AMIANTIT

AMITECH

Flowtite Pipe Systems

Potable Water

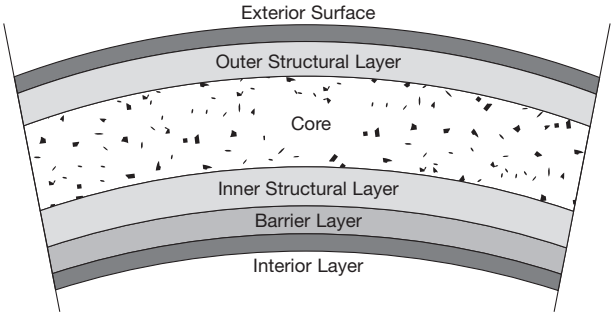
AMIANTIT PIPE SYSTEMS

1 Production process

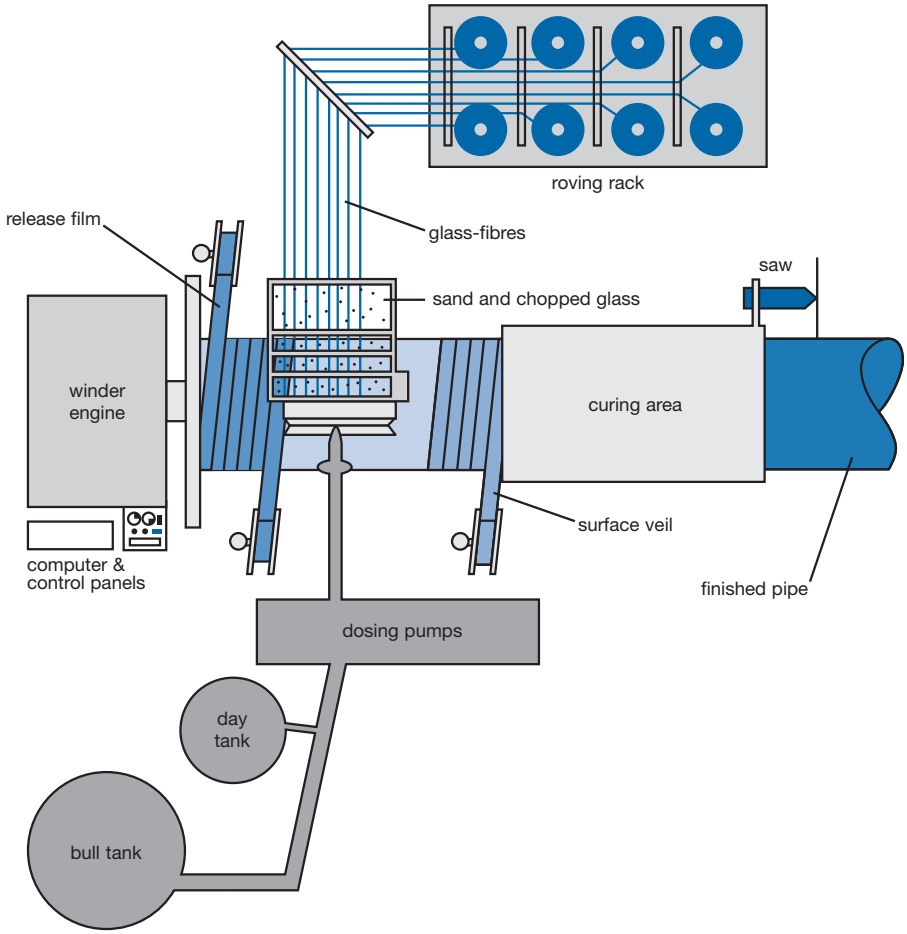
The basic raw materials used in the FLOWTITE pipe's manufacturing are resin, fibreglass and silica sand. Usually unsaturated polyester resins are used since they give good performance for potable water applications.

FLOWTITE pipes are manufactured using the continuous advancing mandrel process, which represents the state of the art in GRP pipe production. This process allows the use of continuous glass fibre reinforcements in the circumferential direction. For a pressure pipe or buried conduit, the principle stress is in the circumferential direction, thus incorporating continuous reinforcements in this direction yields a higher performing product at a lower cost. Using technology developed by material specialists, a very dense laminate is created that maximizes the contribution from three basic raw materials. Both continuous glass fibre rovings and choppable roving are incorporated for high hoop strength and axial reinforcement. A sand fortifier is used to provide increased stiffness by adding extra thickness, placed near the neutral axis in the core. With the FLOWTITE dual resin delivery system, the equipment has the capability of applying a special inner resin liner for severe corrosive applications while utilising a less costly resin for the structural and outer portion of the laminate.

Taking advantage of the winding process, other materials, such as a glass veil or polyester veil can be used to enhance the abrasion resistance and the finishing of the pipe.



The figure above shows a typical cross section of a pipe laminate. This section, as well as the way of applying and placing different raw materials, can differ depending on the pipe application.



2 Product Advantages

FLOWTITE Technology has been able to bring a product to the market that can provide a low cost, long-term piping solution to customers around the world. The long list of features and benefits add up to provide the optimum installed and life cycle cost system.

Features & Benefits

Corrosion-resistant
- Long, effective service-life materials
- No need for linings, coatings, cathodic protection, wraps or other forms of corrosion protection
- Low maintenance costs
- Hydraulic characteristics essentially constant over time

Light weight
(1/4 weight of ductile iron; 1/10 weight of concrete)
- Low transport costs (nestable)
- Eliminates need for expensive pipe handling equipment

Long standard lengths
(up to 18 metres with individual lengths on request)
- Fewer joints reduce installation time
- More pipe per transport vehicle means lower delivery costs

Extremely smooth bore
- Low friction loss means less pumping energy needed and lower operating costs
- Minimum slime build-up can help lower cleaning costs

Precision FLOWTITE
with elastomeric REKA gaskets
- Tight, efficient joints designed for coupling to eliminate infiltration and ex-filtration
- Ease of joining, reducing installation time
- Accommodates small changes in line direction without fittings or differential settlement

Flexible manufacturing
- Custom diameters can be process manufactured to provide maximum flow volumes with ease of installation for rehabilitation lining projects

High technology pipe design
- Lower wave celerity than other piping materials can mean less cost when designing for surge and water hammer pressures

High technology pipe manufacturing system
- High and consistent product quality worldwide which produces pipe ensures a reliable product that complies to stringent performance standards (AWWA, ASTM, DIN, EN, etc.)
- Quick and easy installation with construction site equipment due to light weight
- Fast installation with a reduced number of couplings due to pipe lengths up to 18 m
- simple and inexpensive tightness tests
- long usage with consistently high flow rates
- minimal effort for repairs and maintenance
- excellent corrosion resistance
- reinforced inner surface with a high resistance against abrasion

Due to these factors, projects made with FLOWTITE pipe systems are very economical and long-lasting with low maintenance efforts over the years.

3 Certificates and Approvals

FLOWTITE pipe systems have been tested and approved for the conveyance of potable water meeting many of the world's leading authorities' and testing institutes' criteria, including:

- NSF (Standard No. 61) – United States
- DVGW – Germany
- Lyonnaise des Eaux – France
- Sanitary and Hygienic Conclusion – Russia
- Hygienic Conclusion of Sanitary and Epidemiological Expertise about the Product Security – Kazakhstan
- Oficina Técnia De Estudios Y Controles – Spain
- Państwowy Zakład Higieny (National Institute of Hygiene) – Poland
- ÖVGW – Austria
- NBN.S. 29001 – Belgium
- KIWA – Netherlands

FLOWTITE pipe systems fulfil the product standards AWWA, ASTM, DIN, ISO and EN.

Other local approvals are also available, dependent on country specific requirements.

Amiantit is participating in the development of all these standards with representatives of all the worldwide organisations, thereby ensuring performance requirements will result in reliable products.

Local approvals and certifications are attached at the inner package of this brochure.

4 Quality Characteristics

4.1 Raw Materials

Raw materials are delivered with vendor certification demonstrating their compliance with Flowtite quality requirements. In addition, all raw materials are sample tested prior to their use. These tests ensure that the pipe materials comply with the specifications as stated. Raw materials should be, according to Flowtite quality requirements, pre-qualified in such a way that their suitability to be use in the process and in the final product is demonstrated.

Raw Materials used in pipe production are:

- Glass
- Resin
- Catalyst
- Sand
- Additives

Only FLOWTITE approved raw materials can be used for the production of the FLOWTITE pipe.

Glass
Glass is specified by tex which is = weight in grams/1000 meters length
Hoop roving: Continuous roving used in different tex for the production of the FLOWTITE pipe
Chop roving cut directly on the machine to provide strength in different directions.

Resin
Only qualified resin for the winding process. Usually it is delivered in drums or bulk. The resin is prepared in day tanks at the winder. Normal application temperature is 25°C. Resin is delivered from the producer and may be diluted before use on the winder with styrene to reach the required and acceptable viscosity, as defined by FLOWTITE Technology.

Catalyst
The right amount of catalyst is added to the resin for curing the mix right before application on the mandrel. Only approved catalysts are used in the manufacturing process of the FLOWTITE pipes.

Sand
Sand is added to the core of the pipe and the inner layer of couplings. High silica sand must be within the FLOWTITE specifications for approved raw material.

Additives
Additives are used as accelerator for the resin and are mixed with it in the day tanks. The additives are available in different concentration and may be diluted by the producers in mineral spirit to reach the required concentration needed for the production of the FLOWTITE pipes.

4.2 Physical Properties

The manufactured pipe's hoop and axial load capacities are verified on a routine basis. In addition, pipe stiffness and deflection tests are carried out in accordance with our internal Flowtite quality regulations.

4.3 Finished Pipe Properties

100% of all finished pipes for potable water are checked for the following:

- Visual inspection
- Barcol hardness
- Wall thickness
- Section length
- Diameter
- Hydrostatic leak tightness test to twice rated pressure (PN6 and above)
  - ! **Note:** Pressure and diameters are limited by the hydrotest capacity

4.4 Other Quality Characteristics

More detailed information about many other quality characteristics such as:

- Hydrostatic Design Basis – HDB
- Long-term Ring Bending
- Hydro-testing
- Surge and Water Hammer
- Load Capacity Values
- Hoop Tensile Load Capacity
- Axial Tensile Load Capacity
- Flow Velocity
- UV Resistance
- Poisson's Ratio
- Flow Coefficients
- Abrasion Resistance

can be found in our brochure "Technical Characteristics" of FLOWTITE pipes.

5 Product Range

FLOWTITE pipe systems are supplied in nominal diameters ranging from DN 80 up to DN 4000 mm. The nominal diameter is considered as the inside diameter. The **standard** diameter range in mm is defined as below:

100 · 150 · 200 · 250 · 300 · 350 · 400 · 450 · 500 · 600 · 700 · 800 · 900 · 1000
1100 · 1200 · 1400 · 1600 · 1800 · 2000 · 2200 · 2400 · 2600 · 2800 · 3000

The locally manufactured standard diameter range varies according to manufacturing facilities. For detailed information, please do not hesitate to contact your on-site contact. Larger diameters than DN 3000 up to 4000 mm and other diameters are available on request.

5.1 Stiffness Classes

FLOWTITE pipe systems show the following specific initial stiffness (EI/D^3) expressed in N/m^2 and the FLOWTITE standard is defined as follows:

Stiffness Class SN	Stiffness (N/m^2)
2500	2500
5000	5000
10000	10000

Table 5-1 Stiffness Class

Other stiffness classes are available on request. We also supply custom-designed pipe systems with a stiffness tailored to the needs of the project.

5.2 Pressure

Our FLOWTITE pipe systems for potable water applications are supplied in the standard pressure classes as listed below:

Pressure Class PN	Pressure Rating Bar	Upper diameter limit
6	6	3000
10	10	2400
16	16	2000

Table 5-2 Pressure Class

Custom-designed pipes with pressure tailored to the needs of the project are also available.

5.3 Length

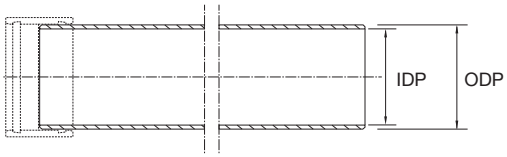
Our FLOWTITE Pipes for potable water are available in standard length of 6, 12 and 18 m. Other tailor-made lengths are available on request.

5.4 Hydro-testing

Maximum Factory Test Pressure 2.0 x PN (Pressure Class). Maximum Field Test Pressure 1.5 x PN (Pressure Class). Pressure and diameter upper limit are functions of the hydrotest capacity in the plants.

5.5 Standard Pipe and Coupling Data Sheet

Our Flowtite pipe systems for potable water applications are supplied in the standard diameter range, pressure and stiffness classes as listed below. Other diameters and pressure classes are available on request.



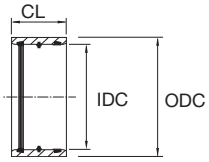
Pipe FPP

"B2" – OD Series	SN	10000			
	PN	10/16			
		DN	ODP	IDP	kg/m*
		mm	mm	mm	
		100	116.4	109.2	2.0
		150	168.4	158.8	4.2
		200	220.9	208.9	7.3
		250	272.5	258.3	11.0
		300	325.1	308.5	15.4

* Approx. Weights

Table 5-3 Small Diameters – pipe dimensions & weight

SN = Pipe stiffness, PN = Nominal Pressure, ODP = Outside diameter of pipe, IDP = Inside diameter of pipe



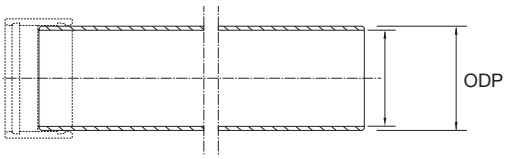
Double Bell Coupling FPC

SN	10000				
PN	10/16				
	DN	IDC	ODC	CL	kg/pc*
	mm	mm	mm	mm	
	100	116.5	138.9	150	1.3
	150	168.5	190.9	150	2.1
	200	222.0	256.4	175	4.2
	250	273.6	308.0	175	5.1
	300	326.0	360.4	175	6.0

* Approx. Weights

Table 5-4 Small Diameters – coupling dimensions & weight

SN = Pipe stiffness, PN = Nominal Pressure, ODC = outside diameter of coupling, IDC = Inside diameter of coupling, CL = Coupling length

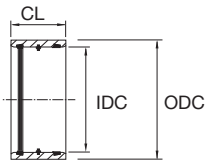


Pipe FPP

	SN		2500			5000			10000		
	PN		6	10	16	6	10	16	6	10	16
		ODP									
	DN	mm	kg/m*	kg/m*	kg/m*	kg/m*	kg/m*	kg/m*	kg/m*	kg/m*	kg/m*
"B2" – OD Series	300	324.9	8.1	7.9	7.4	10.3	10.2	9.4	12.6	12.6	12.1
	350	376.8	11.0	10.5	9.9	14.2	13.7	12.5	17.2	17.2	16.2
	400	427.7	14.4	13.4	12.5	18.4	17.5	16.0	22.3	22.3	20.7
	450	478.6	18.3	16.7	15.7	23.4	21.7	19.8	28.1	28.1	25.2
	500	530.5	22.8	20.4	19.1	29.1	26.7	24.5	34.8	34.8	31.6
"B1" – OD Series	600	617.4	31.3	27.4	25.6	39.2	35.9	32.8	47.8	47.8	42.9
	700	719.4	42.2	37.0	34.3	53.0	48.6	44.2	65.5	65.5	57.9
	800	821.4	54.8	48.1	44.3	68.6	62.9	57.2	85.1	85.1	74.9
	900	923.4	69.2	60.6	55.6	86.5	80.3	71.9	107.1	107.1	94.6
	1000	1025.4	85.3	74.5	68.1	106.0	98.8	88.3	132.4	132.4	116.2
	1100	1127.4	103.1	89.6	82.0	128.1	119.1	106.2	160.3	160.3	140.2
	1200	1229.4	121.9	106.1	97.1	151.5	141.5	125.8	190.0	190.0	166.3
	1300	1331.4	143.1	124.1	113.4	178.7	165.6	147.2	222.8	222.8	194.4
	1400	1433.4	165.3	143.7	131.1	206.5	191.3	170.4	257.8	257.8	225.4
	1500	1535.4	188.5	164.1	149.9	237.4	219.3	195.0	294.8	294.8	258.3
	1600	1637.4	214.9	186.8	170.1	269.2	249.5	221.4	335.8	335.8	293.3

* Approx. Weights

Table 5-5 Large Diameters – Pipe data



Double Bell Coupling FPC

	PN			6		10		16	
		Length CL	IDC	ODC		ODC		ODC	
	DN	mm	mm	mm	kg/pc*	mm	kg/pc*	mm	kg/pc*
	300	270	326.0	367.8	10.9	368.6	11.1	369.8	11.4
	350	270	377.9	419.5	12.4	420.7	12.8	422.1	13.3
	400	270	428.8	470.4	14.0	471.6	14.5	474.2	15.6
	450	270	479.7	520.9	15.6	522.5	16.3	524.5	17.1
	500	270	531.6	572.6	17.2	574.2	17.9	576.0	18.7
	600	330	618.5	666.1	28.6	667.7	29.6	669.9	31.0
	700	330	720.5	767.7	32.8	770.1	34.5	774.5	37.8
	800	330	822.5	869.5	37.1	873.7	40.6	878.9	44.9
	900	330	924.5	972.5	42.5	977.1	46.8	980.3	49.1
	1000	330	1026.5	1075.5	48.1	1080.3	53.1	1083.9	56.0
	1100	330	1128.5	1178.1	53.5	1183.5	59.5	1187.5	63.3
	1200	330	1230.5	1280.7	58.9	1286.5	65.9	1291.1	70.9
	1300	330	1332.5	1380.8	64.4	1388.8	72.4	1394.2	78.6
	1400	330	1434.5	1485.7	69.9	1491.9	78.7	1499.5	88.6
	1500	330	1536.5	1587.6	75.4	1594.2	85.4	1604.4	100.1
	1600	330	1638.5	1690.7	81.2	1697.5	92.3	1709.9	111.4

* Approx. Weights

Table 5-6 Large Diameters – Double Bell Coupling (FPC) data

6 Pipe joining

6.1 Double Bell Coupling (FPC)

FLOWTITE pipe sections are typically joined using FLOWTITE Pressure GRP couplings (FPC). Pipe and couplings may be supplied separately, or the pipe may be supplied with a coupling installed on one end. The FLOWTITE coupling utilises an elastomeric gasket (REKA system) for sealing. The gasket sits in a precision-machined groove in each end of the coupling and seats and seals against a spigot surface. The REKA gasket system has been proven in use for more than 75 years.

Note: Detailed installation instructions can be found in our separate publications for pipe installation.

Joint Angular Deflection

The joint is extensively tested and qualified in accordance with ASTM D4161, ISO DIS8639 and EN 1119. Maximum angular deflection (turn) at each coupling joint, measured as the change in adjacent pipe centre lines, must not exceed the amounts given in table below.

Nom Pipe Diameter (mm)	Angular deflection (degrees)
DN ≤ 500	3.0
15 < DN ≤ 800	2.0
900 < DN ≤ 1800	1.0
DN > 1800	0.5

Table 6-1 Angular Deflection at Double Coupling Joint

The pipes must be joined in a straight alignment, but not all the way to the home line, and thereafter deflected angularly as required (***Figure 6-1***).

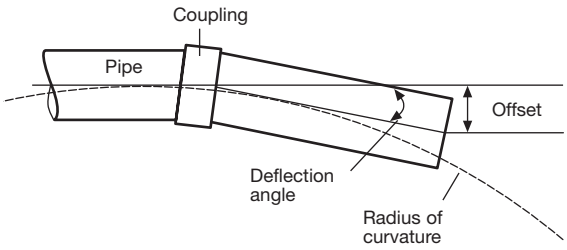
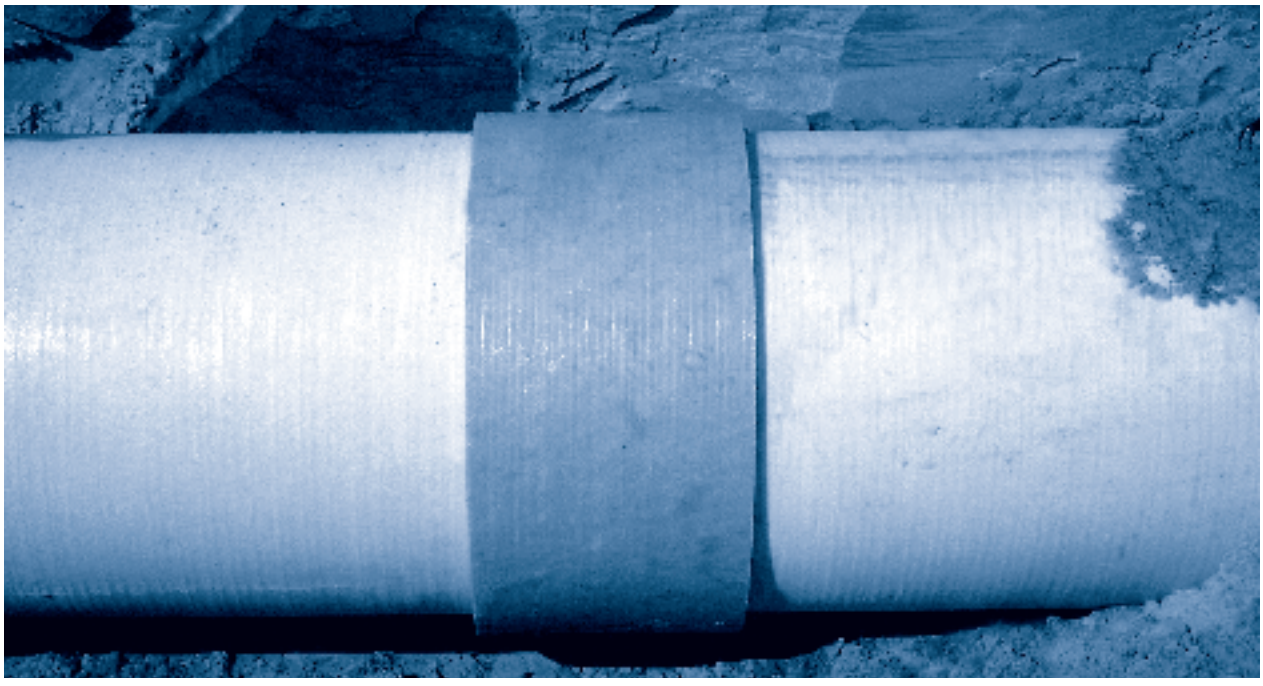


Figure 6-1 Offset and radius of curvature

Angle of Deflection (deg)	Maximum Offset (mm) Pipe length			Radius of Curvature (m) Pipe length		
	3 m	6 m	12 m	3 m	6 m	12 m
3.0	157	314	628	57	115	229
2.5	136	261	523	69	137	275
2.0	105	209	419	86	172	344
1.5	78	157	313	114	228	456
1.3	65	120	240	132	265	529
1.0	52	105	209	172	344	688
0.8	39	78	156	215	430	860
0.5	26	52	104	344	688	1376

Table 6-2 Offset and Radius of Curvature



6.2 Locked Joints

The FLOWTITE locked joint is a double bell with rubber gaskets and locking rods to transfer axial thrust from one pipe section to another. On each side, the coupling bell has a standard rubber gasket and a rod-groove system, through which the load is transferred via compressive and shear action. The pipe spigot for locked joints has a matching groove.

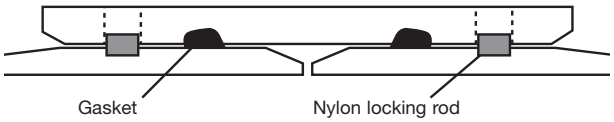


Figure 6–2 Locked Joint

The joint is assembled by using a similar procedure as the standard FLOWTITE coupling, except that there is no centre register.

6.3 Other Joining Systems

GRP Flanges

The standard bolt pattern to which our flanges are manufactured is in accordance with ISO2084. Other bolting dimension systems such as AWWA, ANSI, DIN and JIS can also be supplied. Available are flange connections with fibreglass adhesives, as well as zinc steel loose-type flanges. Fibreglass tight flanges and loose-type flanges made of fibreglass can be delivered to order. Loose and fixed flanges are available for all pressure classes.

Contact moulded Flanged joints:

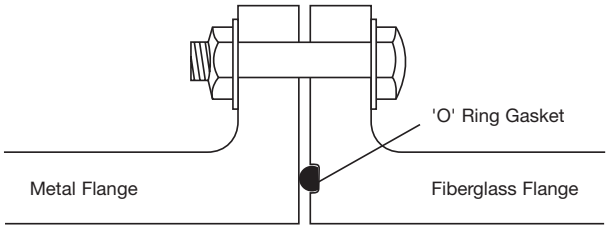


Figure 6-3 Flanged joint

Fixed Flange joints:

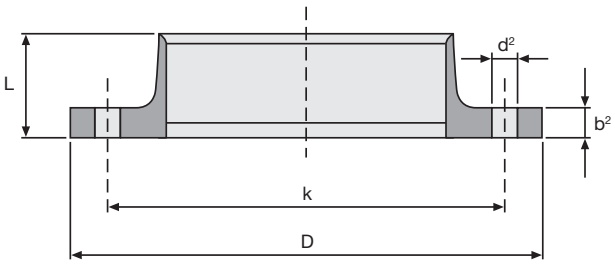


Figure 6-4 Fixed Flanged joint

Loose Ring Flanges:

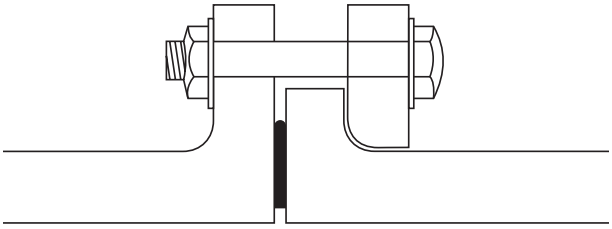


Figure 6-5 Loose Ring with flat gasket incl. steel support

Mechanical Steel Couplings

When connecting FLOWTITE pipe to other materials with different outside diameters, flexible steel couplings are one of the preferred jointing methods. These couplings consist of a steel mantle with an interior rubber sealing sleeve. They may also be used to join FLOWTITE pipe sections together, for example in a repair or for closure. Three grades are commonly available:

- Coated steel mantle
- Stainless steel mantle
- Hot dip galvanized steel mantle

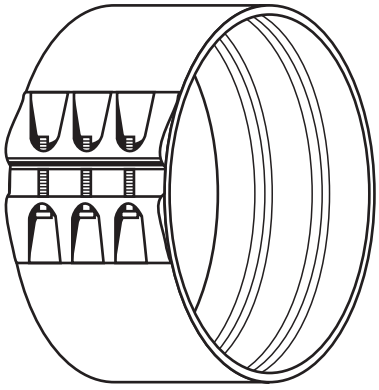


Figure 6-6 Flexible steel coupling

Mechanical couplings have been used to join pipes of different materials and diameters, and to adapt to flange outlets. FLOWTITE Technology has found a wide manufacturing variance in these couplings, including bolt size, number of bolts and gasket design which makes standardized recommendations impossible. If a mechanical joint is used to join FLOWTITE to another pipe material then a dual independent bolting system allows for the independent tightening of the FLOWTITE side which typically requires less torque than recommended by the coupling manufacturer.

Consequently, we cannot recommend the general use of mechanical couplings with FLOWTITE pipe. If the installer intends to use a specific design (brand and model) of mechanical coupling, he is advised to consult with the local FLOWTITE pipe supplier prior to its purchase. The pipe supplier can then advise under what specific conditions, if any, this design might be suitable for use with FLOWTITE.

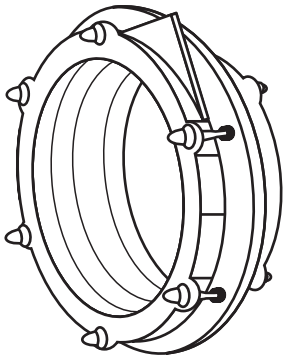


Figure 6-7 Dual bolt mechanical coupling

Laminated Joints (Butt strap)

Laminated Joints are typically where the transmission of axial forces from internal pressure is required, or as a repair method. The length and thickness of the lay-up depends on diameter and pressure.

Detailed information about the local availability of joints and joining systems can be requested from your local supplier, or is attached to this brochure.

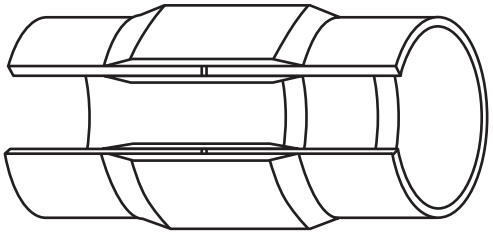


Figure 6-8 Laminated joint

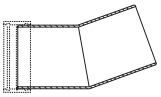
7 Accessories

FLOWTITE Technology has created a standardised line of GRP fittings that are moulded or fabricated using the same materials that are used to produce FLOWTITE pipe. One of the benefits of FLOWTITE pipe is the ability to fabricate a wide assortment of fittings, standard as well as non-standard.

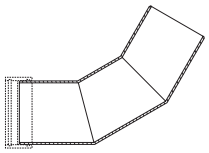
The standard delivery of our fittings include the coupling pre-mounted at one/one both ends. Additionally we are able to supply complete spools with pre-installed flange connections.

The manufacturing of our accessories follows internationally well accepted ISO standards.

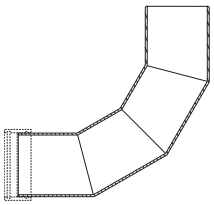
One Segment Bends:
See section 7.1 ➔



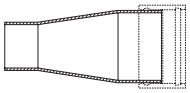
Two Segmented Bends:
See section 7.1 ➔



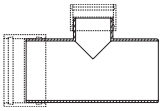
Three Segmented Bends:
See section 7.1 ➔



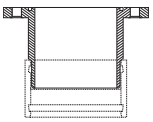
Concentric Reducers:
See section 7.2 ➔



Tees – Equal and Reduced – :
See section 7.3 ➔

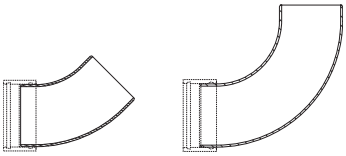


Fix Flanges – Type A:
See section 7.4 ➔

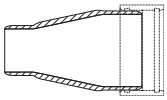


Fix Flanges – Type B:
See section 7.5 ➔

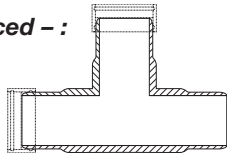
Moulded Bends:
See section 7.6 ➔



Moulded Reducers, concentric:
See section 7.7 ➔



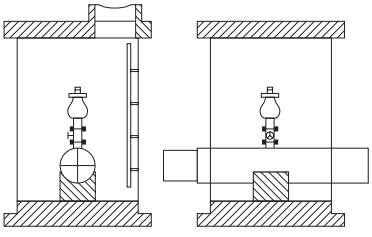
Moulded Tees – Equal and Reduced – :
See section 7.8 ➔



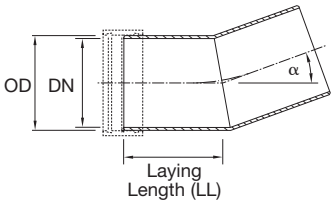
Blind Flanges:
See section 7.9 ➔

Loose Flanges and Collars:
See section 7.10 ➔

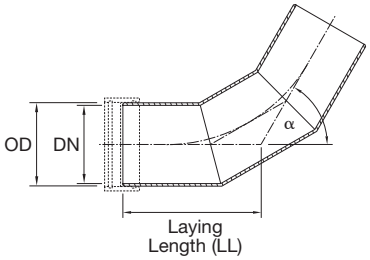
Valve Chambers:
See section 7.11 ➔



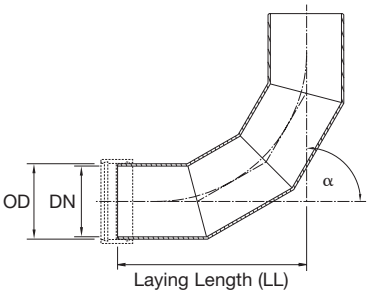
7.1 Segmented Bends



One Segmented Bend



Two Segmented Bend



Three Segmented Bend

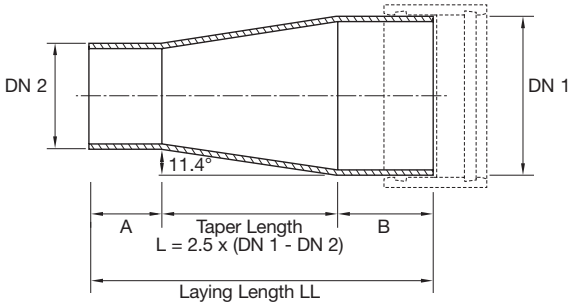
		Angle α						
"B2" OD Series		11.25°	15°	22.5°	30°	45°	60°	90°
DN	OD	No. of Mitres with Laying Length (LL)						
mm	mm	1	1	1	1	2	2	3
100	116	250	250	250	250	250	300	350
150	168	250	250	250	250	300	300	400
200	220	250	250	250	300	350	400	500
250	272	300	300	300	300	400	450	600
300	324	400	350	400	400	500	550	750
350	376	400	400	400	450	550	600	800
400	427	450	450	450	450	600	650	900
450	478	450	450	500	500	600	700	1000
500	530	450	450	500	500	650	750	1050

Table 7-1-1 Small Diameters – laying length LL in mm – stiffness and pressure classes acc. to table 5-1 and 5-2

		Angle α						
"B1" OD Series		11.25°	15°	22.5°	30°	45°	60°	90°
DN	OD	No. of Mitres with Laying Length (LL)						
mm	mm	1	1	1	1	2	2	3
600	617	400	400	400	450	600	700	1100
700	719	400	400	450	450	650	800	1200
800	821	450	450	450	500	700	850	1350
900	923	450	450	500	550	800	950	1500
1000	1025	450	500	500	550	850	1000	1650
1100	1217	500	500	550	600	900	1100	1800
1200	1229	500	550	600	600	950	1200	1950
1400	1433	600	600	650	700	1100	1350	2250
1600	1637	650	700	750	800	1250	1550	2550

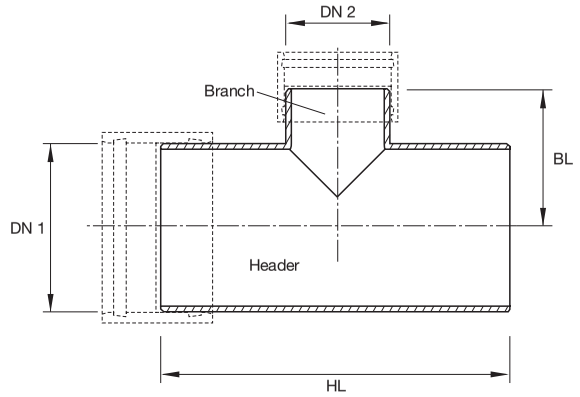
Table 7-1-2 Large Diameters – laying length LL in mm – stiffness and pressure classes acc. to table 5-1 and 5-2

7.2 Segmented Concentric Reducers



DN 1	DN 2	Taper Length L [mm]	Pipe Length A=B [mm]	Laying Length LL [mm]
150	100	125	300	725
200	100	250	300	850
200	150	125	300	725
250	150	250	300	850
250	200	125	300	725
300	200	250	400	1050
300	250	125	400	925
350	250	250	400	1050
350	300	125	400	925
400	300	250	400	1050
400	350	125	400	925
450	350	250	400	1050
450	400	125	400	925
500	400	250	400	1050
500	450	125	400	925
600	400	500	500	1300
600	450	375	400	1175
600	500	250	400	1050
700	500	500	400	1300
700	600	250	400	1050
800	600	500	400	1300
800	700	250	400	1050
900	700	500	400	1300
900	800	250	400	1050
1000	800	500	400	1300
1000	900	250	400	1050
1100	900	500	500	1500
1100	1000	250	500	1250
1200	800	1000	500	2000
1200	1000	500	500	1500
1200	1100	250	500	1250
1400	1200	500	500	1500
1400	1300	250	500	1250
1600	1200	1000	600	2200
1600	1400	500	600	1700
1600	1500	250	600	1450

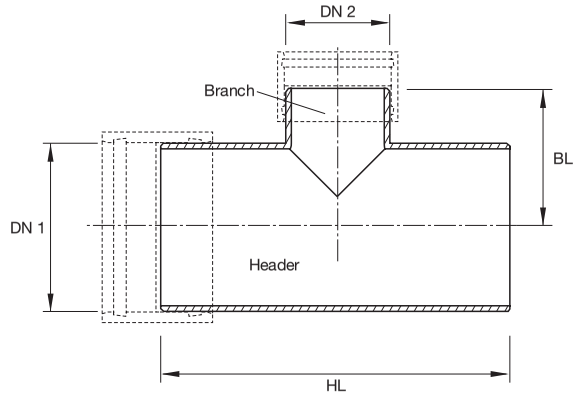
Table 7-2 Concentric Reducers – Stiffness and pressure classes acc. to table 5-1 and 5-2



Segmented Tees
PN 06
DN 2 = 100 – 600 mm

DN 2	100		125		150		200		250		300		350		400		450		500		600	
DN 1	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	720	380	740	380	780	380	820	400	900	420	1000	500	–	–	–	–	–	–	–	–	–	–
350	720	400	740	400	780	400	820	420	900	460	1020	540	1100	560	–	–	–	–	–	–	–	–
400	720	440	740	440	780	440	820	440	920	480	1020	560	1100	580	1180	600	–	–	–	–	–	–
450	720	460	760	460	780	460	840	480	920	500	1020	580	1100	600	1180	620	1260	640	–	–	–	–
500	720	480	760	480	780	480	840	500	920	520	1020	620	1100	640	1180	640	1280	680	1360	680	–	–
600	780	520	820	520	840	520	900	540	980	560	1080	660	1160	680	1260	700	1340	720	1420	720	1560	800
700	800	580	820	580	860	580	920	600	980	620	1080	700	1160	720	1260	740	1340	760	4440	780	1600	860
800	800	620	820	620	860	640	920	660	1000	680	1080	760	1160	780	1260	800	1360	820	1440	840	1600	900
900	820	680	840	680	880	680	940	700	1000	720	1100	800	1180	820	1260	840	1360	880	1440	880	1600	960
1000	850	750	850	750	900	750	950	750	1000	800	1100	850	1200	900	1300	900	1400	950	1450	950	1600	1000
1100	850	800	900	800	900	800	950	800	1050	850	1100	900	1200	950	1300	950	1400	1000	1450	1000	1600	1050
1200	850	850	900	850	900	850	950	900	1050	900	1150	1000	1200	1000	1300	1000	1400	1050	1450	1050	1650	1100
1300	850	900	900	900	950	900	1000	950	1050	950	1150	1050	1250	1050	1300	1050	1400	1100	1500	1100	1650	1200
1400	900	950	900	950	950	950	1000	1000	1050	1000	1150	1100	1250	1100	1300	1100	1400	1150	1500	1150	1650	1250
1500	900	1000	950	1000	950	1000	1000	1050	1050	1050	1150	1150	1250	1150	1300	1150	1400	1200	1500	1200	1650	1300
1600	950	1050	950	1050	1000	1100	1050	1100	1100	1100	1150	1200	1250	1200	1300	1200	1400	1250	1500	1250	1650	1350

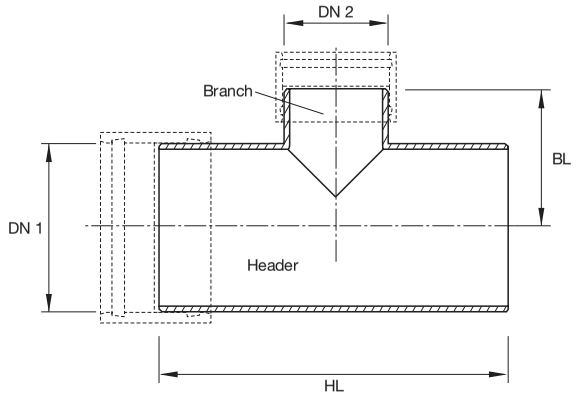
Table 7-3-1 Header- and Branch Lengths Segmented Tee, Pipe Series PN 06 in mm in Stiffness Classes acc. to table 5-1



Segmented Tees
PN 06
DN 2 = 700 – 1600 mm

DN 2 / DN 1	700		800		900		1000		1100		1200		1300		1400		1500		1600	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
700	1760	880	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
800	1780	940	1940	980	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
900	1800	1000	1960	1040	2120	1060	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1000	1800	1050	2000	1100	2150	1150	2300	1150	–	–	–	–	–	–	–	–	–	–	–	–
1100	1800	1100	2000	1150	2150	1200	2350	1250	2500	1250	–	–	–	–	–	–	–	–	–	–
1200	1800	1150	2000	1200	2150	1250	2350	1300	2500	1300	2700	1350	–	–	–	–	–	–	–	–
1300	1800	1200	2000	1250	2150	1300	2350	1350	2550	1400	2700	1400	2850	1450	–	–	–	–	–	–
1400	1800	1250	2000	1300	2150	1350	2350	1400	2550	1450	2700	1450	2850	1500	3050	1550	–	–	–	–
1500	1800	1300	2000	1350	2200	1400	2350	1450	2550	1500	2700	1500	2900	1550	3050	1600	3200	1650	–	–
1600	1850	1350	2000	1400	2200	1450	2350	1500	2550	1550	2700	1550	2900	1600	3050	1650	3250	1700	3400	1700

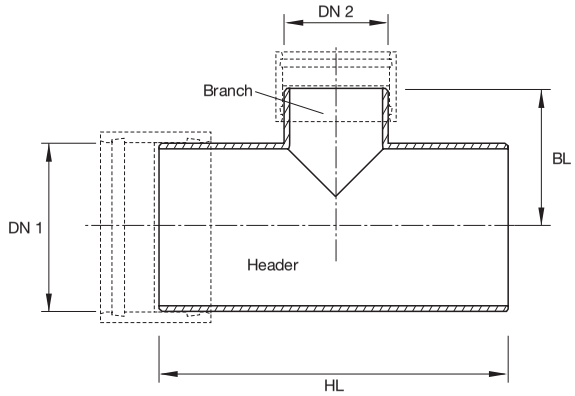
Table 7-3-2 Header- and Branch Lengths Segmented Tee, Pipe Series PN 06 in mm in Stiffness Classes acc. to table 5-1



Segmented Tees
PN 10
DN 2 = 100 – 600 mm

DN 2 / DN 1	100		150		200		250		300		350		400		450		500		600	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	720	380	800	400	860	420	940	440	1040	520	–	–	–	–	–	–	–	–	–	–
350	720	400	800	420	860	440	940	460	1040	560	1120	580	–	–	–	–	–	–	–	–
400	740	440	800	440	860	460	940	500	1040	580	1140	600	1220	620	–	–	–	–	–	–
450	740	460	800	480	860	500	940	520	1060	600	1140	620	1240	640	1320	660	–	–	–	–
500	740	500	800	500	860	520	960	540	1060	640	1140	660	1240	680	1320	700	1400	720	–	–
600	820	540	880	540	940	560	1020	580	1120	680	1220	700	1320	720	1400	740	1500	760	1640	820
700	820	600	880	600	940	620	1020	640	1140	720	1220	760	1320	780	1400	800	1500	820	1660	900
800	820	640	900	640	960	660	1040	700	1140	780	1220	800	1320	820	1420	860	1500	860	1660	940
900	840	700	900	700	960	720	1040	740	1140	840	1240	860	1320	880	1420	900	1500	920	1680	1000
1000	850	750	950	750	1000	800	1050	800	1150	900	1250	950	1350	950	1450	950	1550	1000	1700	1050
1100	850	800	950	800	1000	850	1050	850	1200	950	1250	1000	1350	1000	1450	1000	1550	1050	1700	1100
1200	900	850	950	900	1000	900	1100	900	1200	1000	1250	1050	1350	1050	1450	1100	1550	1100	1700	1150
1300	900	950	950	950	1000	950	1100	950	1200	1050	1300	1100	1350	1100	1450	1150	1550	1150	1700	1200
1400	900	1000	950	1000	1050	1000	1100	1050	1200	1100	1300	1150	1400	1150	1450	1200	1550	1200	1700	1250
1500	950	1050	1000	1050	1050	1050	1100	1100	1200	1150	1300	1200	1400	1200	1500	1250	1550	1250	1750	1350
1600	950	1100	1000	1100	1050	1100	1150	1150	1200	1200	1300	1250	1400	1250	1500	1300	1600	1300	1750	1400

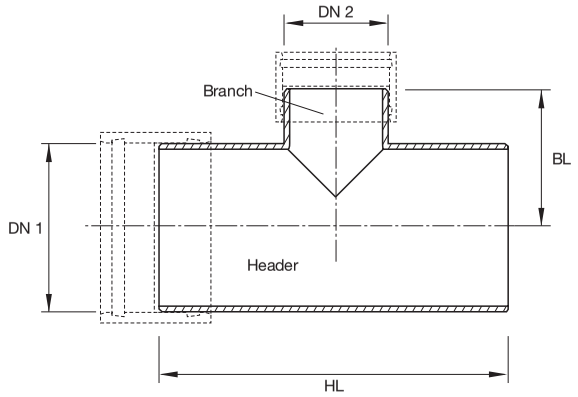
Table 7-3-3 Header- and Branch Lengths Segmented Tee, Pipe Series PN 10 in mm in Stiffness Classes acc. to table 5-1



Segmented Tees
PN 10
DN 2 = 700 – 1600 mm

DN 2 / DN 1	700		800		900		1000		1100		1200		1300		1400		1500		1600	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
700	1840	920	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
800	1860	980	2020	1020	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
900	1860	1040	2060	1080	2220	1120	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1000	1900	1100	2050	1150	2250	1200	2450	1250	–	–	–	–	–	–	–	–	–	–	–	–
1100	1900	1150	2100	1200	2250	1250	2450	1300	2600	1300	–	–	–	–	–	–	–	–	–	–
1200	1900	1200	2100	1250	2300	1300	2450	1350	2650	1400	2800	1400	–	–	–	–	–	–	–	–
1300	1900	1250	2100	1300	2300	1350	2450	1400	2650	1450	2850	1500	3000	1500	–	–	–	–	–	–
1400	1950	1300	2100	1350	2300	1400	2500	1450	2650	1500	2850	1550	3000	1550	3200	1600	–	–	–	–
1500	1950	1350	2100	1400	2300	1450	2500	1500	2700	1550	2850	1600	3050	1650	3250	1650	3400	1700	–	–
1600	1950	1400	2100	1450	2300	1500	2500	1550	2700	1600	2900	1650	3050	1700	3250	1750	3400	1800	3600	1800

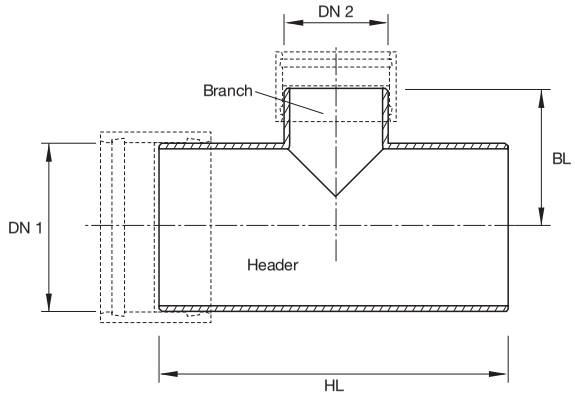
Table 7-3-4 Header and Branch Lengths Segmented Tee, Pipe Series PN 10 in mm in Stiffness Classes acc. to table 5-1



Segmented Tees
PN 16
DN 2 = 100 – 600 mm

DN 2 / DN 1	100		150		200		250		300		350		400		450		500		600	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	740	400	820	400	900	440	980	460	1080	540	–	–	–	–	–	–	–	–	–	–
350	760	420	820	440	900	460	1000	500	1100	580	1180	600	–	–	–	–	–	–	–	–
400	760	460	820	460	900	480	1000	520	1100	600	1180	620	1280	640	–	–	–	–	–	–
450	760	480	840	480	900	500	1000	540	1120	640	1200	660	1300	680	1380	700	–	–	–	–
500	780	500	840	520	900	540	1000	560	1120	660	1220	700	1300	700	1400	740	1500	760	–	–
600	840	560	920	560	980	580	1060	620	1180	700	1280	740	1380	760	1480	780	1560	800	1740	880
700	860	620	920	620	1000	640	1080	660	1200	760	1280	780	1380	800	1500	840	1580	860	1740	940
800	860	660	960	680	1000	700	1100	720	1200	800	1300	840	1400	860	1500	900	1600	920	1760	980
900	880	720	960	720	1020	740	1100	780	1220	860	1320	900	1400	920	1500	940	1600	960	1760	1040
1000	900	800	1000	800	1050	800	1150	850	1250	950	1350	950	1450	1000	1550	1000	1600	1050	1800	1100
1100	950	850	1000	850	1050	900	1150	900	1250	1000	1350	1000	1450	1050	1550	1050	1650	1100	1800	1150
1200	950	900	1000	900	1100	950	1150	950	1250	1050	1350	1050	1450	1100	1550	1100	1650	1150	1800	1200
1300	950	950	1050	950	1100	1000	1200	1000	1250	1100	1350	1150	1450	1150	1550	1150	1650	1200	1800	1250
1400	1000	1000	1050	1000	1100	1050	1200	1050	1300	1150	1400	1200	1500	1200	1550	1250	1650	1250	1850	1350
1500	1000	1050	1100	1100	1150	1100	1200	1150	1300	1200	1400	1250	1500	1250	1600	1300	1700	1300	1850	1400
1600	1050	1150	1100	1150	1150	1150	1250	1200	1300	1250	1400	1300	1500	1300	1600	1350	1700	1350	1850	1450

Table 7-3-5 Header- and Branch Lengths Segmented Tee, Pipe Series PN 16 in mm in Stiffness Classes acc. to table 5-1



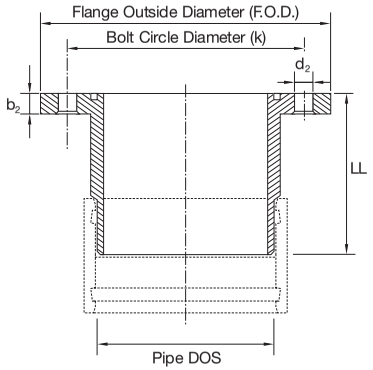
Segmented Tees
PN 16
DN 2 = 700 – 1600 mm

DN 2 / DN 1	700		800		900		1000		1100		1200		1300		1400		1500		1600	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
700	1940	980	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
800	1960	1040	2140	1080	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
900	1980	1100	2180	1140	2360	1180	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1000	2000	1150	2200	1200	2400	1250	2550	1300	–	–	–	–	–	–	–	–	–	–	–	–
1100	2000	1200	2200	1250	2400	1300	2600	1350	2800	1400	–	–	–	–	–	–	–	–	–	–
1200	2050	1250	2200	1300	2400	1350	2600	1400	2800	1450	3000	1500	–	–	–	–	–	–	–	–
1300	2050	1350	2250	1400	2450	1450	2600	1450	2800	1500	3000	1550	3200	1600	–	–	–	–	–	–
1400	2050	1400	2250	1450	2450	1500	2650	1550	2850	1600	3000	1600	3200	1650	3400	1700	–	–	–	–
1500	2050	1450	2250	1500	2450	1550	2650	1600	2850	1650	3050	1700	3250	1750	3450	1750	3600	1850	–	–
1600	2050	1500	2250	1550	2450	1600	2650	1650	2850	1700	3050	1750	3250	1800	3450	1850	3650	1900	3800	1950

Table 7-3-6 Header and Branch Lengths Segmented Tee, Pipe Series PN 16 in mm in Stiffness Classes acc. to table 5-1

7.4 Fix Flanges – Type A

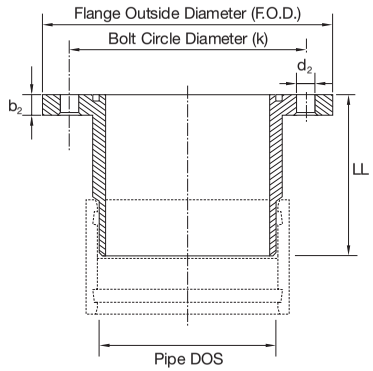
The standard bolting pattern to which flanges are manufactured is ISO 2084. Other bolting dimension systems such as AWWA, ANSI, DIN, JIS can be supplied.



Dimensions PN 06 & PN 10

DN	Pipe DOS	b_2	F.O.D.	LL	k			d_2		
Nominal Diameter	O.D. [mm]	Flange Thickness [mm]	Flange Outside Diameter [mm]	Laying Length [mm]	Bolt Circle Diameter [mm]	Number of Bolts	Bolt Diameter [mm]	Bolt Hole Diameter [mm]	Washer Diameter [mm]	O-Ring Gasket Diameter [mm]
300	324.5	41	450	1000	400	12	20	26	36	12
350	376.4	46	525	1000	460	16	20	26	36	12
400	427.3	47	575	1000	515	16	24	30	44	12
450	478.2	52	625	1000	565	20	24	30	44	12
500	530.1	53	675	1000	620	20	24	30	44	12
600	617	55	800	1000	725	20	27	33	50	12
700	719	64	900	1000	840	24	27	33	50	19
800	821	69	1025	1000	950	24	30	36	56	19
900	923	74	1125	1000	1050	28	30	36	56	19
1000	1025	79	1250	1000	1160	28	33	39	60	19
1100	1127	88	1350	1000	1270	32	33	39	60	22
1200	1229	94	1475	1000	1380	32	36	42	68	22
1400	1433	104	1700	1000	1590	36	39	45	72	22
1500	1535	107	1800	1000	1700	36	39	45	72	22
1600	1637	114	1925	1000	1820	40	45	51	85	22

Table 7-4-1 Dimensions – Fix Flanges – Type A; PN 6 and PN 10 – for all Stiffness Classes

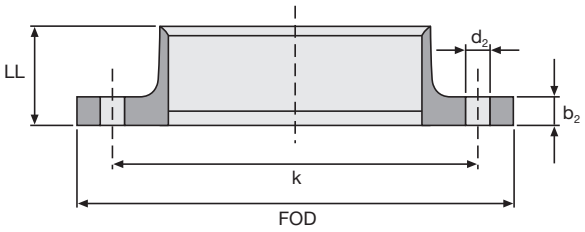


Dimensions PN 16

DN	Pipe DOS	b_2	F.O.D.	LL	k			d_2		
Nominal Diameter	O.D. [mm]	Flange Thickness [mm]	Flange Outside Diameter [mm]	Laying Length [mm]	Bolt Circle Diameter [mm]	Number of Bolts	Bolt Diameter [mm]	Bolt Hole Diameter [mm]	Washer Diameter [mm]	O-Ring Gasket Diameter [mm]
300	324	40	475	1000	410	12	24	30	44	12
350	376	45	525	1000	470	16	24	30	44	12
400	427	47	600	1000	525	16	27	33	50	12
450	478	52	650	1000	585	20	27	33	50	12
500	530	53	725	1000	650	20	30	36	56	12
600	617	57	850	1000	770	20	33	39	60	12
700	719	66	925	1000	840	24	33	39	60	19
800	821	72	1050	1000	950	24	36	42	68	19
900	923	78	1150	1000	1050	28	36	42	68	19
1000	1025	83	1275	1000	1170	28	39	45	72	19
The following flanges list the maximum pipe O.D. on which the flange can be fabricated without interference of bolt hole and spot facing with the flange hub.										
1100	1112	93	1375	1000	1270	32	39	45	72	22
1200	1214	98	1500	1000	1390	32	45	51	85	22
1300	1309	104	1600	1000	1490	32	45	51	85	22
1400	1403	110	1700	1000	1590	36	45	51	85	22
1500	1504	115	1825	1000	1710	36	52	58	98	22
1600	1608	121	2050	1000	1820	40	52	58	98	22

Table 7-4-2 Dimensions – Fix Flanges – Type A; PN 16 – for all Stiffness Classes

7.5 Fix Flanges – Type B



Fix Flanges – Type B – PN 06

DN	FOD [mm]		d_2 [mm]	k [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	170	±1.6	26	±2	45	+5 -0	4	1.68
150	285		20	225		32		65		8	2.72
200	340		20	280		34		125		8	3.72
250	405		20	335		38		100		12	5.07
300	460	±3	24	395		40		125		12	6.87
350	520		24	445		45		145		12	8.72
400	580		24	495		49		165		16	10.43
500	715		24	600		30		75		20	17.47
600	840	±5	28	705		33	+8 -2	90	+10 -0	20	24.32
700	910		28	810	+1.9 -0	37		105		24	29.33
800	1025		31	920		40		120		24	37.37

* Approx. Weights

Table 7-5-1 Fix Flanges Type – B – PN 06

Fix Flanges – Type B – PN 10

DN	FOD [mm]		d_2 [mm]	k [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	180	±1.6	26	±2	45	+5 -0	8	1.88
150	285		24	240		32		65		8	3.28
200	340		24	295		34		125		8	4.45
250	405		24	350		38		100		12	6.02
300	460	±3	24	400		40		125		12	7.33
350	520		24	460		45		145		16	14.84
400	580		28	515		49		165		16	13.38
500	715		28	620		48		125		20	29.80
600	840	±5	31	725		52	+8 -2	150	+10 -0	20	43.40
700	910		31	840	+1.9 -0	56		175		24	49.75
800	1025		34	950		60		200		24	66.57

* Approx. Weights

Table 7-5-2 Fix Flanges Type B – PN 10

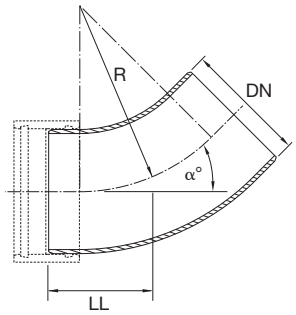
Fix Flanges –Type B – PN 16

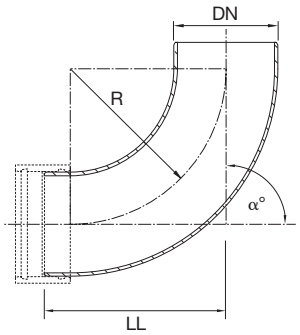
DN	FOD [mm]		d_2 [mm]	k [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	180	±1.6	26	±2	45	+5 -0	8	1.92
150	285		24	240		32		65		8	3.38
200	340		24	295		34		125		12	5.00
250	405		28	355		38		100		12	7.22
300	460	±3	28	410		40		125		12	9.81
350	520		28	470		45		145		16	17.95
400	580		31	525		49		165		16	17.56
500	715		34	650		54		200		20	38.78
600	840	±5	37	770		60	+8 -2	240	+10 -0	20	57.95
700	910		37	840	+1.9 -0	70		280		24	76.90
800	1025		40	950		72		320		24	97.41

* Approx. Weights

Table 7-5-3 Fix Flanges – Type B – PN 16

7.6 Moulded Bends





Dimensions PN 06

DN [mm]	R [mm]		Angle α													
			11°		15°		22°		30°		45°		60°		90°	
			LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]	LL min [mm]	Weight * [kg/pc]
100	150.0	+1 -0	94	1.06	100	1.09	109	1.14	120	1.21	142	1.33	167	1.44	230	1.68
125	187.5		97	1.25	104	1.30	115	1.38	129	1.48	157	1.66	187	1.84	267	2.21
150	225.0		102	1.87	110	1.93	124	2.05	140	2.19	173	2.44	210	2.70	305	3.21
200	300.0		122	3.01	132	3.13	151	3.33	173	3.57	217	4.02	266	4.47	393	5.36
250	375.0		130	4.63	143	4.83	167	5.18	194	5.58	249	6.33	311	7.08	469	8.58
300	450.0		184	7.84	200	8.17	228	8.74	262	9.39	327	10.61	401	11.84	591	14.28
350	525.0	+3 -0	193	11.47	211	11.97	244	12.83	283	13.82	359	15.68	445	17.54	667	21.25
400	600.0		199	13.06	220	13.77	258	15.02	302	16.44	390	19.11	487	21.78	741	27.12
500	750.0		213	18.98	240	20.32	287	22.67	342	25.35	452	30.37	574	35.40	891	45.45
600	900.0		259	29.99	290	32.15	347	35.92	413	40.23	545	48.32	692	56.41	1072	72.58
700	1050.0		273	42.49	310	45.93	376	51.95	453	58.82	607	71.72	778	84.61	1222	110.40
800	1200.0		289	52.98	331	57.91	406	66.53	495	76.38	670	94.84	866	113.31	1373	150.25

* Approx. Weights

Table 7-6-1 Moulded Bends – Stiffness SN 10000 (N/m²)

Dimensions PN 10

DN [mm]	R [mm]		Angle α													
			11°		15°		22°		30°		45°		60°		90°	
			LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]
100	150.0	+1 -0	94	1.06	100	1.09	109	1.14	120	1.21	142	1.33	167	1.44	230	1.68
125	187.5		97	1.25	104	1.30	115	1.38.	129	1.48	157	1.66	187	1.84	267	2.21
150	225.0		102	1.88	110	1.96	124	2.09	140	2.23	173	2.51	210	2.79	305	3.34
200	300.0		122	3.13	132	3.30	151	3.59	173	3.92	217	4.54	266	5.16	393	6.39
250	375.0		130	4.85	143	5.14	167	5.63	194	6.20	249	7.26	311	8.32	469	10.45
300	450.0		184	8.29	200	8.78	228	9.64	262	10.62	327	12.46	401	14.29	591	17.97
350	525.0	+3 -0	193	12.23	211	13.00	244	14.35	283	15.89	359	18.78	445	21.67	667	27.45
400	600.0		199	14.15	220	15.26	258	17.20	302	19.42	390	23.58	487	27.74	741	36.07
500	750.0		213	21.10	240	23.22	287	26.91	342	31.14	452	39.06	574	46.98	891	62.82
600	900.0		259	33.41	290	36.81	347	42.75	413	49.55	545	62.30	692	75.04	1072	100.53
700	1050.0		273	47.99	310	53.43	376	62.94	453	73.82	607	94.21	778	114.61	1222	155.39
800	1200.0		289	61.34	331	69.30	406	83.24	495	99.17	670	129.03	866	158.89	1373	218.62

* Approx. Weights

Table 7-6-2 Moulded Bends – Stiffness SN 10000 (N/m²)

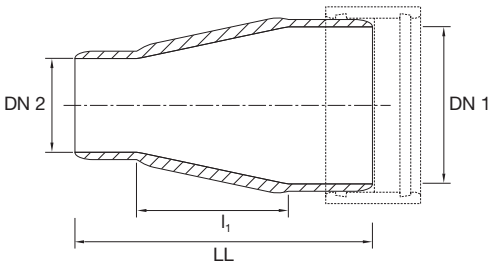
Dimensions PN 16

DN [mm]	R [mm]		Angle α													
			11°		15°		22°		30°		45°		60°		90°	
			LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]	LL min [mm]	Weight* [kg/pc]
100	150.0	+1 -0	94	1.06	100	1.10	109	1.16	120	1.23	142	1.36	167	1.48	230	1.74
125	187.5		97	1.30	104	1.37	115	1.49	129	1.62	157	1.87	187	2.12	267	2.63
150	225.0		102	1.97	110	2.07	124	2.25	140	2.46	173	2.85	210	3.25	305	4.03
200	300.0		122	3.34	132	3.58	151	3.99	173	4.47	217	5.37	266	6.27	393	8.06
250	375.0		130	6.04	143	6.47	167	7.21	194	8.06	249	9.65	311	11.24	469	14.42
300	450.0		184	11.00	200	11.71	228	12.95	262	14.37	327	17.03	401	19.69	591	25.00
350	525.0	+3 -0	193	15.03	211	16.15	244	18.13	283	20.39	359	24.62	445	28.86	667	37.32
400	600.0		199	18.91	220	20.60	258	23.56	302	26.93	390	33.27	487	39.60	741	52.26
500	750.0		213	27.12	240	30.31	287	35.88	342	42.25	452	54.20	574	66.14	891	90.03
600	900.0		259	46.97	290	52.38	347	61.85	413	72.68	545	92.97	692	113.26	1072	153.85
700	1050.0		273	65.68	310	74.16	376	89.00	453	105.96	607	137.76	778	169.56	1222	233.17
800	1200.0		289	87.00	331	99.52	406	121.44	495	146.48	670	193.43	866	240.39	1373	334.30

* Approx. Weights

Table 7-6-3 Moulded Bends – Stiffness SN 10000 (N/m²)

7.7 Moulded Reducers



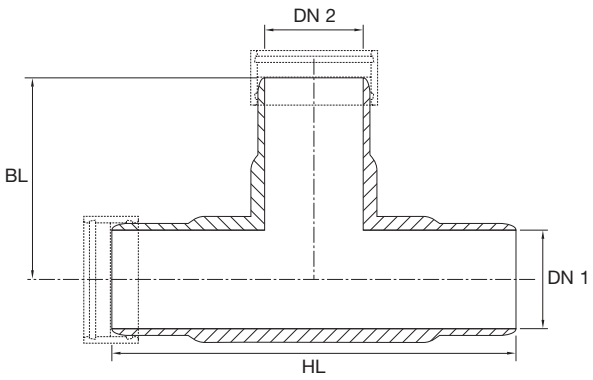
Concentric Reducers

					PN 06	PN 10	PN 16
DN 1	DN 2	l_1 [mm]	LL [mm]		Weight* [kg/pc]		
125	100	72.5	221.5	+0 -4	1.26	1.26	1.26
150	100	135.0	315.0		1.72	1.72	1.91
150	125	72.5	251.5		1.60	1.60	1.75
200	100	260.0	453.0	+0 -6	2.88	2.88	3.62
200	125	197.5	389.5		2.77	2.77	3.40
200	150	135.0	328.0		2.72	2.72	3.26
250	150	260.0	454.0		3.87	4.33	5.67
250	200	135.0	342.0		3.81	4.16	5.24
300	200	260.0	514.0		6.21	7.45	9.44
300	250	135.0	390.0		5.73	6.66	8.87
400	250	385.0	640.0		10.73	12.81	17.40
400	300	260.0	562.0		11.28	13.05	17.58
500	300	510.0	812.0		18.45	21.66	30.64
500	400	260.0	562.0		16.65	18.90	25.55
600	400	510.0	843.0	+0 -8	25.20	31.23	45.23
600	500	260.0	593.0		22.54	26.76	37.13
700	500	510.0	843.0		35.00	42.18	61.52
700	600	260.0	624.0		32.63	37.67	52.97
800	600	510.0	875.0		46.66	57.88	84.36
800	700	260.0	625.0		42.67	50.41	69.08

* Approx. Weights

Table 7-7 Concentric Reducers – Stiffness SN 10000 (N/m²)

7.8 Moulded Tees – Equal and Reduced –



Moulded Tees

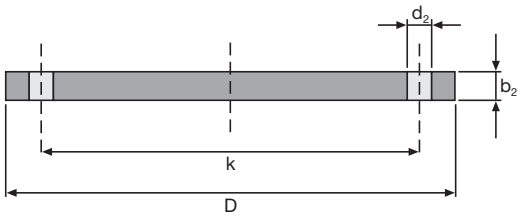
						PN 06	PN 10	PN 16
DN 1	**DN 2**	**HL [mm]**		**BL [mm]**		**Weight* [kg/pc]**		
100	100	330		165		1.87	1.87	1.87
125	100	350		175		2.38	2.38	2.58
125	125	350	+0 -4	175	+0 -2	2.60	2.60	2.81
150	100	370		185		2.97	2.97	3.23
150	125	370		185		3.19	3.19	3.45
150	150	370		185		3.44	3.44	3.70
200	100	454		215		4.44	4.68	5.49
200	150	454		215		4.83	5.08	5.86
200	200	454		227		5.44	5.70	6.48
250	200	624		312		7.91	9.07	12.15
250	250	624		312		8.46	9.64	13.24
300	200	780		342		11.37	14.16	19.41
300	250	780		342		11.92	14.77	20.45
300	300	780	+0 -6	390	+0 -3	13.27	16.17	22.24
350	300	810		405		16.66	20.13	28.49
350	350	810		405		17.61	21.13	29.90
400	300	860		430		20.28	25.64	35.64
400	400	860		430		22.27	27.75	38.07
500	400	970		485		32.81	42.98	59.78
500	500	970		485		34.60	44.92	62.39
600	500	1130		535		49.82	67.23	94.69
600	600	1130		565		53.10	70.28	97.12
700	600	1230		615		72.82	96.60	138.21
700	700	1230	+0 -8	615	+0 -4	76.80	100.80	141.23
800	700	1330		665		98.86	132.62	192.35
800	800	1330		665		101.82	135.84	195.93

* Approx. Weights

Table 7-8 Moulded Tees – Stiffness SN 10000 (N/m²)

7.9 Blind Flanges

The standard bolting pattern to which flanges are manufactured is ISO 2084. Other bolting dimension systems such as AWWA, ANSI, DIN, JIS can be supplied.



Blind Flanges PN 06

DN	D [mm]		d_2 [mm]	k [mm]		b_2 [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	170	±1,6	26	±2	4	1.39
150	285		20	225		32		8	2.58
200	340		20	280		34		8	3.84
250	405		20	335		38		12	5.69
300	460	±3	24	395		40		12	7.30
350	520		24	445		45		12	10.25
400	580		24	495		49		16	13.30
500	715		24	600		54		20	21.88
600	840	±5	28	705		60		20	32.55
700	910		28	810	±1,9 -0	70		24	42.49
800	1025		31	920		72		24	57.45

* Approx. Weights

Table 7-9-1 Blind Flanges PN 06

Blind Flanges PN 10

DN	D [mm]		d_2 [mm]	k [mm]		b_2 [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	180	±1,6	26	±2	8	1.75
150	285		24	240		32		8	3.62
200	340		24	295		34		8	5.52
250	405		24	350		38		12	8.35
300	460	±3	24	400		40		12	11.47
350	520		24	460		45		16	15.55
400	580		28	515		49		16	20.46
500	715		28	620		54		20	36.30
600	840	±5	31	725		60		20	49.89
700	910		31	840	±1,9 -0	70		24	62.80
800	1025		34	950		72		24	84.99

* Approx. Weights

Table 7-9-2 Blind Flanges PN 10

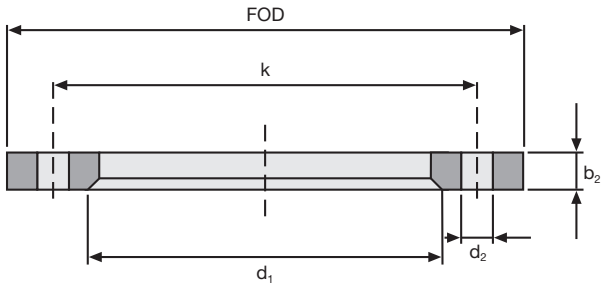
Blind Flanges PN 16

DN	D [mm]		d_2 [mm]	k [mm]		b_2 [mm]		No. of bolts	Weight* [kg/pc]
100	220	±2	20	180	±1,6	26	±2	8	1.93
150	285		24	240		32		8	3.77
200	340		24	295		34		12	5.73
250	405		28	355		38		12	8.94
300	460	±3	28	410		40		12	11.85
350	520		28	470		45		16	16.99
400	580		31	525		49		16	22.85
500	715		34	650		54		20	37.20
600	840	±5	37	770		60		20	57.32
700	910		37	840	±1,9 -0	70		24	77.31
800	1025		40	950		72		24	101.52

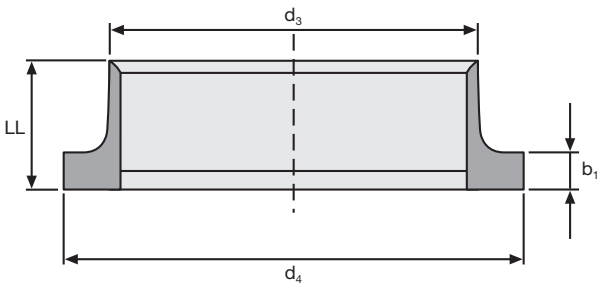
* Approx. Weights

Table 7-9-3 Blind Flanges PN 16

7.10 Loose Flanges and Collars



Loose Flange



Moulded Collar

Loose Ring Flanges PN 06

DN*	FOD [mm]		d_1 [mm]	d_2 [mm]	d_3 [mm]		d_4 [mm]		k [mm]		b_1 [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight** [kg/pc]		
																		Collar	Flange	Total
100	220		134	20	133		148		170		26		26		45		4	1.68	0.84	2.52
125	250		161	20	160		178	+0.5 -0	200		30		30		55		8	2.27	1.07	3.34
150	285	±2	189	20	188		201		225		32		32		65		8	2.72	1.41	4.12
200	340		238	20	237	±1	257		280		34		34		125		8	3.72	1.91	5.63
250	405		294	20	292		309		335	±1.6	38	±2	38	±2	100	+5 -0	12	5.07	2.64	7.70
300	460		344	24	342		365	+1 -0	395		40		40		125		12	6.87	3.16	10.03
350	520	±3	388	24	386		415		445		45		45		145		12	8.63	4.47	13.10
400	580		442	24	440	±2	466		495		49		49		165		16	10.43	5.49	15.92

** Approx. Weights

* other diameters up to DN 1600 are available on request

Table 7-10-1 Loose Ring Flanges PN 06

Loose Ring Flanges PN 10

DN*	FOD [mm]		d_1 [mm]	d_2 [mm]	d_3 [mm]		d_4 [mm]		k [mm]		b_1 [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight** [kg/pc]		
																		Collar	Flange	Total
100	220		134	20	133		158		180		26		26		45		8	1.88	1.06	2.94
125	250		161	20	160		188	+0.5 -0	210		30		30		55		8	2.53	1.40	3.93
150	285	±2	189	24	188		212		240		32		32		65		8	3.28	1.97	5.26
200	340		238	24	237	±1	268		295		34		34		125		8	4.45	2.75	7.20
250	405		294	20	292		320		350	±1.6	38	±2	38	±2	100	+5 -0	12	6.02	3.87	9.89
300	460		344	24	342		370	+1 -0	400		40		40		125		12	7.33	4.96	12.29
350	520	±3	388	24	386		430		460		45		45		145		16	10.48	6.78	17.26
400	580		442	28	440	±2	482		515		49		49		165		16	13.38	8.45	21.83

** Approx. Weights

* other diameters up to DN 1600 are available on request

Table 7-10-2 Loose Ring Flanges PN 10

Loose Ring Flanges PN 16

DN*	FOD [mm]		d_1 [mm]	d_2 [mm]	d_3 [mm]		d_4 [mm]		k [mm]		b_1 [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight** [kg/pc]		
																		Collar	Flange	Total
100	220	±2	134	20	133	±1	158	+0.5 -0	180	±1.6	26	±2	26	±2	45	+5 -0	8	1.92	1.17	3.09
125	250		161	20	160		188		210		30		30		55		8	2.60	1.60	4.19
150	285		189	24	188		212		240		32		32		65		8	3.38	2.06	5.43
200	340		238	24	237		268	+1 -0	295		34		34		125		12	5.00	2.85	7.85
250	405		294	28	292		321		355		38		38		100		12	7.22	4.14	11.36
300	460	±3	344	28	342		376		410		40		40		125		12	9.81	5.13	14.94
350	520		388	28	386	±2	436		470		45		45		145		16	12.96	7.41	20.37
400	580		442	31	440		488		525		49		49		165		16	17.56	9.44	27.00

** Approx. Weights

* other diameters up to DN 1600 are available on request

Table 7-10-3 Loose Ring Flanges PN 16

7.11 Valve Chambers

Most pressure pipelines periodically have in-line valves for isolating a portion of the supply or distribution system, air and vacuum relief valves at high points in the pipeline to slowly release accumulated air thereby avoiding blockages or to allow air to enter in order to avoid under pressure, and clean out (wash out) or drainage chambers. All of these different appurtenances can be accommodated with FLOWTITE valve chambers. The ultimate responsibility for the design of the piping systems is the professional engineer. However over the years FLOWTITE Technology engineers have observed many different methods of incorporation these appurtenances into a pipeline using FLOWTITE pipe.

Below are some examples, detailed information is available in the “Installation Guide for Buried Pipes”.

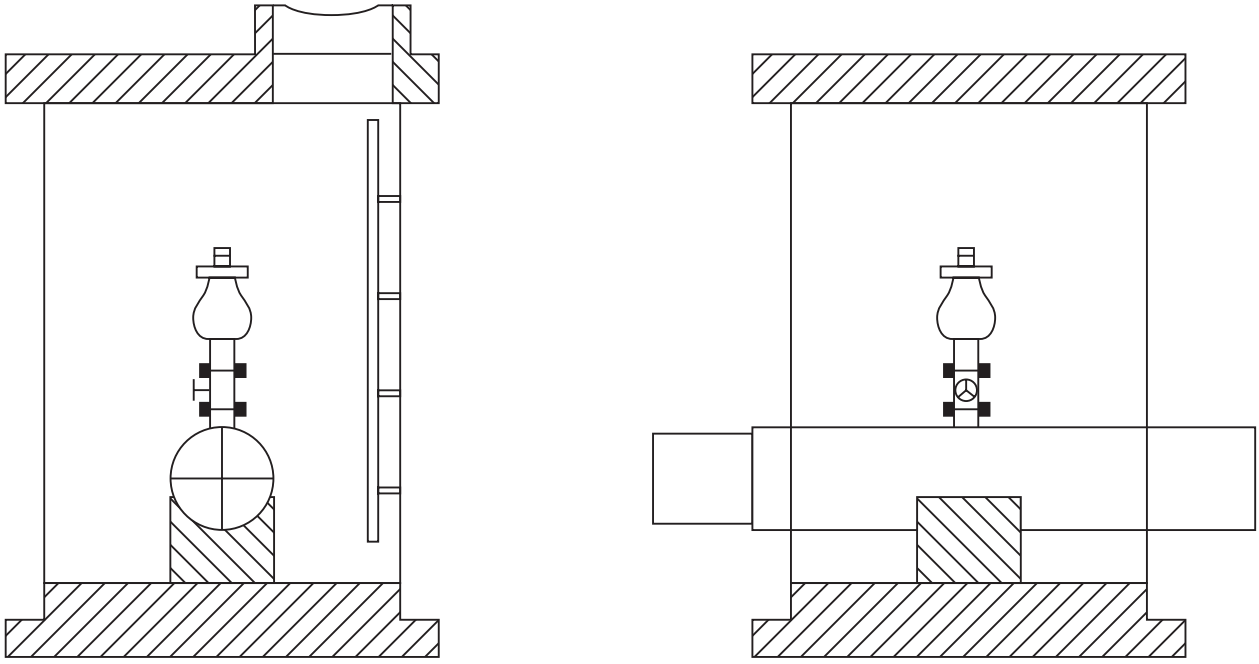


Figure 7-11 Valve Chambers

8 Tapping

Scope
This procedure outlines the tapping procedure to be used with FLOWTITE pipes.

Tapping Water Pipelines under Pressure

1. The surface of the exposed main pipe where the tapping is to be done should be clean. An approved flexible gunmetal tapping saddle should be placed at the designated place. Usually these saddles are two half circles connected with bolts. The minimum distance between two saddles is 500 mm and the maximum torque on the bolts should not exceed 10 Nm.

   As a standard, the diameter of the outlet will vary from 2 to 4 inches. However other sizes are also available.

2. Tapping machines vary from one manufacturer to another. Below is a general description of the tapping method.

   - Screw the main cock into the saddle after removing the plug.
   - Install the hole-cutting tool into the tapping machine. The tool should be long enough to cut through out the pipe.
   - Start drilling. These machines could be operated manually, pneumatically or electrically.
   - The drill is then raised and the plug closed.
   - Unscrew the drilling machine.

Saddle Material
Any flexible gunmetal tapping saddles can be used. Plastic saddles (thermoplastic type) are also recommended.

8.1 Procedure

A procedure for hot and cold tapping of GRP FP pipes is presented in this document. The strength and flexibility of GRP pipes make them well suited for tapping. The structural integrity and sealing performance of tapped GRP pipes has been verified through extensive research and development work. The procedure presented herein covers general aspects as well as specifics for GRP pipes, such as choice and mounting of the tapping sleeve and cutting the hole in the GRP pipe.

Introductory Information
This procedure is intended to assist the installer and owner of GRP pipe systems in understanding the requirements and the procedures for successful mounting of tapping sleeves on existing pipelines. Tapping is convenient for fitting a branch pipe or valve to an already existing pipeline where it is not practical to use a standard GRP nozzle or tee fitting. The procedure covers both hot and cold tapping.

This tapping procedure is founded on extensive research and development work. A series of short and long term pressure tests as well as FEM analysis was performed for the qualification of a tapping sleeve for use on a GRP pipe. Stainless steel material was selected as the material for the tapping sleeves to obtain a service life similar to that of the GRP pipe system. Not all types of tapping sleeves are suitable for this service.

This tapping procedure applies to all properly installed standard FP GRP pipes carrying water or water based fluids. The tapping sleeve must be placed in an area with low local axial pipe stresses. Extra support may be needed for above ground pipes.

The following definitions apply:

- Hot tapping. Installation of a nozzle or branch pipe on an existing pressurised or fluid filled GRP pipeline using a steel sleeve.
- Cold tapping. Installation of a nozzle or branch pipe on an existing empty and non-pressurized GRP pipeline using a steel sleeve.

Flexible stainless steel sleeves (see ***Figure 8-1***) are recommended for tapping into GRP pipes. Approved tapping sleeves suitable for GRP pipes are given in ***Table 8-1***.

Figure 8-1 Recommended tapping sleeves for GRP pipes

It is recommended that tapping experts are engaged for both hot and cold tapping jobs. The tools for performing the hot and cold tapping may vary.

For hot tapping the sleeve is mounted on the pressurized pipe. A valve and a tapping machine containing the cutter are mounted on the sleeve. The valve is opened and a hole drilled. The cutting device is then retracted, the valve closed and the tapping equipment is removed leaving the sleeve and the closed valve. A branch pipe can then be fitted on the valve and the valve opened.

For cold tapping, a branch pipe hole is drilled in a non-pressurised pipe. The tapping sleeve is then mounted around the pipe with the branch aligned with the hole. A branch pipe or valve can then be fitted to the tapping sleeve. – The procedure for hot tapping can also be used for cold tapping.

Selection and use of tapping Sleeves
GRP approved tapping sleeves are given below.

Sleeve Type	Dimensions Pressure Class	Gasket Type	Supplier
Romacon SST (Stainless steel tapping sleeve)	Up to DN800 Up to 16 bar working pressure	SBR Rubber Gasket	Romacon Pipeline Products B.V., Panningen, Netherlands

Table 8-1

The maximum tapping branch pipe diameter shall be limited to:
- 20 % of header pipe diameter for SN2500 pipe.
- 25 % of header pipe diameter for SN5000 pipe.
- 30 % of header pipe diameter for SN10000 pipe.

Maximum surge (water hammer) pressure that can arise in the pipeline must be accounted for in the selection of tapping sleeve pressure rating.

The tapped system is qualified for vacuum corresponding to the pipe stiffness.

The tapping sleeves are designed to closely fit the outer diameter of the pipe. The tapping sleeve will therefore need to match the outer diameter of the GRP pipe.

Thrust that the tapped system may generate must be balanced.

The location of the sleeve shall be at minimum:
- A length of not less than one pipe diameter away from the nearest coupling and/or fitting.
- The tapping sleeve must be placed in an area with low local axial pipe stresses. Extra support may be needed for above ground pipes.

Tapping Procedures

Care must always be exercised when working with pressurised systems. This is especially true for hot tapping, where pressurised media is irreversibly exposed. Expert advice and expertise should always be sought in such cases.

When working in trenches precautions should be taken to prevent objects falling into the trench, or its collapse caused by instability, position or movements of adjacent machinery or equipment.

This procedure covers preparation, mounting, bolt torques, cutting, inspection and testing.

8.2 Preparation

Adequate access for mounting the tapping sleeve and the tapping machine must be provided. The pipe must be uncovered if buried. The pipe must be cleaned thoroughly prior to mounting the tapping sleeve. Loose particles, dust, sand, and grease, etc. must be removed. Normally, no further surface preparation is necessary.

The pipe surface must be inspected for damage in the area underneath and adjacent to the tapping sleeve after cleaning. No damage to the pipe is acceptable in this area.

8.3 Tapping

Hot and cold tapping procedures are covered below.

Hot Tapping

For hot tapping, a specialised tapping machine is always required. In addition to the tapping sleeve and machine, the assembly consists of a branch valve (gate or ball) and the cutting device (see ***Figure 8-3***). The pressure rating of the branch valve and the tapping equipment must be at least equal to the pressure rating of the pipeline.

For hot tapping the following procedure is to be followed:

1. The tapping sleeve must be located and oriented according to the plans and / or drawing.
2. Mount the tapping sleeve on the pipe. The installation instructions issued by the tapping sleeve manufacturer for the tapping sleeve must be used except for the bolt torque. Bolt torques applicable for GRP pipes, are given in ***Table 8-2***.
3. Mount the valve on the on the tapping sleeve. Follow the instructions for the valve or flange assembly with respect to bolt torque, seal type, etc
4. A pressure test to verify sealing of tapping sleeve and valve is recommended prior to tapping. It should be noted that a test with overpressure between sleeve and pipe is more demanding on the rubber seal than a pressure test of the tapped pipe.
   - If the tapping sleeve is equipped with a test plug, this test can be conducted with the branch valve closed. Otherwise a blind flange with test plug can be mounted on the valve and the test conducted with an open valve. Some tapping machines are equipped with a test plug rendering the blind flange superfluous.
   - Fill the space between the pipe and the tapping sleeve with water, see ***Figure 8-2***, evacuate trapped air and pressurise to test the integrity of the seals between the sleeve and the pipe and between the sleeve and the valve. The test pressure need not exceed the actual internal pressure of the pipe to be tapped by more than 3 bars. (If a leak occurs, dismount and inspect for dirt or damage. Do not increase the bolt torque on the sleeve). – The test pressure must also neither exceed the maximum test pressure rating of the tapping sleeve nor the pipe, see ***Section 8.4*** ➔.
5. Mount the tapping machine on the valve. Follow the instructions for the tapping machine or flange assembly with respect to bolt torque, seal type, etc.
6. Make sure that the valve is open and perform the cutting operation, see ***Figure 8-2***. Detailed instructions for cutters and cutting are given in Section for cutting requirement ➔.
7. After cutting, the cutting device with the coupon is retrieved through the valve. The tapping machine with the cutting tool along with the pipe coupon can be removed once the valve is closed (see ***Figure 8-4***).

Inspection and hydrostatic test of the assembly can be performed upon completion of installation. See details in ***Section 8.4*** ➔.

Figure 8-2 Pressure testing of sleeve and valve assembly

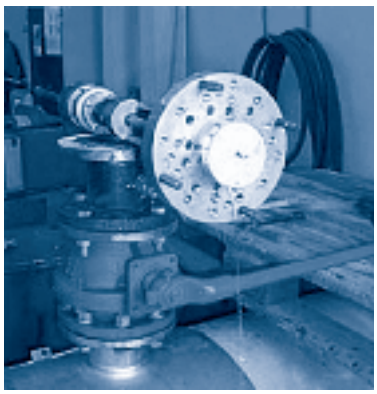


Figure 8-3 Tapping machine, valve and retrieved coupon

Cold Tapping

For cold tapping the following procedure must be followed:

1. The tapping sleeve must be located and oriented according to the plans and/or drawing.
2. The hole may be cut in advance or after mounting the tapping sleeve for cold tapping. Detailed instructions for cutting are given in the next section about cutting.
3. The steel sleeve must be mounted around the existing pipe such that the sleeve branch tapping hole is aligned with the hole in pipe.
4. The procedure issued by the tapping sleeve manufacturer for mounting of the tapping sleeve must be followed except for the bolt torque. Bolt torques applicable for GRP pipes see ***Table 8-2***.
5. The sealing between the tapping sleeve and the pipe wall may be tested prior to cutting the hole. Follow the pressure test procedure for hot tapping given in ***Section 8.4*** ➔.
6. The valve or branch pipe can be installed after cutting and assembly of the sleeve for the cold tapping.

Inspection and hydrostatic test of the assembly can be performed upon completion of installation. See details in ***Section 8.4*** ➔.

Bolt Torque

The flexibility and pressure expansion of GRP pipes significantly enhances the sealing performance of a tapping sleeve compared to mounting on rigid pipes like steel or ductile iron. The bolt torque required for mounting of tapping sleeves on GRP pipes is thus lower than for inflexible materials, and high torques may indeed be harmful for the system. The recommended bolt torque for tapping of GRP pipes are given in ***Table 8-2***. Higher bolt torques is not recommended.

Sleeve Type	Bolt Dimensions [mm]	Torque [Nm]	Comment
Romacon SST (Stainless steel tapping sleeve)	M 16	70	The bolt torque is lower for GRP pipes than for steel pipes.

Table 8-2 Bolt torque for hot and cold tapping of GRP pipes

Cutting

Cutting tools suitable for the cutting of fibreglass reinforced plastics should be used for cutting the tapping holes. The cutting tool must give a clean cut without tearing or breaking the pipe wall. This is especially important when the cutting device penetrates the inner surface of the GRP pipe to avoid peeling.

The following should be observed with respect to cutting the tapping hole:

- A special diamond coated cutting device for glass fibre laminates is recommended. A closely spaced thin-walled fine tooth steel cutting device may also be used (see ***Figure 8-4***); however, this type of device tends to wear out fast.
- Advancement rate of the cutter during drilling must be limited to avoid damage and peeling of the inner surface. A test cut on a pipe wall sample is recommended for operators and tools not previously exposed to GRP pipes.
- The cut surface may be left as it is after cutting without further surface preparation.

Figure 8-4 Alternative cutter with closely spaced teeth

8.4 Inspection and Testing

Checking, hydrostatic testing and inspection of the installed pipe assembly should be performed according to GRP installation instructions.

For inspection the following should be observed:

- The tapping sleeve should not be bulged, deformed or otherwise damaged.
- Proper support and thrust restraint is provided.

Hydrostatic testing of the sleeve assembly should be performed after installation according to GRP installation instructions.

The test pressure should not exceed the lowest of the following:

- 1.5 times the design pressure or pressure rating of the pipeline system as defined in GRP Installation Instructions, or
- Maximum test pressure for the sleeve system as defined for the tapping sleeve.

The buried pipe section can be backfilled according to GRP installation instructions after inspection and acceptance.

9 Local Approvals and Certificates

This handbook is intended as a guide only. All values listed in the product specifications are nominal. Unsatisfactory product results may occur due to environmental fluctuations, variations in operating procedures, or interpolation of data. We highly recommend that any personnel using this data have specialised training and experience in the application of these products and their normal installation and operating conditions.
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