May 2006

DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.	Industrial piping made of thermoplastics Design and execution Above-ground pipe systems Flanged joints: Description, requirements and assembly	DVS Technical Code DVS 2210-1 Supplement 3

Contents:

1 Scope of application

The DVS 2210-1 technical code includes fundamentals for the design, calculation, prefabrication and assembly of industrial piping made of thermoplastics and laid above ground.

Supplement 3 describes the fundamental design principles and requirements for flanged joints in above-ground piping made of thermoplastics. It should serve to supplement the generic standards (e. g. DIN 16962-4/12, DIN 16963-4/11 and DIN 8063-4 as well as DIN EN ISO 15493 ff. and DIN EN ISO 10931) with regard to the proper application in the construction of plastic piping. This supplement will replace Section 5.3.3.3 of DVS 2210-1.

The fundamentals for the dimensioning of flanged joints are dealt with in DVS 2210-1, Supplement 4 (under preparation). The recommendations included in Supplement 4 encompass not only flanged joints whose dimensions have not yet been standardised but also flanged joints whose loading limits should be established by caculation.

1.1 Remarks about application

The application of Supplement 3 is not restricted to certain areas of use of thermoplastic piping.

The fundamental principles are applicable to all flanged joints that are joined in a non-positive-locking form using bolts and a seal.

Supplement 3 deals exclusively with flanged joints that must bear forces from internal pressure loads and/or forces or moments from the thermal expansion of the pipe system. These also include tank flanges if they are joined with piping in a non-positive-locking form.

Any flange nozzles (not connected by piping) on plastic tanks with an internal overpressure of $p \leq 0.5$ bar must be structurally designed according to the DVS 2205-4 technical code, Supplement 1.

Special flanges, e. g. in an oval or rectangular shape, are not included in the scope of the DVS 2210-1 technical code or its supplements.

The scope of application can only be extended to flanged joints in buried piping if loads from outside (e. g. due to the installation location) are considered separately.

1.2 Materials

The area of application of Supplement 3 is valid without restrictions for pipe systems made of:

Polyethylene:	PE (PE 80 and PE 100)
Polypropylene:	PP-H, PP-B and PP-R (Types 1, 2 and 3)
Polyvinyl chloride:	PVC-C and PVC-U
Polyvinylidene fluoride:	PVDF

Comprehensive parameters and experience relating to their behaviour when subjected to long-term loads are available for the thermoplastics named above. Therefore, it may be assumed that the fundamental principles are the same for these materials.

The diversity of thermoplastics, with their different material properties, does not permit the generalisation of all the fundamental principles summarised in Supplement 3.

The behaviour of other thermoplastics, such as ABS, PB or ECTFE, is similar to that of the above plastics but their applicable parameters are currently incomplete.

When choosing the seal material, attention must be paid not only to good ductility but also to the chemical and thermal suitability.

When choosing the material for the loose flanges, the loads to be expected on the flanged joint are an essential factor. It must be guaranteed that the bolting force applied during assembly is maintained permanently, i.e. the flanges subjected to permanent loads must have insignificant creep.

If the parameters for determining the material properties and behaviour of flanged joints subjected to loads are available for any particular application, the fundamental principles specified in Supplement 3 can be used accordingly. This applies, for example, to flanged joints in pipe systems made of thermoset plastics.

Unless otherwise mentioned, Supplement 3 only deals with those flanged joints whose parts have standardised shapes and dimensions (see Section 5).

Flanged joints outside the above scope may be subject to other standards, technical codes and guidelines that are not included in the scope of DVS 2210-1. In this case, no or only limited reference may be made to Supplement 3 in order to solve specific problems. In any case, the user is responsible for the proper use of the fundamental principles described in Supplement 3.

DVS, Technical Committee, Working Group "Joining of Plastics"

Orders to: DVS Media GmbH, P. O. Box 10 19 65, 40010 Düsseldorf, Germany, Phone: +49(0)211/1591-0, Telefax: +49(0)211/1591-150

2 Components of the flanged joint

Below, the essential components of a flanged joint are listed and described. The flanged joint predominantly used in the construction of plastic pipe systems using loose flanges is depicted in Fig. 1.

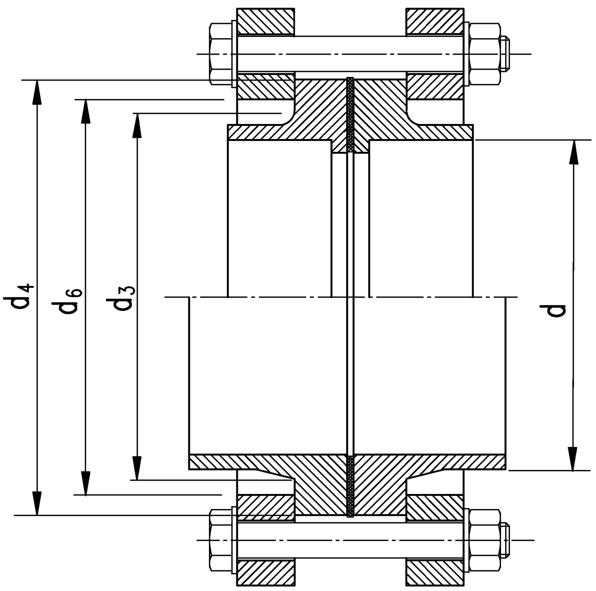

Figure 1. Standard flanged joint with loose flanges.

2.1 Welding necks

Necks with welding ends, generally called welding necks, can be joined with the pipe using both the heated tool butt welding process (HS) and the electrofusion welding process (HM) – this applies mainly to PE but also to PP. Necks with short (HS) and long (HS and HM) welding ends are available for this purpose.

Standardised dimensions for welding necks are specified in DIN 16962-4, DIN 16963-4 and DIN EN ISO 10931. The standardisation of the welding necks does not cover all pipe series. Therefore, dimensional requirements outside standardised specifications must be made for applications with higher internal pressures (see also Section 2.6).

In this respect, it must be ensured that the diameter of the neck shoulder, d_3, remains within the dimensional limits specified in DIN EN 1092-1 (Fig. 2).

The connecting dimension, d_4, of the standardised welding necks, classified according to nominal pressure, should comply with DIN 2501-1 with the designation according to Table 1.

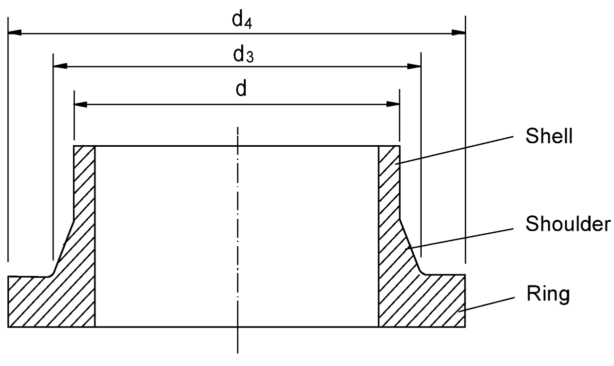

Figure 2. Welding neck.

Table 1. Designation of the connecting dimensions.

DN	**d_3** (DIN EN 1092-1)	**d_4** (DIN 2501-1)
Up to DN 150	After PN 10	After PN 40
As from DN 200		After PN 10

Remark: The connecting dimensions according to Table 1 depend on the nominal pressure and do not provide any information about the load-bearing capacity of the welding neck or of the flanged joint.

Depending on the strength of the material, the welding neck with associated dimensions related to the nominal pressure can, if necessary, be subjected to an internal overpressure p > nominal pressure. In applications above the nominal pressure, calculational proof must be provided or a manufacturer's certificate obtained

2.2 Neck bushes

Neck bushes (Fig. 3) are joined to the pipe using an overlap joint. Depending on the properties of the material concerned, the joint can be formed by means of heated tool sleeve welding or adhesive bonding.

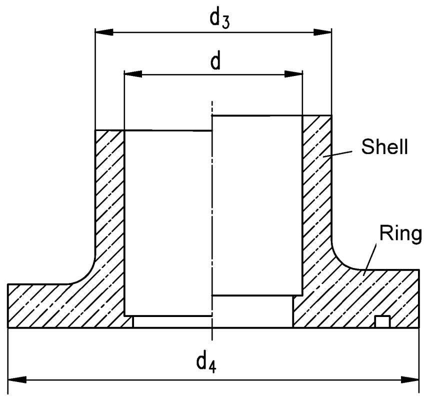

Figure 3. Neck bush.

Standardised dimensions for neck bushes are given in DIN 8063-4, DIN 16962-12, DIN 16963-11, DIN 16832-1 and DIN EN ISO 10931. With regard to the designation of the connecting dimensions of neck bushes and their internal pressure capacity, attention must be paid to the information in Section 2.1.

2.3 Loose flanges

Loose flanges are supported on the ring of the welding neck or the neck bush and must exhibit a sufficient bending stiffness when the bolting forces are applied. In addition, attention must be paid to their corrosion resistance, depending on the application.

It is possible to manufacture loose flanges from solid plastic if the material strength permits economically viable dimensioning (e. g. loose flanges made of glass-fibre-reinforced plastic or PVC). The combination of a plastic flange with an insert made of steel or cast iron has proven to be suitable due to its low deformation.

The standardisation of loose flanges for welding necks and neck bushes made of plastic is based on the dimensions in DIN EN 1092-1, "Steel flanges, PN 10".

2.4 Blind flanges

Blind flanges are used to shut off a section of pipe and permit the subsequent continuation of an existing line. Blind flanges analogous to Shape A (without a sealing strip) in DIN EN 1092-1 are predominantly used in the construction of plastic pipe systems. In this case, the load-dependent thickness of the flange is determined mainly by the strength of the material used. As in the case of loose flanges, various materials and material combinations are used.

During the operation of the pipe system, blind flanges frequently come into contact with the medium being transported. It is therefore advantageous to use blind flanges made of the same material as is used for the piping. If plastic blind flanges that are not standardised are used, the flange thickness must be dimensioned according to the stresses from internal overpressure.

Plastic blind flanges can be equipped with connecting nozzles for pressure tests, venting or for the attachment of sampling valves.

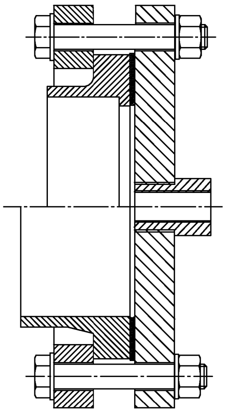

Figure 4. Blind flange with an optional connecting nozzle.

A combination of a plastic blind disc (protective function) and a shimmed steel flange (load-bearing function) has proven to be suitable for high internal pressures or large nominal diameters (Fig. 5).

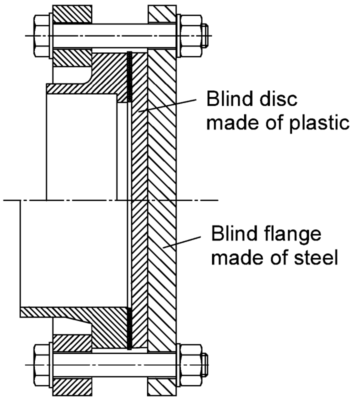

Figure 5. Blind disc made of plastic with a protective function.

One additional possibility of using blind discs made of plastic is shown in Fig. 6. The supporting effect of the counterflange is used so that the blind disc can reliably bear the internal pressure loads.

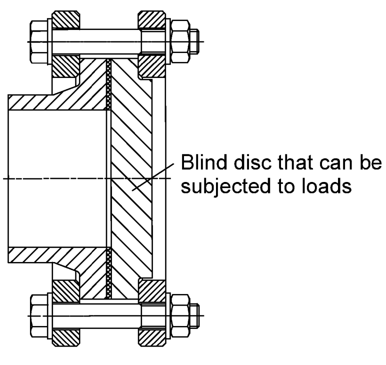

Figure 6. Blind disc made of plastic that can be subjected to loads.

2.5 Integral flanges

In valve, tank and apparatus construction integral flanges are preferred rather than a neck and a loose flange. In addition to the information about welding flanges in DIN EN 1092-1, dimensions for integral flanges made of plastic can be found in the supplement to DVS 2205-4. The dimensions begin at DN 500 and apply to a maximum operating overpressure of 0.5 bar.

At higher operating overpressures or for integral flanges < DN 500, the flange thickness can be dimensioned according to DVS 2205-4. Integral flanges are usually designed for the same load-bearing capacity of the pipe. The bolt-tightening torques to be applied are given in Table 5.

Integral flanged joints can be equipped with either a flat seal or an O-ring seal. Variants with a shimmed or integrated steel disc keep the deformation of the plastic integral flange within permissible limits (Fig. 7).

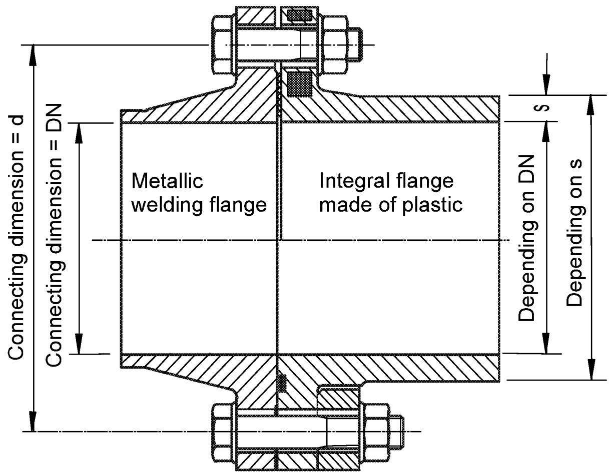

Figure 7. Plastic integral flange for connections to metallic piping with the same inside diameter.

Plastic integral flanges with an integrated or shimmed steel disc are suitable, in particular, for connection to metallic piping or valves with the same inside diameter. Piping parts with different nominal diameters can be joined in this way. This is made possible by adjusting the plastic integral flange to the dimensions of the connecting steel flange.

In the case of piping with nominal diameters ≥ DN 200, there is misalignment of the inside diameters between flanged joints using metallic welding flanges and a standard neck made of plastic and a loose flange. This is extremely unfavourable from a hydraulic viewpoint.

Fig. 7 shows how the inside diameters can be adjusted without misalignment using the integral flanged joint.

2.6 Special flanged joints

In the case of internal pressures above the nominal pressure or at a higher operating temperature, design-related measures for stiffening the flanged joint may be necessary in order to prevent the thermoplastic from deforming. For this purpose, the manufacturers of necks, neck bushes and loose flanges provide an extensive range of special products, some of which are described below.

2.6.1 Flanged joints with optimised dimensions

In the case of the standardised flanged joint (Fig. 1), a gap can be seen between the loose flange inside diameter [d_6] and the neck shoulder diameter [d_3]. The unsupported neck region may deform when it is subjected to high internal pressures, which may lead to leaks at the flanged joint.

Fig. 8 shows how the bending stiffness of the flanged joint can be improved by changing the shape of the neck and adapting it to the standardised loose flange.

Further optimisation of the dimensions not only increases the resistance moment of the neck but also increases the contact area between the neck and the loose flange. This leads to a reduction in the interface pressure.

In order to achieve a more uniform interface pressure, it is possible to increase the number of bolts and, at the same time, reduce the bolt size.

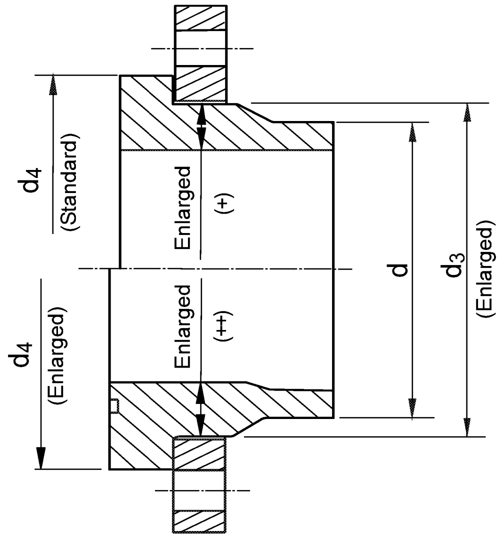

Figure 8. Increase in the bending stiffness by changing the shape of the welding neck (analogous to DIN EN ISO 15494).

Fig. 9 shows another approach, where as well as the loose flange, the dimensions of the neck are also optimised. This increases the contact area between the neck and the loose flange, leading to a reduction in the interface pressure.

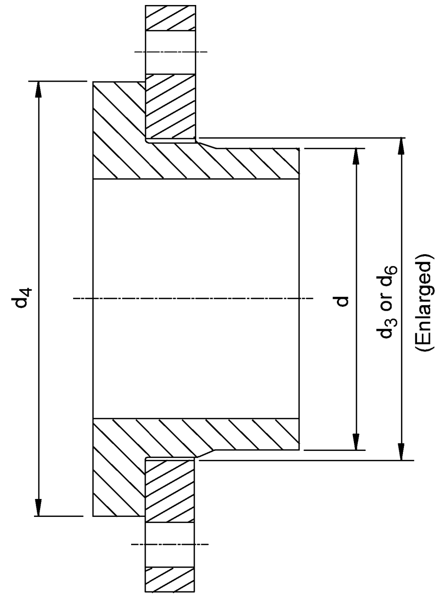

Figure 9. Improving the load-bearing capacity by adjusting the dimensions of the loose flange and the welding neck.

2.6.2 Flanged joints with chambered necks

Another method of increasing the load-bearing capacity of flanged joints is to encapsulate the welding neck with the aid of a positive-locking loose flange. This can counteract the neck ring deformation during the tightening of the joining bolts and keep this within permissible limits.

2.6.3 Flanged joints with special loose flanges

The standard flanged joint may also be improved by modifying the standard loose flange shape according to DIN EN ISO 15493 or DIN EN ISO 15494 in order to increase the tilting stability of the loose flange and achieve a more uniform force distribution at the neck.

2.6.4 Flanged joints without a seal

Because of the elasticity of some thermoplastics, flanged joints may be used without a seal subject to certain conditions. Such flanged joints must not only have distinctly smooth sealing faces but must also be assembled carefully using mechanical screwdrivers (Classification I in Table 4). The applicability of the flanged joints without a seal is limited and requires a prior suitability test.

2.6.5 Flanged joints at butterfly valves

When installing butterfly valves in thick-walled thermoplastic pipe systems, it must be ensured that the valve disc can be opened totally without hitting the inside of the pipe.

If possible, butterfly valves that are adapted to plastics and whose valve disc is adjusted to the reduced inside diameter of the pipe should be utilised.

Necks with funnel-shaped bevels may be used as an alternative, providing the bevelling is carried out properly (no notches or grooves) and the neck is not weakened (preservation of the resistance moment). If necessary, calculational proof should be carried out to prove that this is the case.

The installation of adapters upstream and downstream of the butterfly valve is complicated but is another alternative.

2.7 Seals

Taking account of the operating conditions and the sealing forces, the selection of suitable flange seals in thermoplastic piping is dependent on the following factors:

– shape
– dimensions
– material

2.7.1 Shape of the seal

The seal may be formed as a flat ring, a profiled ring, an O ring, or a combination of the above shapes. The conventional flat seal, with minimum thicknesses according to Table 3, is adequate for most applications. If a wide flat seal is used, it must be ensured that the bolting forces applied for the preliminary deformation of the seal do not cause an overloading of the welding neck or the neck bush.

Profiled flat seals, as well as the O-ring seal, have proven to be suitable at increased operating and testing pressures. For stabilisation and to prevent blowing-out, the seal may be reinforced with a steel flat ring. However, the reinforcement must not influence the elasticity on the inside of the seal. Seals can be used according to Table 2.

The profiled seal and O-ring seal offer the following advantages:

– reliable leak tightness with low bolt-tightning torques
– can be used at higher internal pressures and with an internal partial vacuum
– reduced influence of the flange or neck surface
– safety when joining piping made of different materials

Table 2. Operational limits for seals.

Seal shape	Recommended operational limits	Flange and neck design
Flat ring	p up to 10 bar for DN ≤ 150 p up to 6 bar for DN > 150 - 600 T up to 40°C	With sealing grooves * Seal width: Depending on the permissible loads on the neck
Profiled flat ring	p up to 16 bar All nominal widths All temperatures within the range of application	With or without sealing grooves * * concentric arrangement
O ring	General use p = -1 to 16 bar All temperatures within the range of application	Groove dimensions: DIN 8063-4 DIN 16962-4 DIN 16963-4

2.7.2 Dimensions of the seal

The seal dimensions are stipulated in the generic standards for pipe joint parts (see Section 5). Greater dimensional differences between the inside diameter of the welding neck or neck bush and the inside diameter of the seal may, in certain circumstances, lead to disturbances at the flanged joint. Deviations in the inside diameter of the seal greater than ± 10 mm are not acceptable.

If the seals have excessive inside diameters, there is a danger that deposits will accumulate in the annular gap (dead space), which may lead to a concentration of the medium at the seal and premature failure. If the seal protrudes into the pipe, this may cause accelerated wear on the inside of the seal and reduced sealing capability.

The outside diameters of seals are standardised (e. g. DIN EN 1514-1). The minimum thicknesses of flat seals are given in Table 3. The thicknesses of profiled seals are specified by the manufacturer.

Table 3. Minimum thicknesses of flat seals.

Nominal width	Thickness of flat seals
Up to d 90 / DN 80	s ≥ 2 mm
≥ d 110 / DN 100	s ≥ 3 mm

2.7.3 Seal materials

When choosing a seal material, it is necessary to take account of the medium, the operating conditions, the properties of the seal material, the shape and surface finish of the sealing face as well as the loads on the flanged joint.

In plastic piping, preference should be given to the use of seals made of elastomer materials such as EPDM, CSM or FPM with a Shore A hardness up to 70°. Seal materials with a higher hardness (e. g. as used in metallic piping) are often not suitable for thermoplastic piping.

If seals with a particular chemical resistance (e. g. made of PTFE) and whose preliminary deformation requires bolt-tightning torques above the values specified in Table 5 are to be used, it is recommended to consult the moulding manufacturer. If in doubt, the operational safety of the flanged joint must be proven.

An operationally-safe seal with effective chemical resistance can be achieved by using modified PTFE seals. The properties of multidirectionally-oriented seals made of expanded PTFE (ePTFE) allow good conformity to the sealing faces with low bolting forces.

Seals with reinforcement can only be used if the load-bearing part is completely surrounded by the seal material. Due to their high preliminary deformation forces, fabric-reinforced elastomer seals tend to be unsuitable for flanged joints in plastic piping.

2.8 Bolts

According to DIN 2501-1, bolt dimensions and the number of bolts for flanged joints are stipulated depending on the nominal pressure.

Due to the high strength of the bolt material and the limited internal pressure resistance of thermoplastic piping, the bolting forces used are usually significantly below the maximum permissible value. For this reason, the bolt quality is less significant than in the case of metallic piping. More stringent requirements are, however, frequently set on the corrosion resistance of the bolts.

The bolt tightening forces on flanged joints in thermoplastic piping are influenced more by ambient and operating temperatures as well as by the material behaviour than for metallic piping.

The above factors require multiple checking and retightening of the bolts during ,and on completion of the, pressure test, and if necessary, also after commissioning the pipe system.

3 Assembly of flanged joints

With regard to the assembly of flanged joints, particular attention must be paid to the following remarks.

3.1 Joining of the parts

The construction length of the neck must be taken into consideration when welding necks are joined to the pipe using the HS process. For short welding necks that do not have sufficiently long cylindrical ends for clamping, welding machines with a neck holder must be used, if possible. In particular, this applies whenever, due to space constraints, the loose flange has to be pushed over the neck before welding.

When integral flanges are welded on, it must be ensured that the bolt holes are arranged in such a way that they are symmetrical to both main axes of the pipe (Fig. 10).

3.2 Alignment of the parts

Ideally, the welding neck, the neck bush or the integral flange, the seal and the loose flange should be aligned centrally with the pipe axis. When aligning the seal, it must be checked whether the seal dimensions conform to the outside and inside diameters of the welding neck or neck bush.

Before the bolts are tightened, the sealing faces of the welding neck, the neck bush or the integral flange must be located parallel to each other and must be in close contact with the seal. Adjusting the position of the sealing faces by means of bolt pretensioning using a spanner is not permissible.

In the case of piping sections with a horizontal course, the bolt alignment shown in Fig. 10 is recommended since the medium being transported would not run directly over the bolts if there were any leaks at the flanged joint.

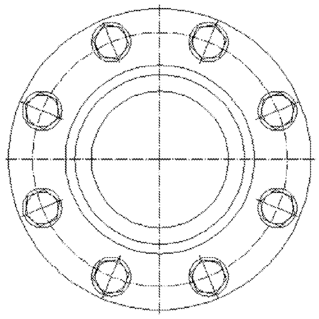

Figure 10.
Alignment of the bolts outside both the main axes.

3.3 Bolt assembly

The length of the bolts must be chosen in such a way that the bolt thread protrudes over the nut by no more than two to three thread turns. Washers must be placed not only at the bolt head but also at the nut.

In order to aid the smooth tightening of the bolts as well as loosening after being in service for a long time, the thread and all friction faces must be provided with an anti-seizing agent (e. g. molybdenum sulphide).

The bolts must be tightened diagonally and uniformly, ideally using a torque-controlled mechanical or impact screwdriver.

3.3.1 Bolting force

After the assembly of the flanged joint, the bolting force and the resulting torque, under the influence of setting and creep phenomena, must not be less than the minimum value in order to ensure that a seal is achieved. The tightening process determines the scatter of the bolting force [F_M] between $F_{M\,min}$ and $F_{M\,max}$ (Table 4).

$F_{M\,min}$ = lower value of the bolting force
$F_{M\,max}$ = upper value of the bolting force
Scatter = difference between the lower and upper values of the bolting force

Due to the significant scatter during the tightening processes according to Classifications III and IV, it is not recommended that these are applied to a flanged joint.

Table 4. Guide values for the scatter of the bolting force.

Classification	Scatter	Tightening process
I	± 5 %	Mechanical screwdriver, controlled according to the rotating angle, motor-driven or manual
II	± 20 %	Mechanical screwdriver, torque-controlled
III	± 40 %	Impact screwdriver, manual, with torque control
IV	± 60 %	Impact screwdriver, manual, without torque control

3.3.2 Bolt-tightening torques

The necessary bolt-tightening torque is dependent on the shape and material of the chosen seal as well as on the friction in the screw thread and at the nut contact face [ges μ_R]. A friction coefficient, ges μ_R = 0.15, may be expected for average (normal) conditions.

The bolt-tightening torque to be applied during the preliminary deformation of the seal must generate a compressive stress of $Q_{min} \geq 0.5$ N/mm^2 in the elastomer seal. Below this minimum compressive stress, the leak rate may be exceptionally high and non-uniform.

If excessive torques are applied, not only may the seal be damaged but the welding neck, the neck bush and the loose or integral flange may also be subjected to unacceptable stresses. The guide value for the maximum compressive stress in an elastomer seal is approx. Q_{max} = 10 N/mm^2, depending on the width-to-thickness ratio of the seal (DIN EN 1591-2).

In most cases, the consequence of excessive compressive stress in the elastomer seal is long-term deformation on the neck or the neck bush, resulting in a reduction in operational safety.

Upper limiting values for bolt-tightening torques when using elastomer seals and as-new bolts provided with anti-seize agent are given in Table 5.

Table 5. Bolt-tightening torques for assembling flanged joints using elastomer seals and a friction coefficient, ges μ_R = 0.15.

<table>
<tr><th rowspan="2">Nominal diameter DN</th><th colspan="3">Bolt-tightening torque [Nm]</th></tr>
<tr><th>Flat ring (guide values) zul p ≤ 10 bar</th><th>Profiled ring (guide values) zul p ≤ 16 bar</th><th>O ring (guide values) zul p ≤ 16 bar</th></tr>
<tr><td>15</td><td rowspan="3">15</td><td>10</td><td>10</td></tr>
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<tr><td>150</td><td>60</td><td>35</td><td>30</td></tr>
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<tr><td>250</td><td>80</td><td>50</td><td>40</td></tr>
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<tr><td>350</td><td>100</td><td>70</td><td>50</td></tr>
<tr><td>400</td><td>120</td><td>80</td><td>60</td></tr>
<tr><td>500</td><td>190</td><td>90</td><td>70</td></tr>
<tr><td>600</td><td>220</td><td>100</td><td>80</td></tr>
</table>

zul p = permissible operating overpressure

[shaded] = zul p ≤ 6 bar

Remarks about Table 5:

The specified bolt-tightening torques result in compressive stresses in the seal, Q_{eff}, up to 8 N/mm^2. If the guide values for the flat ring seal are exceeded (scatter) by > 20 %, this may lead to permanent damage of the flanged joint.

If the seal manufacturer stipulates lower torques than those in Table 5, these should not be exceeded. Using the correct procedure and torque-controlled tools, leak tight flanged joints can be achieved using only 80 % of the guide values specified in Table 5.

4 Tests and inspections

4.1 Manufacturers' tests and inspections

The components of a flanged joint must satisfy the quality requirements according to the respective standards. In addition to the single-part tests and inspections, the tests and inspections on the completed flanged joint must also be carried out. The requirements of the tests and inspections, for the different plastics used, can be taken from the standards listed in Section 5. The loading limits generated from the tests and inspections must be documented.

4.2 Visual inspection of the flanged joint

The visual inspection is concerned with the condition of the flanged joint parts before and after installation. Particular attention must be paid to the following:

– undamaged and flat sealing faces
– parallel faces of the attached welding necks or neck bushes
– gap dimension between the sealing faces before the seal is inserted

– checking the integrity of the seal
– concentricity of the loose flange and the seal
– dimensional congruence between the seal and the inside diameter of the pipe
– correct bolt length
– use of plain washers at the nut and bolt head
– checking that an anti-seize agent has been used
– isolated checking of the bolt-tightening torques

4.3 Internal pressure testing of the pipe system

The completed pipe system must be tested according to the DVS 2210-1 technical code, Supplement 2. All flanged joints must be included. If necessary, the bolts must be retightened after the internal pressure has been relieved.

5 Standards, technical codes and regulations that are also applicable

5.1 Material-related standards

DIN 8063-4	Pipe joints and piping parts for pressurised piping made of unplasticised polyvinyl chloride (PVC-U); necks, flanges and seals; dimensions
DIN 8063-5	Pipe joints and fittings for pressurised piping made of unplasticised polyvinyl chloride (PVC-U) – Part 5: General quality requirements, tests and inspections
DIN 16832-1	Pipe joints and fittings for pressurised piping made of chlorinated polyvinyl chloride (PVC-C) – PVC-C 200 – Part 1: Dimensions
DIN 16962-4	Pipe joints and piping parts for pressurised piping made of polypropylene (PP); Types 1 and 2; necks for heated tool butt welding, flanges and seals; dimensions
DIN 16962-12	Pipe joints and fittings for pressurised piping made of polypropylene (PP), PP-H 100, PP-B 80 and PP-R 80 – Part 12: Necks, flanges and sealing rings for sleeve welding; dimensions
DIN 16963-4	Pipe joints and piping parts for pressurised piping made of high-density polyethylene (PE-HD); necks for heated tool butt welding, flanges and seals; dimensions
DIN 16963-11	Pipe joints and fittings for pressurised piping made of polyethylene (PE), PE 80 and PE 100 – Part 11: Necks, flanges and sealing rings for sleeve welding; dimensions
DIN EN ISO 10931	Plastics piping systems for industrial applications – Poly(vinylidene fluoride) (PVDF) – Specifications for components and the system
DIN EN ISO 15493	Plastics piping systems for industrial applications – Acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U) and chlorinated poly(vinyl chloride) (PVC-C) – Specifications for components and the system; Metric series
DIN EN ISO 15494	Plastics piping systems for industrial applications – Polybutylene (PB), polyethylene (PE) and polypropylene (PP) – Specifications for components and the system; Metric series

5.2 Flange standards

DIN 2501-1	Flanges and connecting dimensions
DIN 16872	Pipe joints and piping parts for piping made of thermoplastics; flanges made of glass-fibre-reinforced polyester resins (UP-GF); dimensions
DIN EN 1092-1	Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges
DIN EN 1514-1	Flanges and their joints – Dimensions of gaskets for PN-designated flanges – Part 1: Non-metallic flat gaskets with or without inserts
DIN EN 1514-8	Flanges and their joints – Dimensions of gaskets for PN-designated flanges – Part 8: Polymeric O-Ring gaskets for grooved flanges
DIN EN 1515-2	Flanges and their joints – Bolting – Part 2: Classification of bolt materials for steel flanges, PN designated
DIN EN 1591-1	Flanges and their joints – Design rules for gasketed circular flange connections – Part 1: Calculation method
DIN EN 1591-1 Supplement 1	Flanges and their joints – Design rules for gasketed circular flange connections – Background information
DIN EN 1591-2	Flanges and their joints – Design rules for gasketed circular flange connections – Part 2: Gasket parameters

5.3 DVS technical codes and technical bulletins

DVS 2205-4	Calculation of tanks and apparatus made of thermoplastics – Flanged joints
DVS 2205-4, Supplement	Calculation of tanks and apparatus made of thermoplastics – Welding flanges and welding necks – Design-related details
DVS 2210-1	Industrial piping made of thermoplastics – Designing and execution – Above-ground pipe systems
DVS 2210-1, Supplement 1	Industrial piping made of thermoplastics – Designing and execution – Above-ground pipe systems; calculation example
DVS 2210-1, Supplement 2	Industrial piping made of thermoplastics – Designing and execution – Above-ground pipe systems; recommendations for the internal pressure and leak tests
DVS 2210-1, Supplement 4 (under preparation)	Industrial piping made of thermoplastics – Designing and execution – Above-ground pipe systems; calculation according to yield strengths

Remark: Only the essential standards are listed here, in order to supplement the complexity of subjects dealt with. For any individual case, it may be necessary to comply with more detailed standards, guidelines, technical codes and regulations.