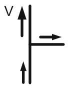
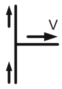
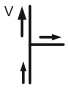
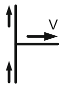
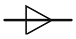
Δp_{Fi}	Pressure loss of all fittings (bar)
$\Sigma\zeta$	Sum of all individual losses
v	Flow velocity v (m/s)
ρ	Density of the medium in kg/m^3 (1 g/cm^3 = 1000 kg/m^3)

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
Reducer (contraction)		0.5
Reducer (enlargement)		1.0
Flange joint, transition fitting	d32: 0.8 d40: 0.7 d50: 0.6	d63: 0.4 d75: 0.3 d90-d225: 0.1
Flexible hoses	½": 2.0 ¾": 1.8 1": 1.4	1 ¼": 1.1 1 ½": 1.0 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
Weld-in port PE/ Sanipex MT		0.1
		1
		1.3

[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.

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:

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

Δp_{Ar} Pressure loss for the valve (bar)
Q Flow rate (m^3/h)
ρ Density of the conveyed medium (kg/m^3) (1 g/cc = 1000 kg/m^3)
k_v Valve characteristic value (m^3/h)

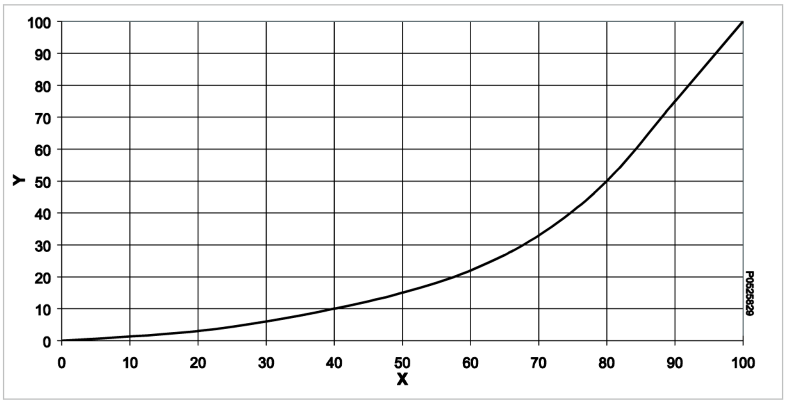
k_v 100-Werte

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

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

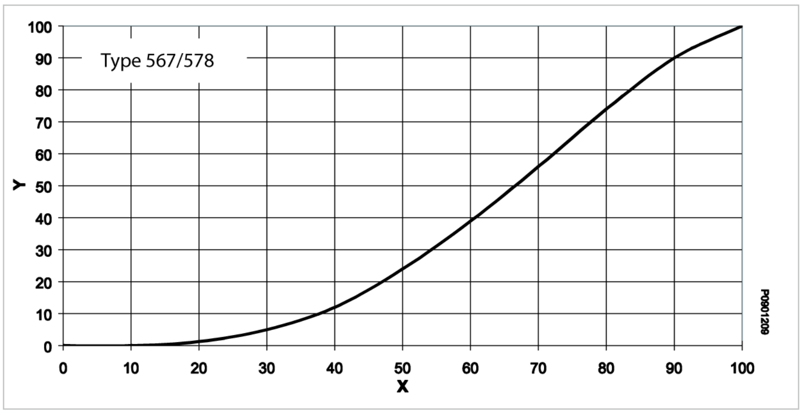
DN (mm)	Zoll (inch)	d (mm)	k_v 100 (l/min)	Cv 100 (gal/min)	k_v 100 (m^3/h)
80[1]	3	90	7'000	490.0	420
100[2]	4	110	3'800	455	390
125[2]	5	140	8'600	602	516
150[2]	6	160	16'600	1'162	1'000
200[2]	8	225	39'600	2'772	2'380

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 Piping Systems 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:

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

Δp_{geod} Geodetic pressure difference (bar)
ΔH_{geod} Difference in elevation of the piping system (m)
ρ Density of the medium (kg/m^3) ($1\ g/cm^3 = 1000\ kg/m^3$)

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/cm^3	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 m^3/ H (flow rate 1.5 l/s = 5.4 m^3/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

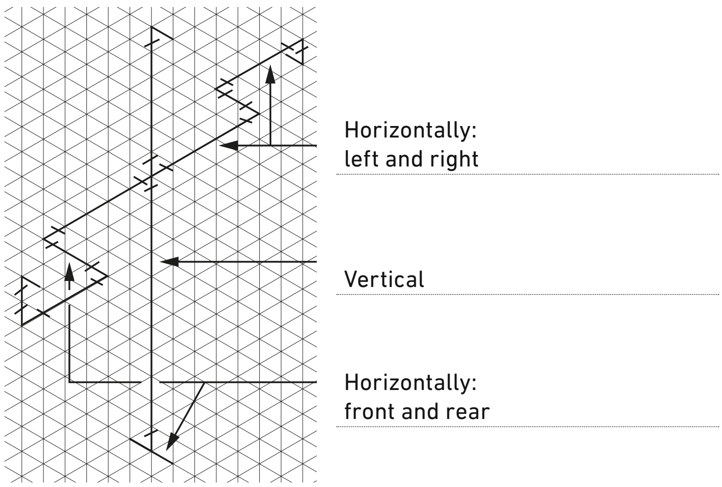
Overview

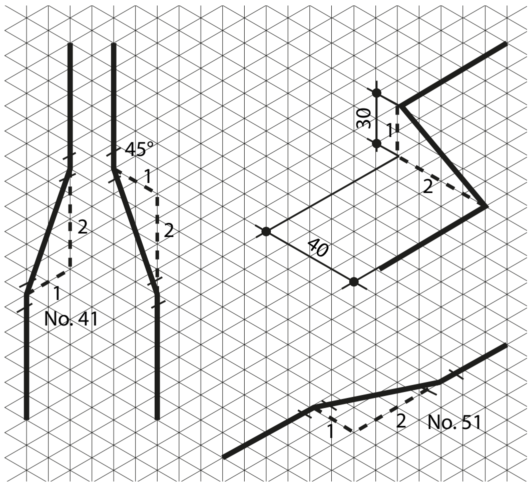
The pressure of competition and high wages makes it essential to install piping systems efficiently. The Georg Fischer Piping Systems method of assembly is highly suited to this task. It replaces the tedious and time-consuming cutting to size of one pipe at a time by a fast and precise way of preparing 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 50.

Please adhere to the following guidelines for drawing:

Pipe running perpendicular to one another	Pipe running diagonally

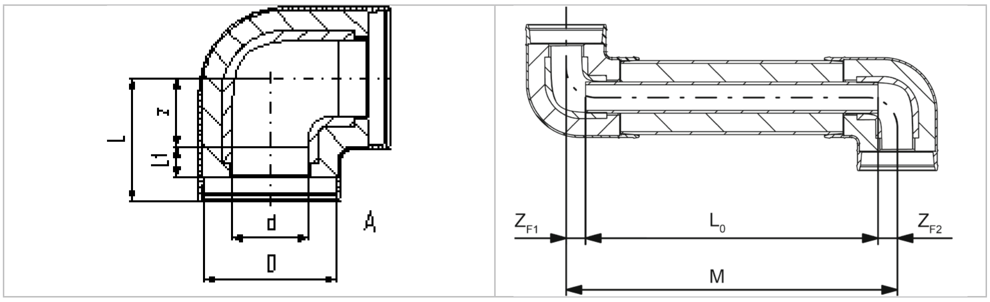




The z-dimensions of the fittings are needed for determining the actual cutting lengths of the pipe. The tables in our product ranges and in the online catalogues contain all the relevant data for the fittings. The length of pipe to be cut is given as in the following diagram by the distance between the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

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

1.4.10 Length changes and flexible sections

Overview

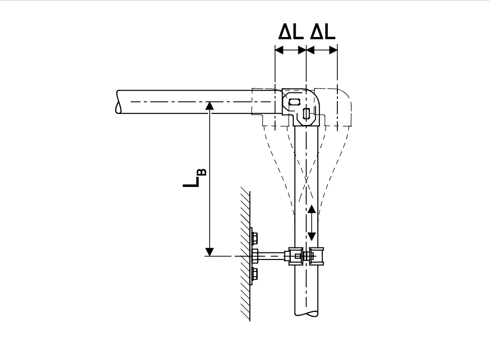
Length changes ΔL and expansion bend L_B – General

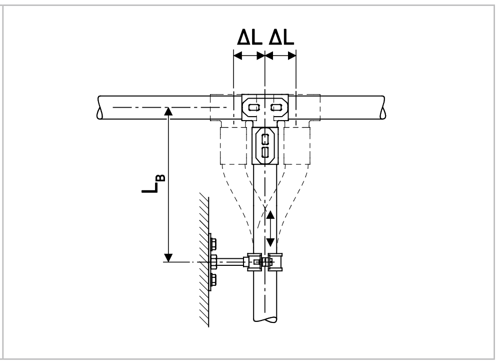
Thermoplastics are subject to higher thermal expansion and contraction than metallic materials. Pipe installed above ground, against walls or in ducts, require changes in length to be taken up in order to prevent any superimposed extra strain on the pipe. This applies especially to pipe exposed to operating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

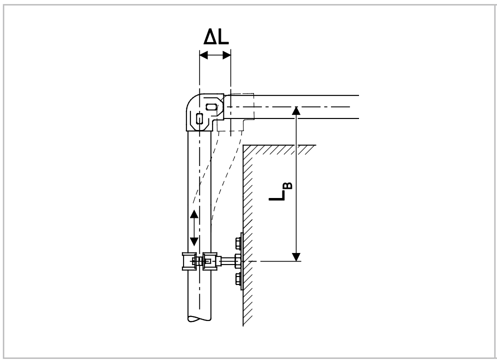


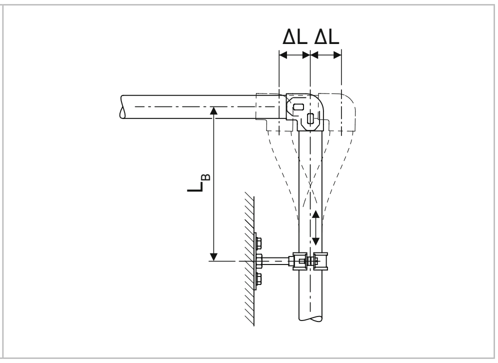


ΔL Change in length
L_B Flexible section

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.





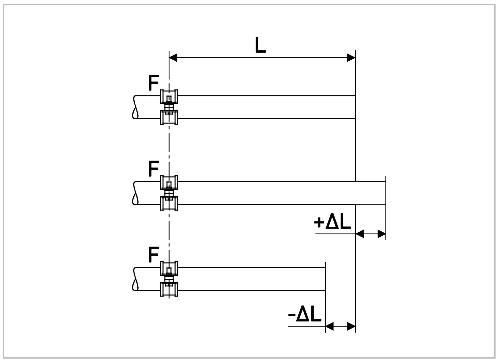
Flexible sections arise naturally at any branching or change in direction of the piping system. The movement L_B of the flexible section as a result of a change ΔL in the length must not be restrained by fixed pipe brackets, wall protrusions, girders or the like.

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 Piping Systems 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

L Laid pipe length

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

Length change ΔL (mm) at 10° C flow temperature				
L (m)	25	50	100	150
d110	-31	-62	-125	-187
d140	-32	-64	-127	-191
d160	-28	-57	-114	-171
d225	-33	-65	-130	-196
d250	-34	-69	-138	-207
d280	-34	-67	-134	-201
d315	-34	-69	-138	-206
d355	-35	-69	-138	-207
d400	-35	-69	-139	-208
d450	-36	-73	-145	-218

Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150
d110	-42	-84	-168	-252
d140	-43	-86	-171	-257
d160	-38	-77	-154	-230
d225	-44	-88	-175	-263
d250	-46	-93	-185	-278
d280	-45	-90	-180	-270
d315	-46	-92	-185	-277
d355	-46	-93	-186	-278
d400	-46	-93	-186	-279
d450	-49	-97	-195	-292

Length change ΔL (mm) at 0° C flow temperature				
L (m)	25	50	100	150
d32	-24	-49	-97	-146
d40	-26	-53	-105	-158
d50	-34	-69	-138	-207
d63	-39	-78	-157	-235
d75	-43	-85	-171	-256
d90	-47	-94	-189	-283
d110	-53	-106	-212	-318
d140	-54	-108	-215	-323
d160	-48	-97	-194	-291
d225	-55	-110	-221	-331
d250	-58	-116	-233	-349
d280	-57	-113	-226	-340
d315	-58	-116	-232	-348
d355	-58	-117	-233	-350
d400	-58	-117	-234	-350
d450	-61	-122	-244	-367

Length change ΔL (mm) at -5° C flow temperature				
L (m)	25	50	100	150
d32	-30	-59	-119	-178
d40	-32	-64	-128	-192
d50	-42	-84	-168	-252
d63	-48	-95	-190	-286
d75	-52	-104	-207	-311
d90	-57	-114	-228	-342
d110	-64	-128	-256	-384
d140	-65	-130	-260	-390
d160	-59	-117	-234	-352
d225	-67	-133	-266	-399
d250	-70	-140	-280	-420
d280	-68	-136	-273	-409
d315	-70	-140	-279	-419
d355	-70	-140	-281	-421
d400	-70	-141	-281	-422
d450	-73	-147	-294	-441

L Laid pipe length

Length change ΔL (mm) at -10° C flow temperature				
L (m)	25	50	100	150
d32	-35	-71	-141	-212
d40	-38	-76	-152	-228
d50	-50	-99	-198	-297
d63	-56	-112	-225	-337
d75	-61	-122	-244	-366
d90	-67	-134	-268	-402
d110	-75	-150	-300	-450
d140	-76	-152	-305	-457
d160	-69	-138	-275	-413
d225	-78	-156	-312	-467
d250	-82	-164	-328	-491
d280	-80	-160	-319	-479
d315	-82	-163	-327	-490
d355	-82	-164	-328	-492
d400	-82	-164	-329	-493
d450	-86	-172	-343	-515

Length change ΔL (mm) at -15° C flow temperature				
L (m)	25	50	100	150
d32	-41	-82	-163	-245
d40	-44	-88	-176	-264
d50	-57	-115	-229	-344
d63	-65	-130	-259	-389
d75	-70	-140	-281	-421
d90	-77	-154	-308	-463
d110	-86	-172	-344	-516
d140	-87	-175	-349	-524
d160	-79	-158	-316	-475
d225	-89	-178	-357	-535
d250	-94	-187	-375	-562
d280	-91	-183	-366	-549
d315	-93	-187	-374	-561
d355	-94	-188	-376	-563
d400	-94	-188	-376	-564
d450	-98	-196	-392	-588

L Laid pipe length

COOL-FIT 4.0F

L Laid pipe length

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

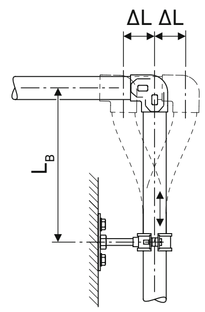
Length change ΔL (mm) at 10° C flow temperature					Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d160	-19	-39	-77	-116	d160	-26	-53	-105	-158
d225	-23	-47	-93	-140	d225	-32	-63	-126	-189

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

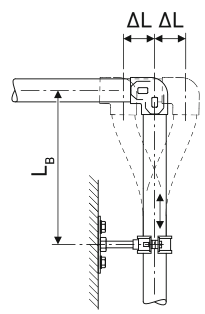


Flexible sections for COOL-FIT 4.0F

Flexible Section L_B

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
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	1'030



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.

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

ΔL	Length difference in mm
ΔT	Temperature difference in K
L	Length of pipeline in m
α	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 Δl	10.08 mm

Calculation of the length of the flexible pipe leg

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

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

$$L_B = 523.9\ mm$$

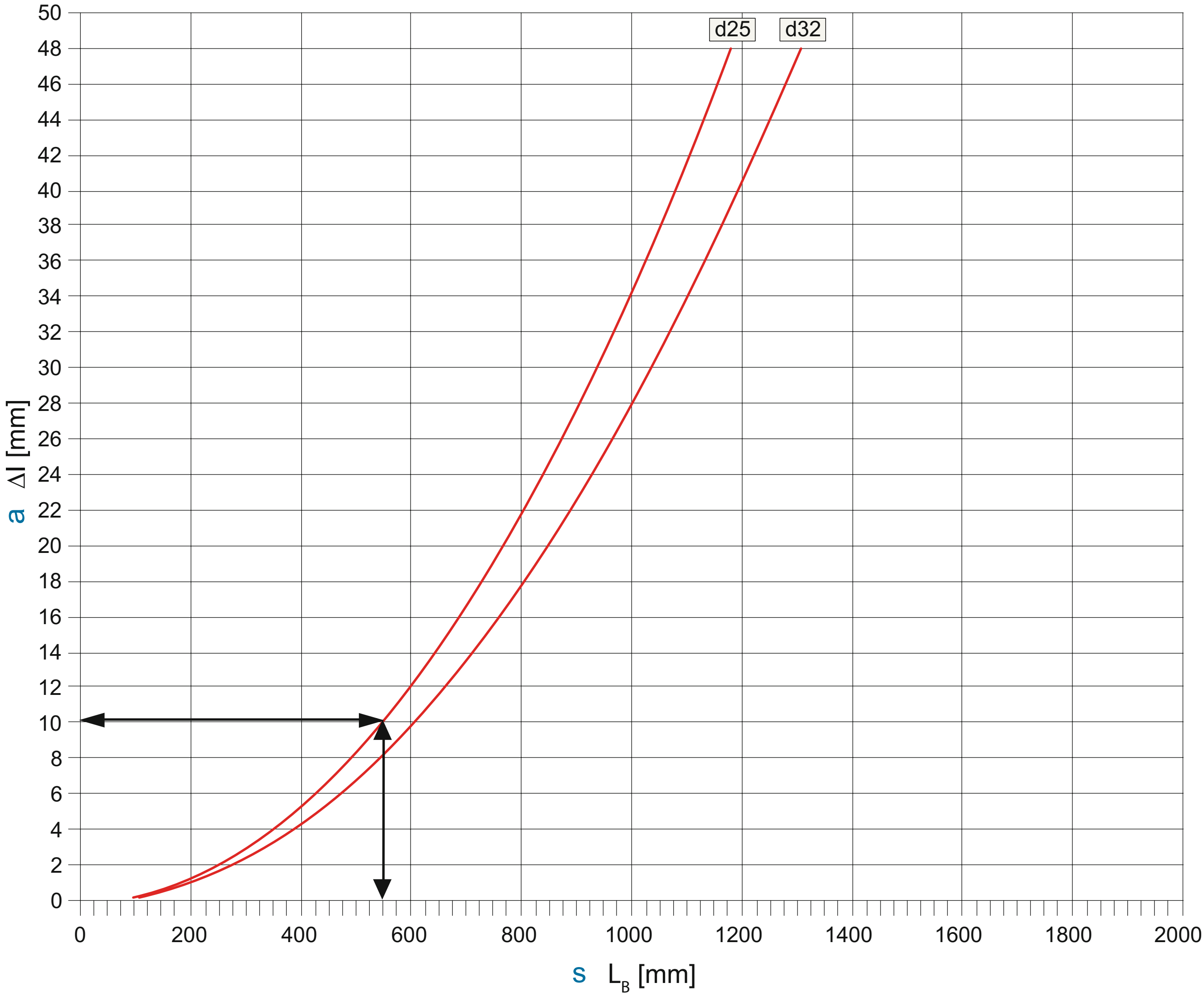
The length of the flexible pipe leg is derived from the pipe's change in length:

Graph reading example

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

L_B = 523.9 mm

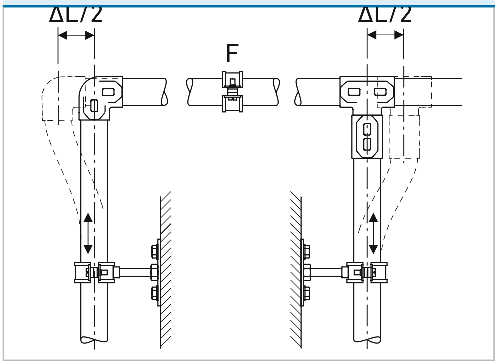
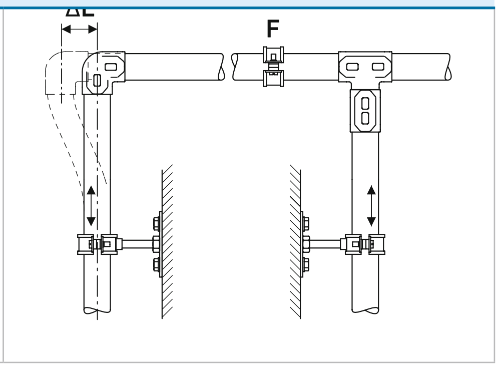
Length of flexible pipe leg
a Change in length of the pipe
s Length of flexible pipe leg



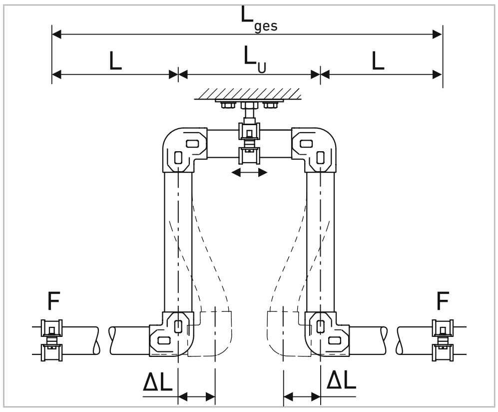
1.4.11 Handling expansion and contraction

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

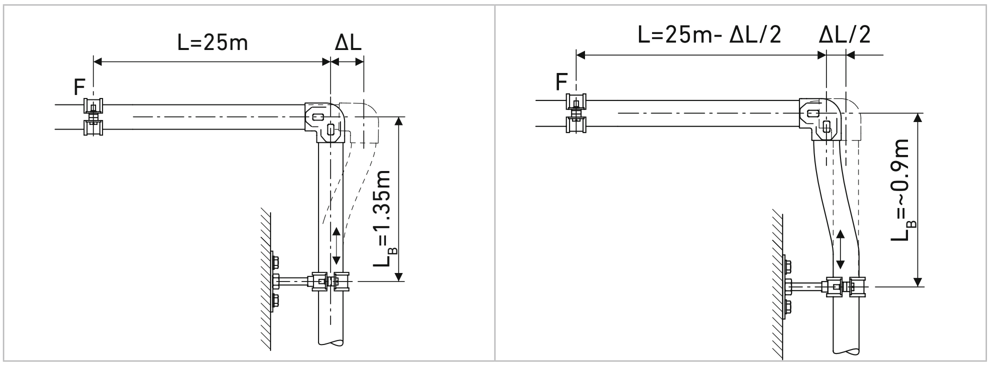
Pipe length L	25 m
Diameter	d225/D315 mm
Installation temperature	25 °C
Min ambient temperature	25 °C constant
Max ambient temperature	25 °C constant
Min flow temperature	10 °C
Max flow temperature	25 °C

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.

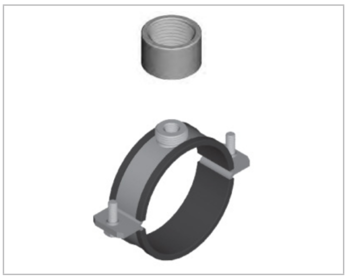


1.4.12 Pipe bracket spacing and support of piping systems

Overview

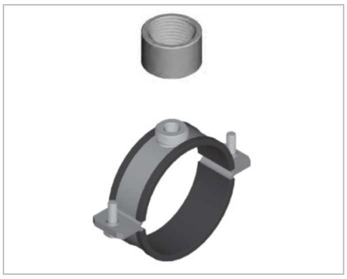
Installation of plastic pipe

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.

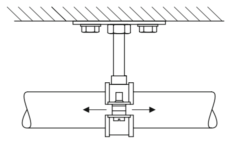
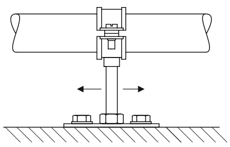
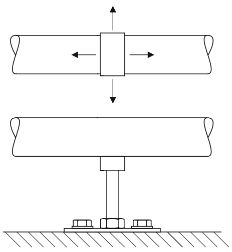


A retaining clamp must be placed next to each fitting.

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.

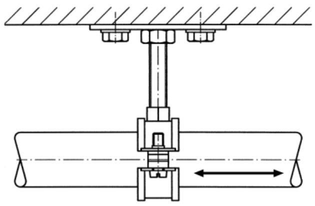
		
Axial displacement of the pipe in the clamp.	Pipe clamp fitted rigidly to the pipe, axial displacement in the suspension of the pipe clamp.	Displacement of the pipe in 2 axes.

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.

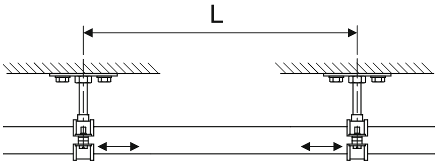


Spacers prevent pinching the pipe

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
L (mm)	1'800	1'950	1'950	2'000	2'100	2'150	2'300	2'450	2'600

d/D (mm)	d225/ D315	d250/ D355	d280/ D400	d315/ D450	d355/ D500	d400/ D560	d450/ D630
L (mm)	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)	d160/ D250	d225/ D315
L (mm)	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.

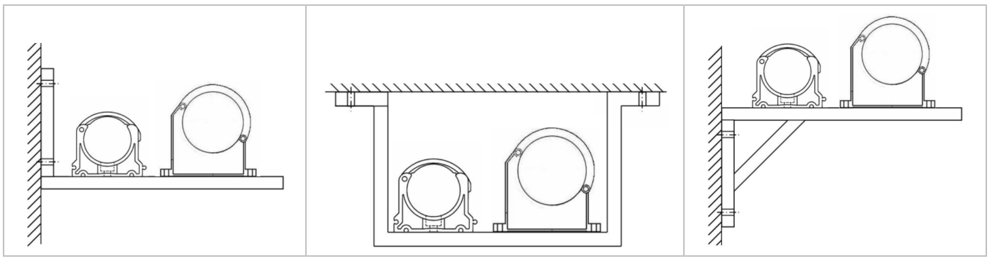
Valid for SDR11 and SDR17.

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.

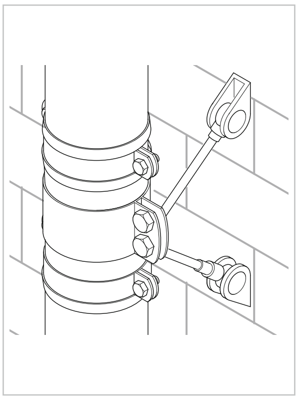
Fixpoint design

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

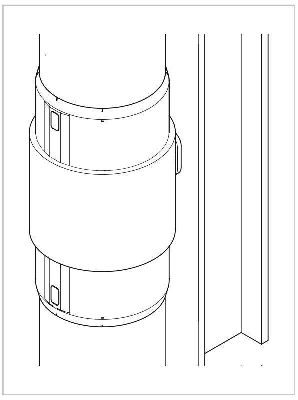
1 Clamps to maintain fusion pressure
2 Electrofusion band

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.



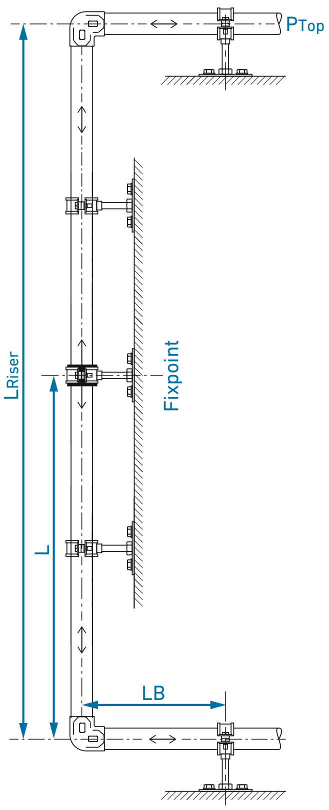
Diameter (mm)	d140/ D225	d160/ D250	d225/ D315	d250/ D355	d280/ D400	d315/ D450	d355/ D500	d400/ D560	d450/ D630
Maximum force F (kN)	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0

⚠ 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 (PTop)
Support distance vertical	Equal to horizontal
Pipe class	d32 - d450 SDR11

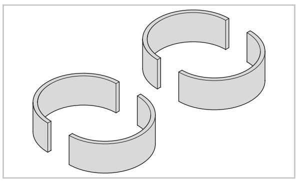
	Pipe support distance reduced for long riser		Fixpoint at jacket pipe		Fixpoint at media pipe	
	Horizontal [m]	Vertical [m]	Max. riser length (LRiser) [m]	Fixpoint force [kN]	Max. riser length (LRiser) [m]	Fixpoint force [kN]
d32/90	1.8	1.8	43	0.9		
d40/110	2.0	2.0	54	1.7		
d50/110	2.0	2.0	44	1.7		
d63/125	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)	d160/ D250	d225/ D315
Maximum force F (kN)	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.

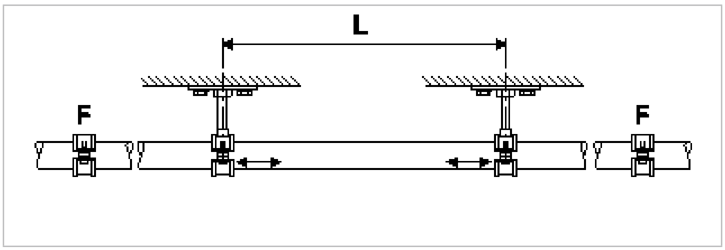
COOL-FIT 4.0 pipe and fittings are suitable for a rigidly fixed installation

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*

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
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 Piping Systems 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

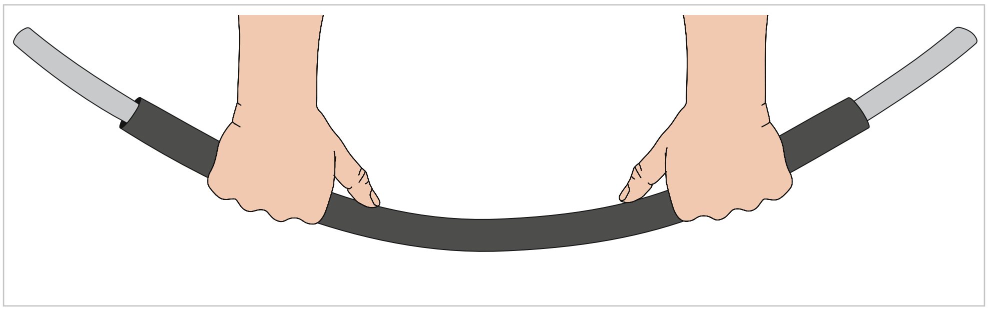
COOL-FIT 4.0 Push System pipes can be bent by hand without the use of bending tools. Ensure the pipes do not kink when bending them.

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

Minimum bending radius of the COOL-FIT 4.0 Push System 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

⚠ **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

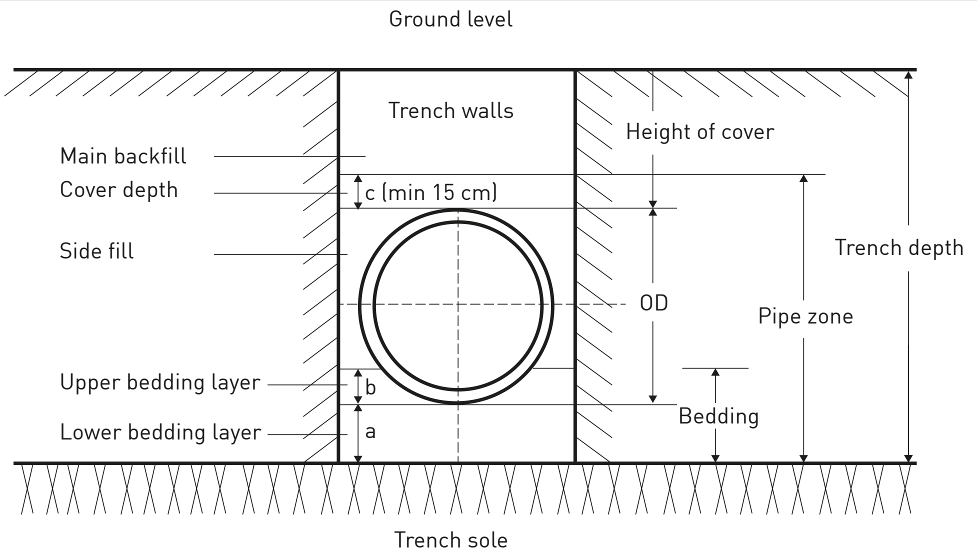
- Store in a cool, dry and dust-free area; avoid direct sunlight or ultraviolet irradiation; protect from nearby heat sources. Piping must not come into contact with substances that can cause damage.
- Hoses and hose assemblies must be stored horizontally, free of tension or bending forces.

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

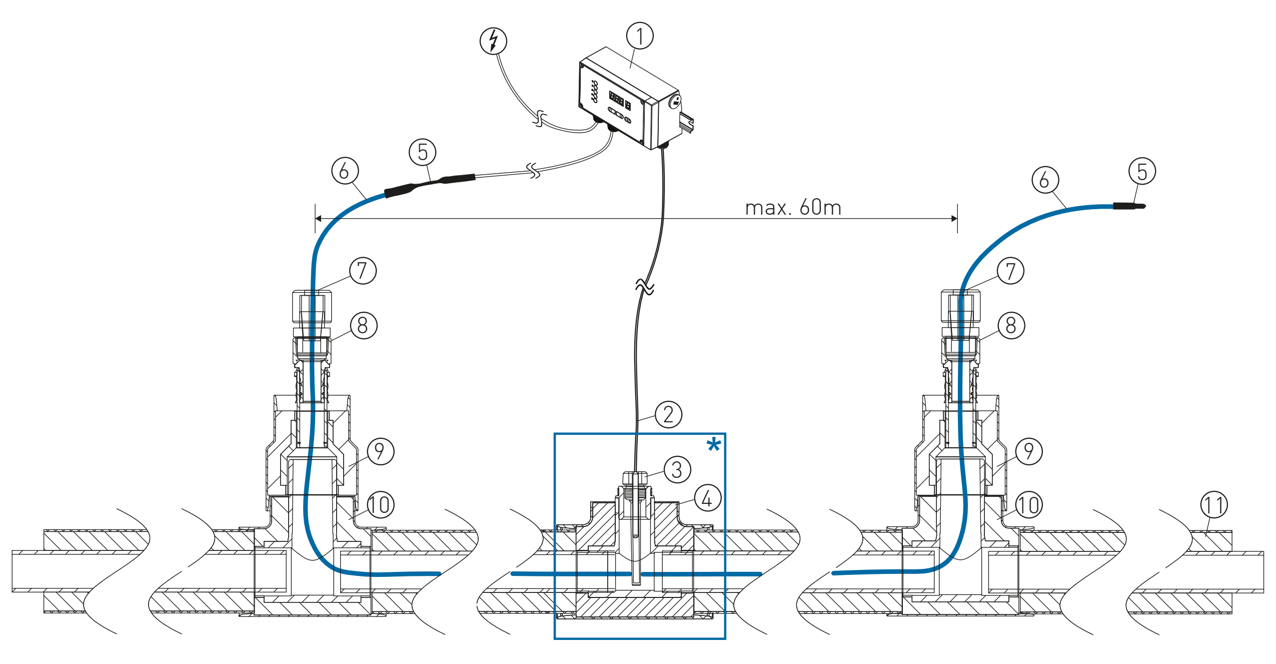
The upper bedding layer b is derived from static calculations. It is also important to ensure that no cavities are created below the pipe. The bedding dissipates all loads from the pipe securely and evenly into the ground. For this reason, the COOL-FIT 4.0 pipe has to rest solidly on the bedding across 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 Piping Systems representative or visit www.gfps.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

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

Temperature (°C)	d nominal diameter (mm)									
	32	40	50	63	75	90	110	140	160	225
	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
30	31.3	39.4	49.4	62.4	74.4	89.4	109.5	139.5	159.5	224.6
20	31.3	39.3	49.3	62.3	74.3	89.3	109.3	139.3	159.3	224.3
10	31.3	39.2	49.2	62.2	74.2	89.2	109.1	139.1	159.1	224.0
0	31.2	39.2	49.2	62.1	74.1	89.0	109.0	138.9	158.8	223.6
-10	31.2	39.1	49.1	62.0	74.0	88.9	108.8	138.7	158.6	223.3

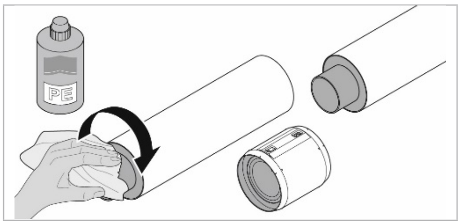
* Minimum diameters do not comply with the pipe tolerance specifications for GF electrofusion fittings. COOL-FIT minimum diameters are verified by release tests.

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.

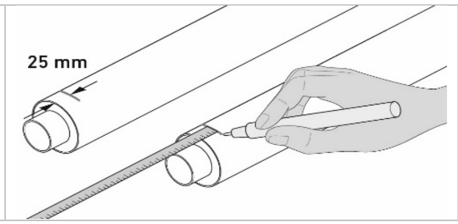
COOL-FIT 4.0 already factory-set free pipe ends (5 m lengths), COOL-FIT 4.0 Valves and COOL-FIT 4.0 Fittings d32 – d225 (Type B, barrel nipple and transition fittings) need not to be peeled.

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

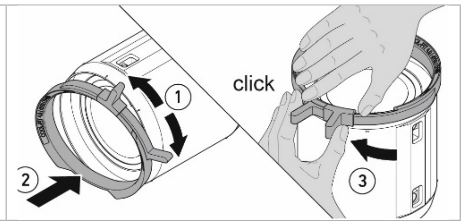
2 Cleaning and installation for welding preparation



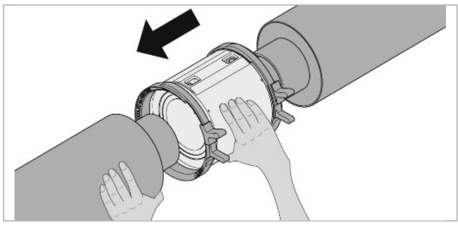
Step 1
Clean the fusion area of the components with Henkel Tangit PE cleaner and lintfree colourless and clean cloth in circum- ferential direction.



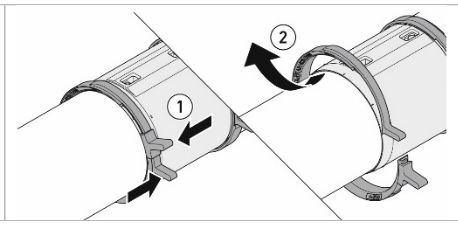
Step 2
Mark the jacket pipe at a distance of 25 mm



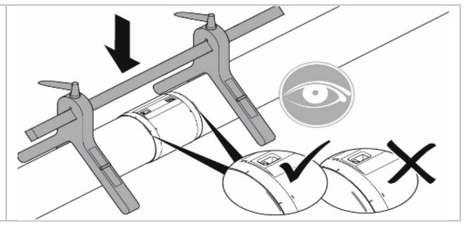
Step 3
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting



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

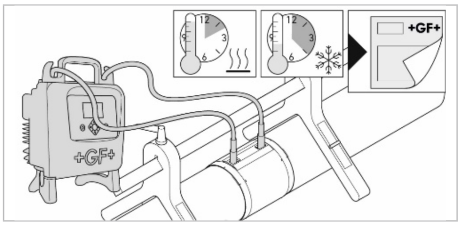


Step 5
Remove the assembly aids

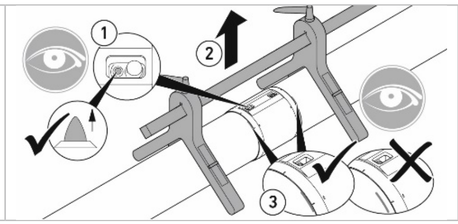


Step 6
Take care for low stress installation and secure the pipe and fitting against dislocation. Check insertions depths of both pipe into the fitting

3 Fusion process



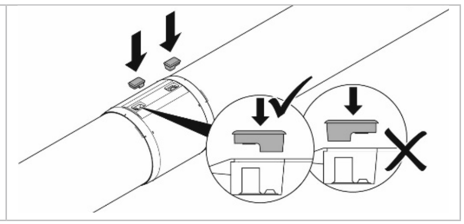
Step 1
Fuse in accordance to the operating instructions of the fusion unit. Use long fusion adaptors (790128035). Pay attention to fusion and cooling time.



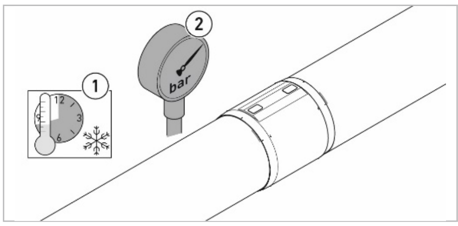
Step 2
After fusion, check fusion indicators on the electrofusion fitting and note the messages on the display of the electro- fusion machine.
Mark the fitting with following informa- tion

- Date
- Welder/ Weld number
- Time at the end of cooling time

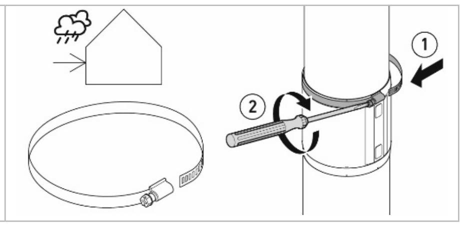
Remove the clamping tool after cooling time



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

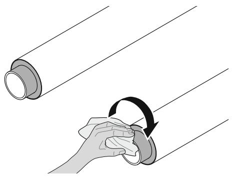
Prepare pipe with stripping and peeling tool for electrofusion welding connection (stripping, peeling and sheath cutting) and check pipe spigot with circumferential measuring tape for compliance with minimum permissible pipe outer diameter.

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

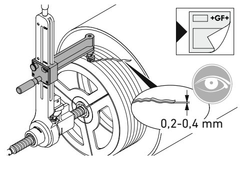
* Minimum diameters do not comply with the pipe tolerance specifications for GF electrofusion fittings. COOL-FIT minimum diameters are verified by release tests.

Step 1



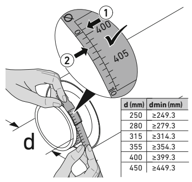
Perform a preliminary cleaning of the media pipe, deburr at a right angle using the pipe cutter, if necessary.

Step 2



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.

Step 3

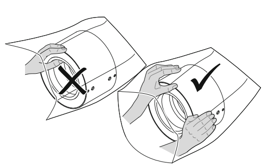
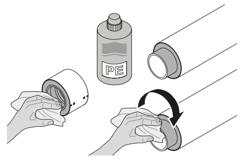
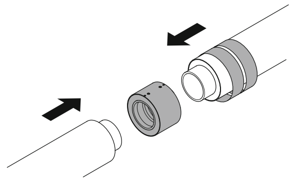


Check minimum permissible pipe outside diameter after peeling with a circumferential measuring tape.

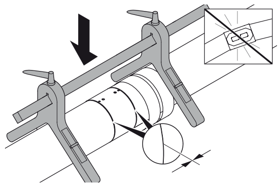
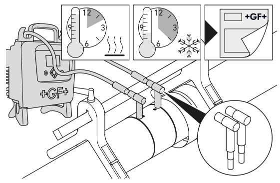
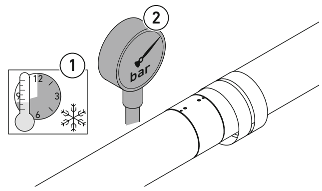
Overview of pipe outer diameter and open spigot length

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.

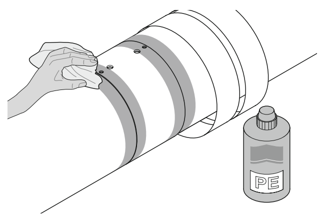
Cooling times before removing clamping tool and pressure/leak testing

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.

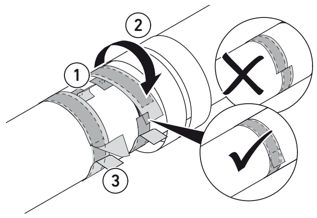
4 Sealing

Step 1



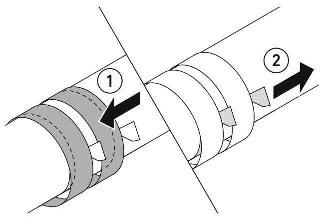
Clean the pipe/fitting type B and partially the coupler over the gap with Tangit PE cleaner.

Step 2



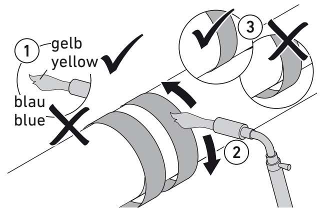
Affix the sealing tape centered over the gap and overlap it at the end. Press it on well and smooth out folds.

Step 3



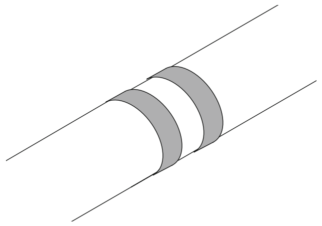
Position the shrink socket centered over the sealing tape, than remove the white separating tape.

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.

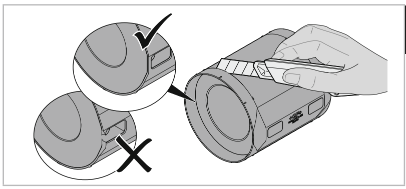
Step 5



The jointing is now finished.

Valves and flange joints

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

1

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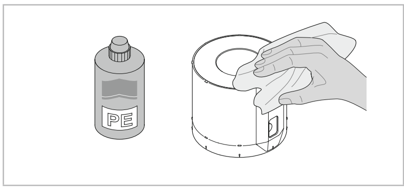

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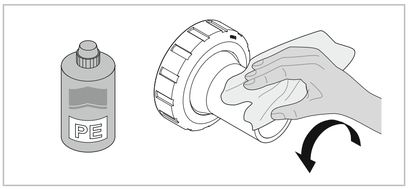
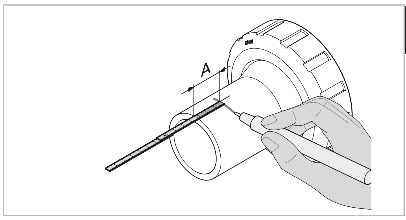


For the jointing to a valve or flange adaptor, the sealing lip of the fitting has to be removed at the valve or flange adaptor side and sealing and fusion surfaces have to be cleaned.

2 Standard fusion

Fuse both valve ends without valve mounted.

4


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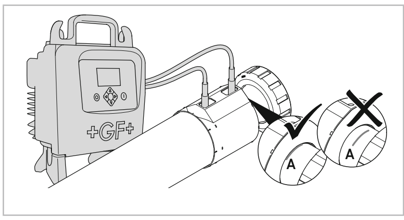

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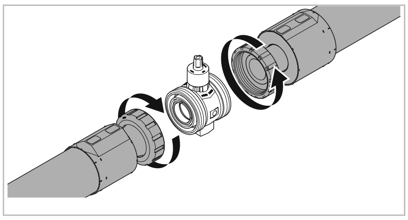
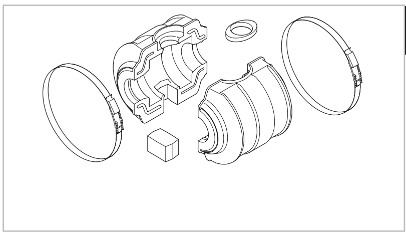


Following insertion depths A are valid for COOL-FIT 4.0 components:

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**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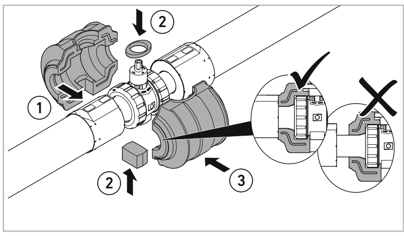

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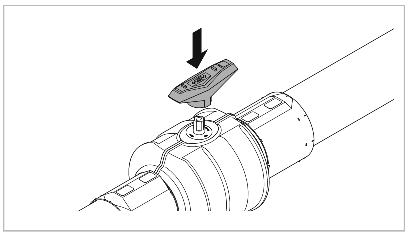
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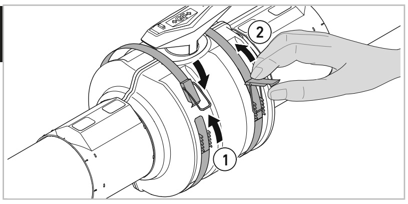


ℹ Further information can be found in the assembly instructions "COOL-FIT 2.0 / COOL-FIT 4.0 insulation for Ball Valve and Butterfly Valve".

ℹ 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.

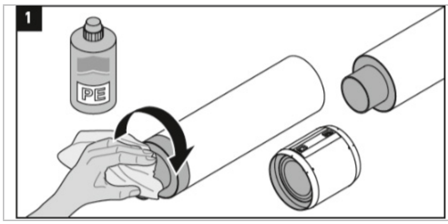
For compact fitting-to-fitting joints, COOL-FIT 4.0 barrel nipple can be used.

- **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.

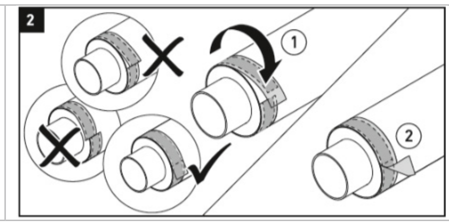
d	d75	d90	d110	d140	d160	d225
L (mm)	165	186	216	252	270	330

L: Length of un-insulated PE100 SDR11 pipe needed

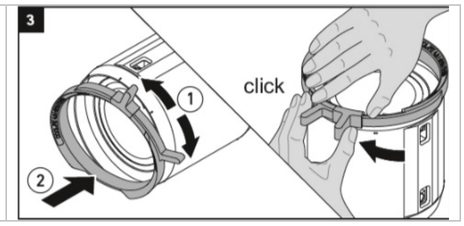
Mounting of sealing tape and transition of insulation



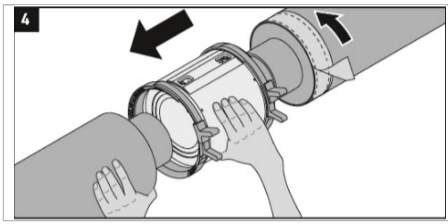
Step 1
In addition to the fusion zone, also clean the jacket of the pipe



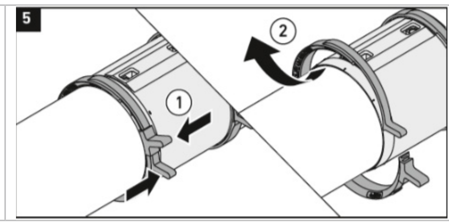
Step 2
Mount sealing tape/ transition of insulation, end to end without offset and fold down liner



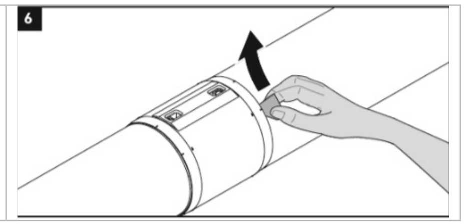
Step 3
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting



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



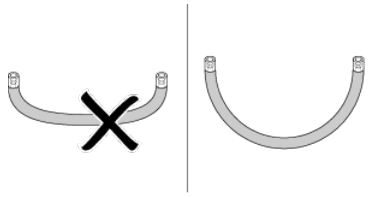
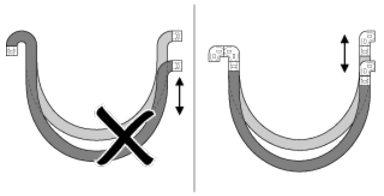
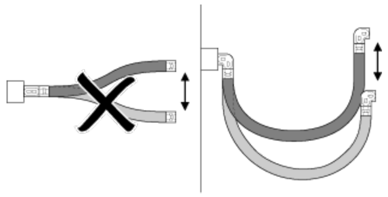
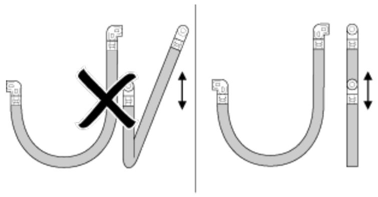
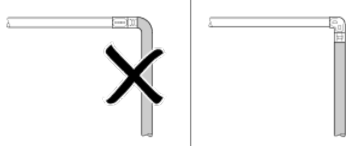
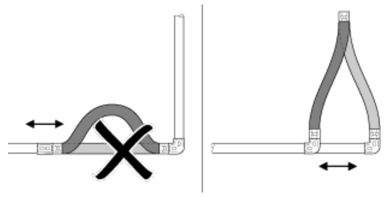
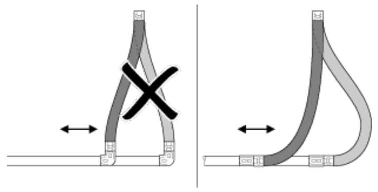
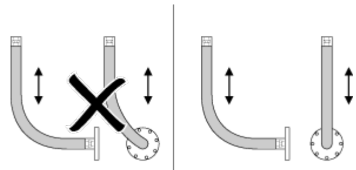
Step 5
Remove the assembly aids

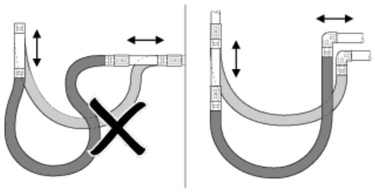


Step 6
Pull off the liner after removal of assembly aids

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 establis-hed 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.

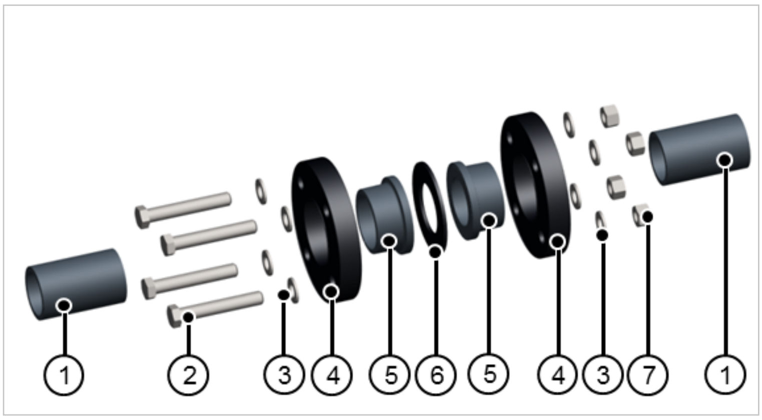
The open joint time is about 3 to 15 minutes depending on temperature and humidity of air.

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.



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

Recommended backing flange of COOL-FIT 4.0 flange joints

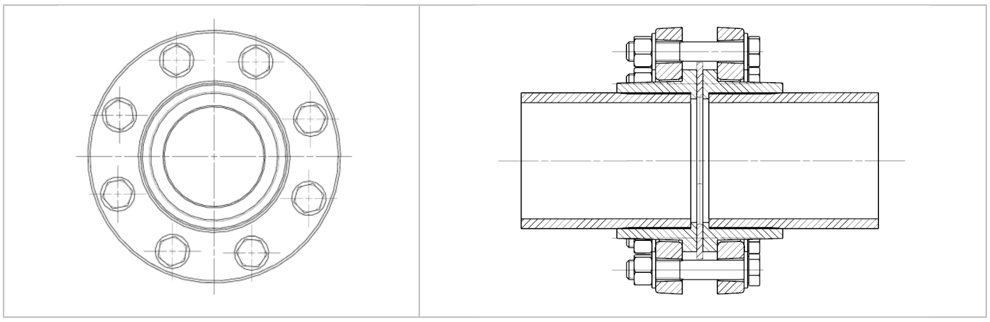
Flange	Properties
PP-steel flange	• Very robust and stiff due to the steel inlay • Corrosion-free plastic flange made of polypropylene PP-GF30 (fiber-glass reinforced) with steel inlay • High chemical resistance (hydrolysis-resistant) • UV-stabilized

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.

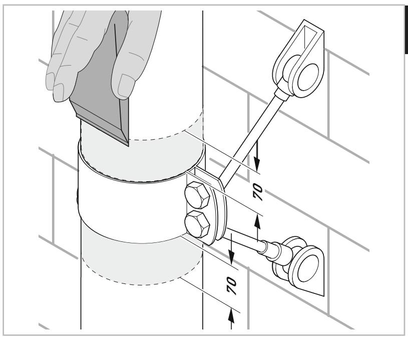
On installing Installation fittings in horizontal piping systems, the sensors should be in 1 – 5 or 7 – 11 clock position.

⚠ 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

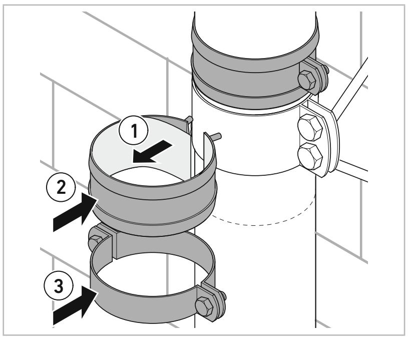
The COOL-FIT pipe shall be intstalled with a standard fix point as shown below.

1



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

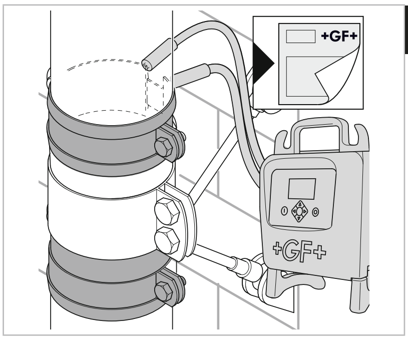
2



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.

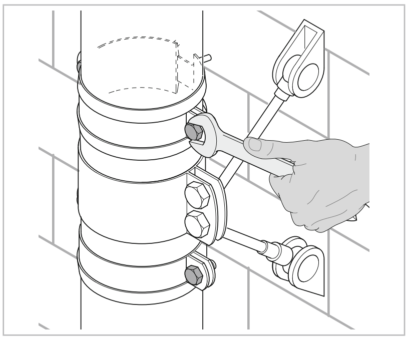
Note: The necessary welding pressure on the clean and dry COOL-FIT pipe is achieved by tightening the pipe clips. Take care that between fixed point clip and weld band there are no visible holes.

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.

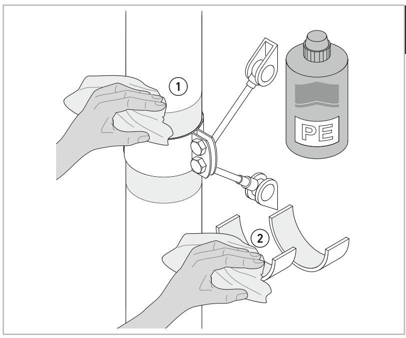
4



Step 4
Retighten the pipe clips after 10 minutes.

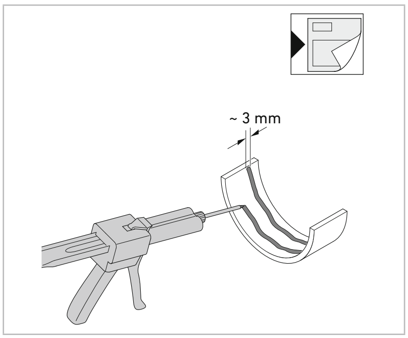
Installation of COOL-FIT 4.0F fixed points

1



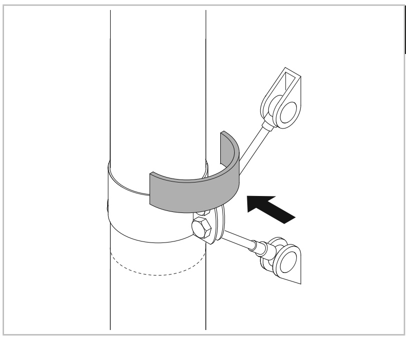
Step 1
Clean the cementing area on the pipe and the components with Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.

2



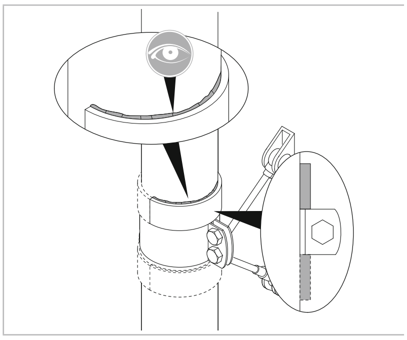
Step 2
Place the Tagit RAPID in about 3mm stripes on the inner side of the fixed point set half shells.

3



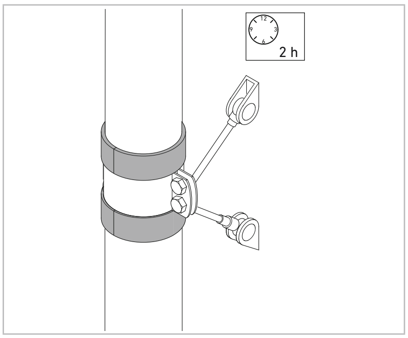
Step 3
Cement the half shelfs on the pipe next to the pipe clamp.

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.

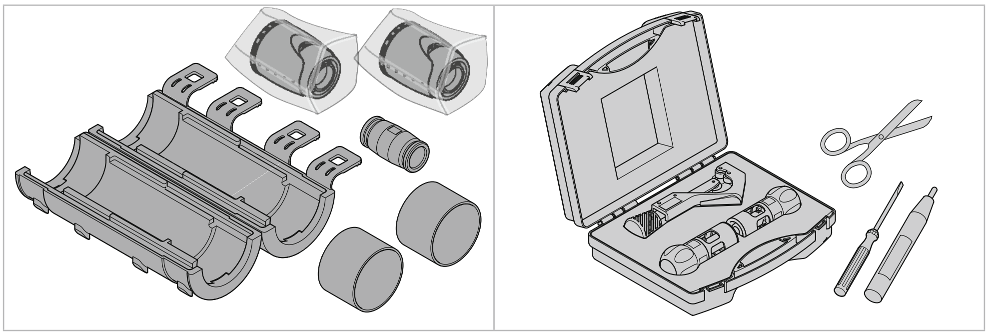
1.5.2 Jointing of COOL-FIT 4.0 Push System

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.

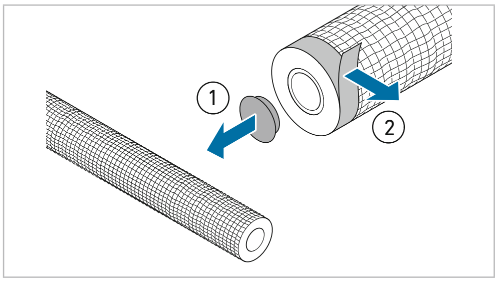
The surfaces to be welded on the pipe and fitting must be carefully protected from dirt, any grease, oil and lubricants. Only cleaning agents suitable for PE may be used.

Work preparation



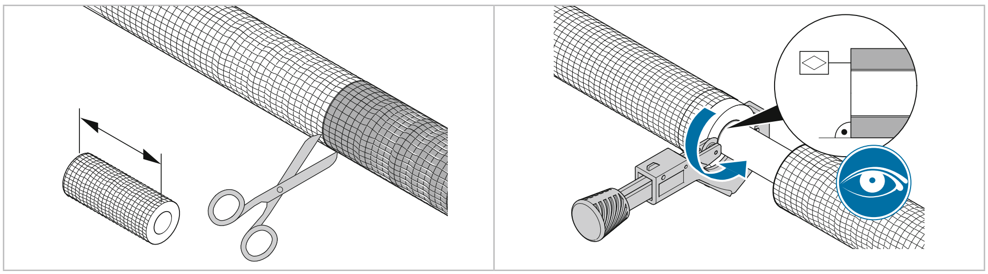
Remove products from packaging immediately before assembly and have necessary tools ready.

Prepare pipe



Step A

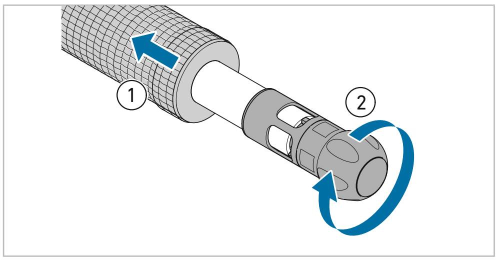
For new pipe start: Remove cap from pipe end and remove tape from insulation.



Step B

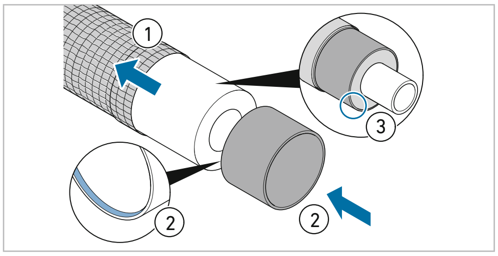
Pipe lengths: Cut the insulation at right angles at the interface using scissors. Push the insulation aside and cut the pipe flush with the insulation using a pipe cutter.

Joint



Step 1

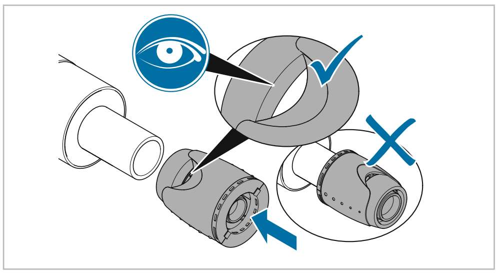
Push back the insulation and chamfer and calibrate the tube end with the chamfering tool. Visually check the chamfering. Remove any chips that may be adhering, also inside the tube.



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.

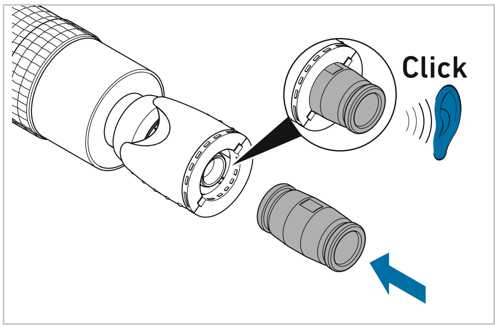
> It is easier to attach the ring if the insulation is first pulled off the pipe, then the ring is slid over the insulation. Then both are pushed back over the pipe.

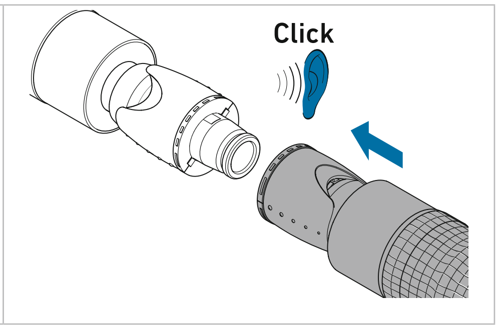


Step 3

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

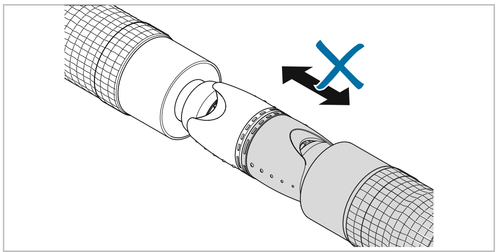
Push the adapter onto the tube end as far as it will go. Visually check that the viewing window of the adapter is completely filled by the tube.





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.

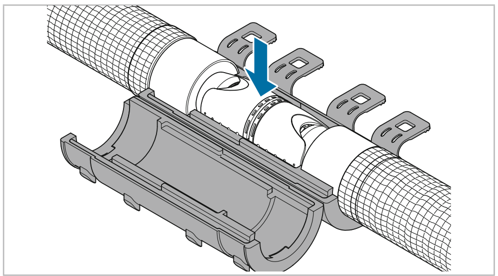


Step 6

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

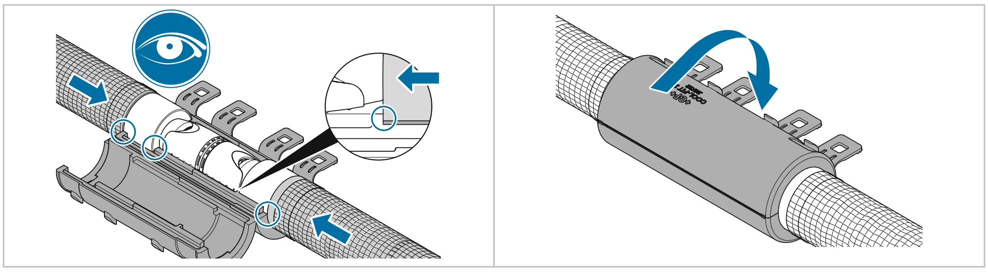
During the counter-tension test, the adapter and module may slide apart by up to 5 mm. Due to the dynamic holding mechanism, the pipe moves back slightly during operation or during the pressure test. This is not a defect of the assembly from a technical point of view.

Insert joint into shell



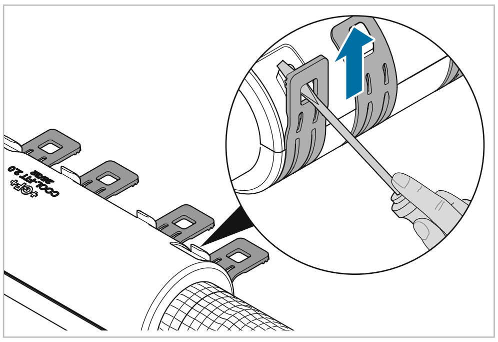
Step 7

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



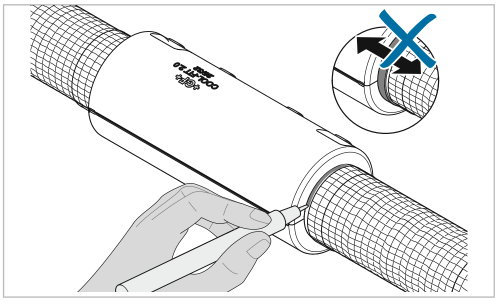
Step 8 - 9

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 • $P_{p\,(perm)}$	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")	$\leq P_{p\ (perm)}$	$\leq 0.85\ P_{p\ (perm)}$
Test duration (depends on the length of the pipe sections)	L ≤ 100 m: 3 h 100 m < L ≤ 500 m: 6 h	L ≤ 100 m: 3 h 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.

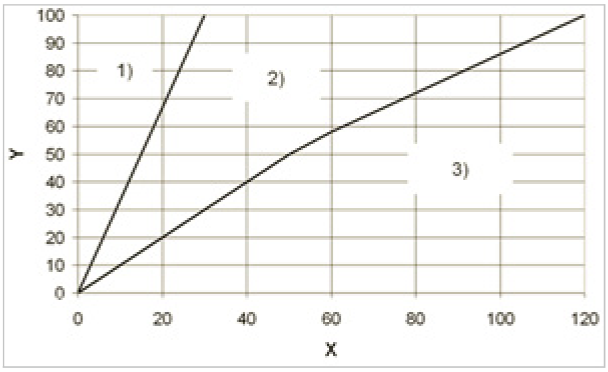
Reference values for the filling volume are given in the table below:

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

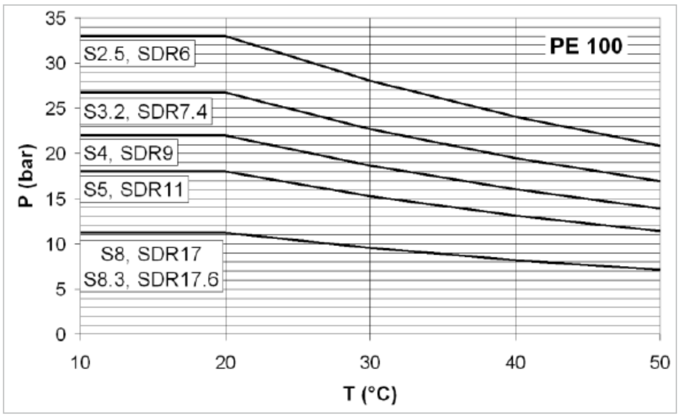
The permissible test pressure is calculated using the following formula:

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

$\sigma_{v(T,\,100\,h)}$ 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

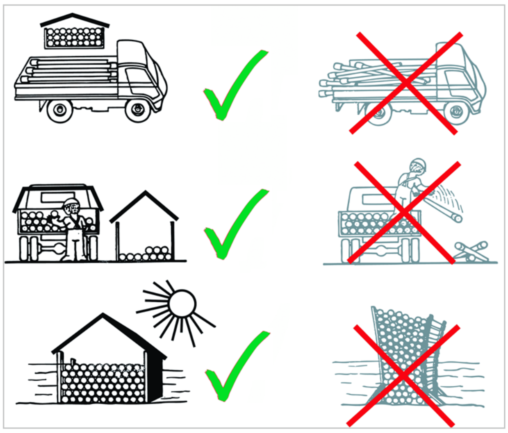
1.6 Transport, Handling and Storage

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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