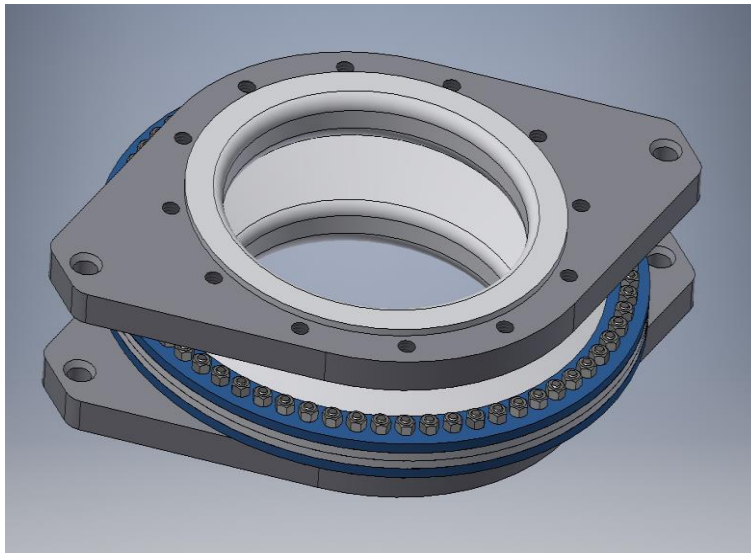
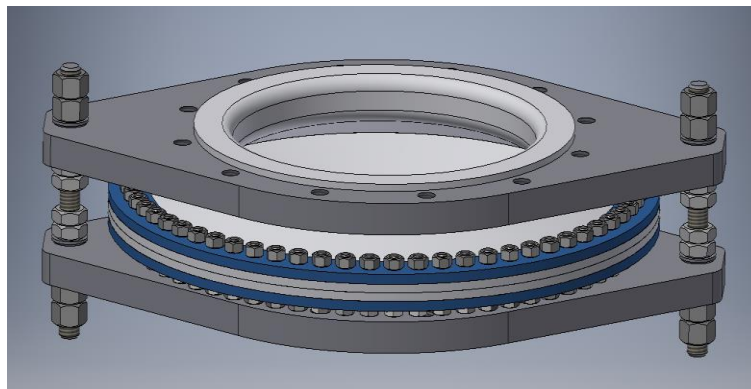


Operating instructions

for vacuum expansion joints

according to the Pressure Equipment Directive 2014/68/EU



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1. Intended Purpose

Vacuum expansion joints with PTFE membranes are designed to compensate for slow axial, lateral or angular movements, which are usually caused by temperature changes in pipeline systems.

The expansion joints are installed between the flanges of the pipeline components such as flange pipes, T-pieces, containers, etc. and decouple the movement of the pipe components within the permissible axial, lateral or angular movement.

When planning the pipe construction, it must be ensured that axial forces resulting from pressure are absorbed by suitable bearings. The vacuum expansion joint can only absorb axial pressure forces that arise from the effective bellows cross-section.

2. Usage

The vacuum expansion joints were designed, constructed and manufactured according to the order information, including pressure and nominal size.

They are to be installed and operated properly.

The operating instructions and installation instructions in the attached documentation must be followed.

Permissible operating pressure / Operating temperature

The expansion joints in sizes from DN150 to DN800 are set to an operating pressure of PS -1 bar ... + 1 bar at TS -10°C... + 200°C.

This pressure range must not be exceeded at any time. If this range is exceeded, the vacuum expansion joints lose their approval as pressure equipment and must be replaced.

Malfunction scenarios for expansion joints DN400 ... DN800

The expansion joints of size DN400 DN800 have been tested and approved by TÜV SÜD Chemie for an unscheduled malfunction operation (max. 72 h) at max.PS 3 bar / TS 200°C. After such a malfunction, they must be replaced.

Resistance

Resistance (materials of the bellows must be resistant to the fluids under operating conditions. If necessary, this must be checked using resistance lists).

If there are concerns about the material specification, these must be reported to the operator so that the situation can be clarified.

As a matter of principle, the operator has to check within the framework of the risk assessment whether the resistance of the material for the medium is given.

Depending on the level of risk of the medium the periodic inspections must be carried out at appropriate frequencies.

3. Transport and storage

General information

The local national (safety) instructions for transport, installation, operation and maintenance must be respected.

The operator is responsible for installation and for the training of the installing and operating personnel.

Hard impacts on the devices are to be avoided during transport, unloading and introduction. Additionally loading of the expansion joint, e.g. by stacking, is not acceptable. Factors that make corrosion more likely are to be avoided, e.g. exposure of the expansion joint to ambient air or to the medium.

The pressure devices may only be placed on the protective covers. The transport eyelet (see Fig. X) must be used to bring it in during assembly (from DN400).

The protective covers must only be removed immediately before installation!

Check for transport-related or other damage

When the expansion joints are delivered, they must be checked for transport-related or other damage. If damage is discernible, this must be reported to the manufacturer immediately. Equipment with recognisable damage must not be installed.

Protective cover

To protect the lining from soiling and mechanical damage from handling and storage and to hold down the flare, all parts are provided with a protective cover. This may only be removed before assembly.

If transport locks are available, they must not be used as a fastening point for assembly equipment. These must be removed after assembly.

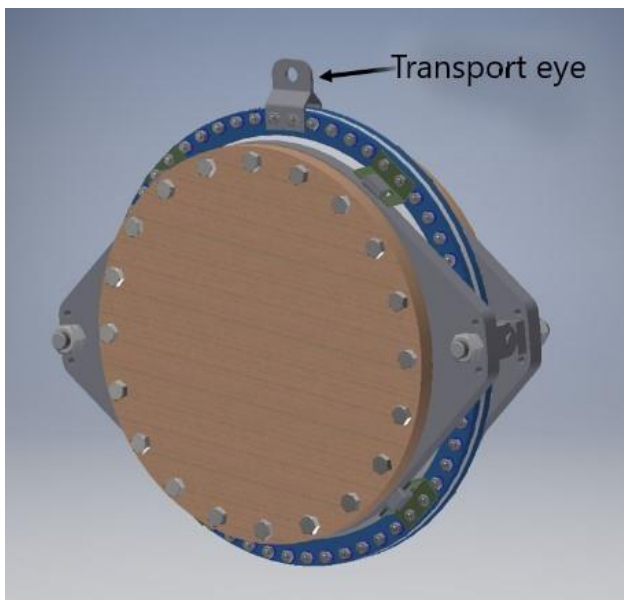


Figure 3.1: Expansion joint with protective cover and transport eye

4. Structure and function of the expansion joints

The vacuum expansion joints with PTFE membrane consist of two expansion joint diaphragms, which are clamped together by means of a clamping ring.

The membrane is crimped into the connection flange and is used as a seal to the counter flange. The expansion joint is connected to the connection flanges with the flanges of the PTFE-lined pipeline system.

The membrane is compressed and stretched by the movement of the connection flanges towards each other. The permissible movement tolerances are described below.

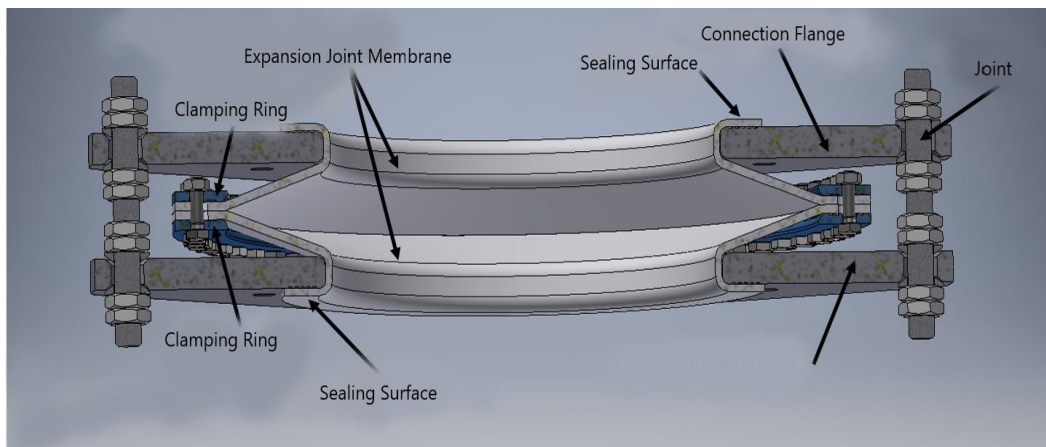


Figure 4.1: Side section of the vacuum expansion joint

5. Movement possibilities and limitations of the expansion joint

The expansion joints are designed to absorb movement in a defined axial, lateral and angular area (see technical data sheet).

The confirmed movement tolerance (e.g. axial) can only be used 100% in one direction, otherwise the membrane will be overstretched.

If several types of movement are used at the same time, the movement tolerance is reduced linearly in another direction.

To protect the expansion joint, there are various movement restrictions, depending on the type of movement. The guide elements can be exchanged and must be set by a specialist (after consultation with the manufacturer) in accordance with the technical data sheet.

For sizes below DN400, the movement limitation is only implemented by means of guide elements (tilt joint, ball joints, etc.).

For the larger expansion joints, stop brackets are also used.

Axial movement

For applications with an axial movement function, the movement tolerance is set using two threaded rods. On size DN400, the bellows are additionally protected against excessive compression by means of a stop bracket.

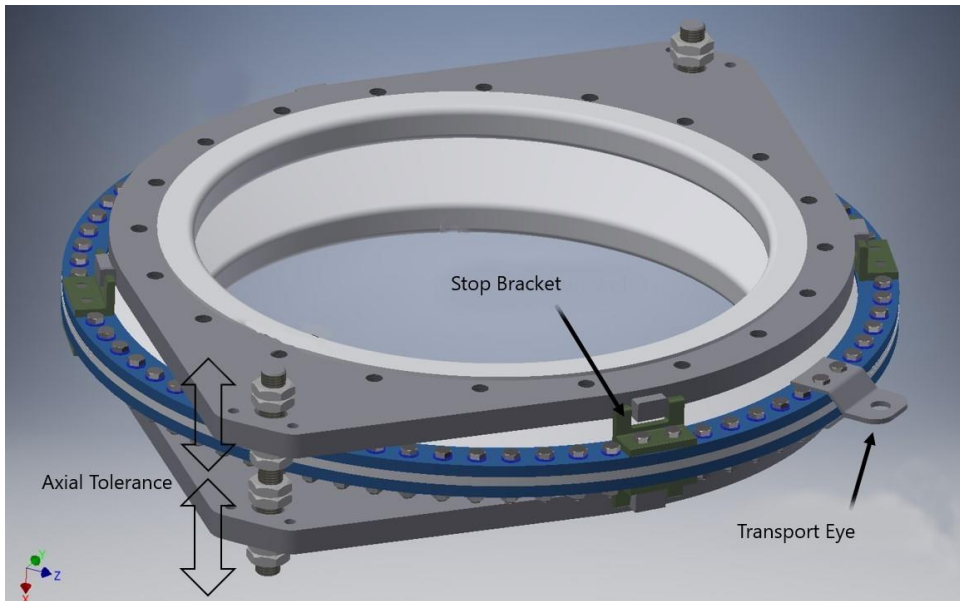


Figure 5.1: Axial movement tolerance

One-dimensional angular and lateral movement

For applications with defined angular and lateral movement, a tilt joint with integrated one-dimensional lateral movement is used. From DN400 onwards, the movement tolerance is additionally limited with stop brackets.

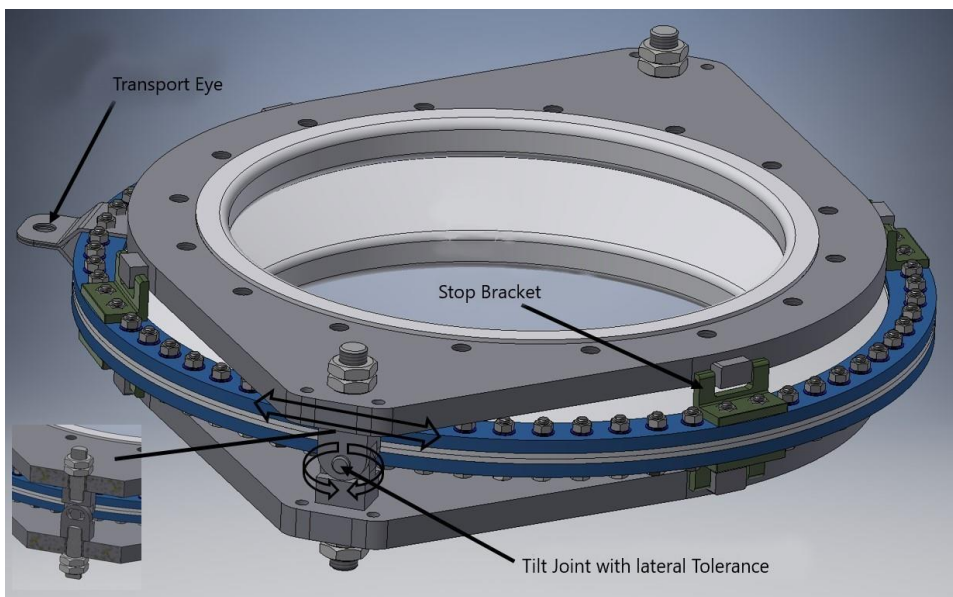


Figure 5.2: Angular and lateral tolerance

One-dimensional angular and multi-dimensional lateral movement

For applications with defined angular and lateral movement, a tilt joint with integrated one-dimensional lateral movement is used. From DN400 onwards, the movement tolerance is additionally limited with stop brackets.

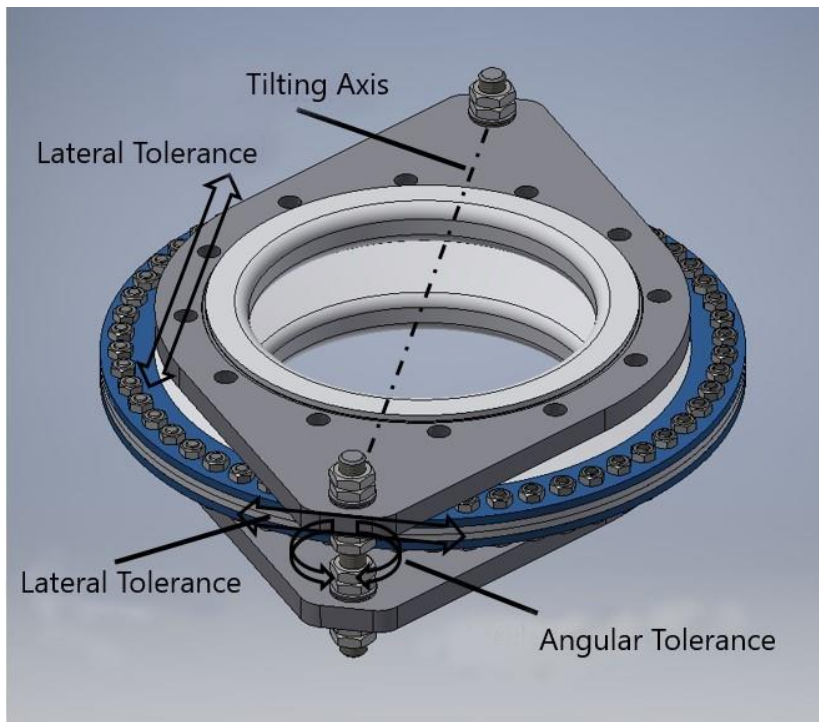


Figure 5.3: One-dimensional angular and multi-dimensional lateral movement

6. Assembly

General information

The required torque wrenches and torque tables for tightening the bolts on the connection flanges must be available for assembly. The expansion joint may only be installed if it is in perfect condition. The bellows membrane must not be soiled or damaged.

During assembly, care must be taken that the expansion joints are not subjected to any torsional loads. The permissible movement tolerance must not be exceeded at any time. The assembly may only be carried out by qualified personnel.

In order to prevent damages, the fixing bolts on the connection flanges shall not touch the bellows membrane at any time (even during operation of the plant). See example (red circle) in figure 6.1.

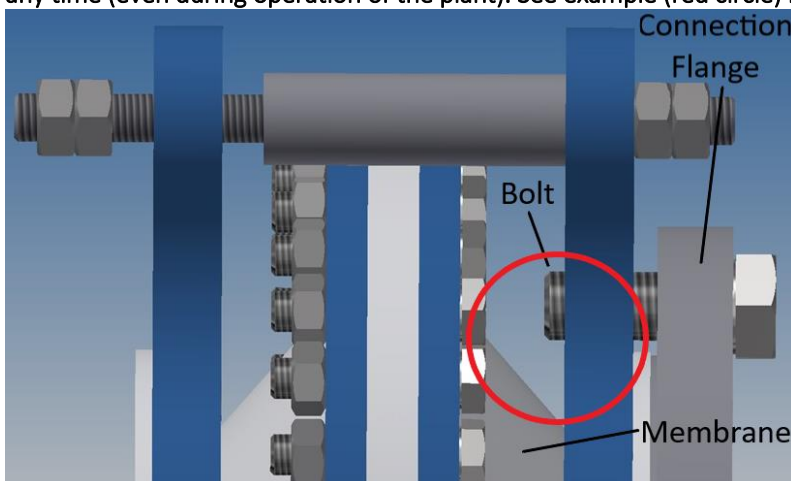


Figure 6.1 Bolting flange/expansion joint

Seals and tightening torques on the connection flanges

When connecting the expansion joints to standard PTFE-lined pipe components from BAUM with DIN or ANSI flanges, it is recommended to use the screw torques from the following table. No additional seals are required.

Diameter Nominal [DN]	PN10		PN16		PN25		PN40	
	bolts	Torque [Nm]	bolts	Torque [Nm]	bolts	Torque [Nm]	bolts	Torque [Nm]
15	4 x M12	15	-	-	-	-	-	-
20	4 x M12	25	-	-	-	-	-	-
25	4 x M12	34	4 x M12	34	4 x M12	34	4 x M12	34
32	4 x M16	55	4 x M16	55	4 x M16	55	4 x M16	55
40	4 x M16	68	4 x M16	68	4 x M16	68	4 x M16	68
50	4 x M16	86	4 x M16	86	4 x M16	86	4 x M16	86
65**	4 x M16	115	4 x M16	115	-	-	-	-
65	8 x M16	58	8 x M16	58	8 x M16	58	8 x M16	58
80	8 x M16	71	8 x M16	71	8 x M16	71	8 x M16	71
100	8 x M16	78	8 x M16	78	8 x M20	107	8 x M20	107
125	8 x M16	89*	8 x M16	89*	8 x M24	156	8 x M24	156
150	8 x M20	141	8 x M20	141	8 x M24	192	8 x M24	192
200	8 x M20	181*	12 x M20	141	12 x M24	200	12 x M27	252
250	12 x M20	166	12 x M24	201	12 x M27	296	12 x M30	378
300	12 x M20	169*	12 x M24	273*	16 x M27	301	16 x M30	399
350	16 x M20	212*	16 x M24	280	16 x M30	479	16 x M33	611
400	16 x M24	291*	16 x M27	430	16 x M33	562	16 x M36	1137
500	20 x M24	315*	20 x M30	567	20 x M33	609	20 x M39	1008
600	20 x M27	457	20 x M33	829	20 x M36	1049	20 x M45	1596
700	24 x M27	467*	-	-	-	-	-	-
800	24 x M30	611*	-	-	-	-	-	-
	<i>For all DIN torque without specific comments we recommend to use screw quality 5.6., A2-70, A4-70 or compatible approved grade.</i>							
*	<i>For flanged connections marked with * lightly oiled screws 25CrMo4 or higher-quality are required.</i>							
**	<i>In this special case, we recommend to use screws quality 8.8 or approved comparable grad.</i>							

Table 6.1: Torque DIN, Source: Tightening torques DIN & ANSI - PTFE components Rev 6

Nominal pipe size [NPS]	Pressure class 150			Pressure class 300		
	bolts	Torque [Nm]	Torque [ft-lb]	bolts	Torque [Nm]	Torque [ft-lb]
1/2"	4 x 1/2"	6	4,4	4 x 1/2"	6	4,4
3/4"	4 x 1/2"	10	7,4	4 x 5/8"	12	8,8
1"	4 x 1/2"	14	10,3	4 x 5/8"	18	13,3
1 1/2"	4 x 1/2"	28	20,6	4 x 3/4"	41	30,2
2"	4 x 5/8"	53	39,1	8 x 5/8"	27	19,9
2 1/2"	4 x 5/8"	66	48,7	8 x 3/4"	39	28,8
3"	4 x 5/8"	94	69,3	8 x 3/4"	56	41,3
4"	8 x 5/8"	67	49,4	8 x 3/4"	80	59
5"	8 x 3/4"	101	74,5	8 x 3/4"	101	74,5
6"	8 x 3/4"	128	94,4	12 x 3/4"	73	53,8
8"	8 x 3/4"	178	131,3	12 x 7/8"	138	101,8
10"	12 x 7/8"	175	129,1	16 x 1"	150	110,6
12"	12 x 7/8"	228	168,1	16 x 1 1/8"	220	162,2
14"	12 x 1"	285	210,2	20 x 1 1/8"	192	141,7
16"	16 x 1"	265	195,4	20 x 1 1/4"	265	195,6
18"	16 x 1 1/8"	389	286,9	24 x 1 1/4"	288	212,5
20"	20 x 1 1/8"	344	253,7	24 x 1 1/4"	318	234,7
24"	20 x 1 1/4"	487	359,1	24 x 1 1/2"	487	359,4

For ANSI torque we recommend to use screws ASTM A193 Grade B7 or approved comparable grad.

Table 6.2: ANSI torque, Source: Tightening torques DIN & ANSI - PTFE components Rev 6

The sealing surfaces must be clean, dry and free of grease. Before assembly, the sealing surfaces must be cleaned with a clean cloth.

The bolts are to be tightened crosswise using a torque wrench in 3 stages with the appropriate torque for the bolt material according to the tightening scheme in the annex:

- 1. Step 40% of the required torque
- 2. Step 80% of the required torque
- 3. Step 100% of the required torque

Note: The reference values of the tightening torques apply only at room temperature!
Due to the flow behaviour of the lining, the bolts should be re-tightened after one day.

Tightening torques apply to lightly oiled/greased bolts at normal temperature and are designed to allow the liner to flow easily for a secure seal. Any further increase of the indicated torques does not necessarily lead to a better seal, but can lead to a deformation of the flange.

After the first temperature cycle and commissioning, we recommend re-tightening the bolts several times.

Note: In the case of sensitive connection devices made of glass, enamel, carbon, etc., additional seals, flange connection geometries and tightening torques must be designed by the system planner.

It must be taken into account that the flange on the expansion joint connection flange can straighten up with low surface pressure.

7. Further notes to be observed

Bolt quality

For information on the recommended bolt quality, see below the respective table.

Seals

Additional seals between the PTFE sealing surfaces are not necessary. In the case of a change in pipe class, e.g. transition to metal, glass, ceramics, enamel, ETFE, PVDF, etc., the necessity of a seal must be checked by the system planner/operator.

The tightening torques in the tables above are invalid here and must be determined by the operator/system designer taking the adjacent flange into account.

The specified neutral dimension (structural dimension) must be observed during installation.

The general rules for the arrangement of expansion joints in pipeline construction must be observed!

Only one expansion joint is to be arranged between two fixed bearings!

The pipeline must not exceed the maximum movement tolerance of the expansion joint!

If combined movement loads (axial, lateral and angular) occur at the same time, the information for individual loads is limited and must be requested from the manufacturer.

A small distance between the expansion joint and the fixed bearing is desirable. A distance of $<3 \times DN$ is advantageous. Spacers of universal expansion joints are used to limit (expansion and compression) inadmissible loads during operation. These are not force-transmitting devices such as joints on the expansion joints.

The adjacent pipelines must be routed through bearings and installed flush.

Note: The installation of glass panels on the vacuum expansion joint is to be avoided.

8. Commissioning

Removal of accompanying material for transport. Remove the transport lock/assembly aid made of plastic or wood to ensure that the expansion joint is in a neutral position after assembly.

The pressure equipment may **only be commissioned** if it has been checked for proper condition with regard to assembly, installation, set-up conditions and safe operation, taking into account the intended operation.

The installation should be performed by a competent expert.

All local national regulations must be observed before commissioning. The commissioning regulations of the system operator must be observed.

Before the components supplied are put into operation, a pressure/leak test (ideally with water) must be carried out on site at room temperature after the fixed and sliding bearings have been installed. The required test pressure is noted on the nameplate or must be discussed with the manufacturer.

Changes in pressure and temperature

During commissioning, rapid pressure and temperature changes should be avoided.

Leaks and deformations

During commissioning, the flange connections must be observed for leaks and the components for deformation.

In the event of leaks, the pipeline system/container must be taken out of service.

The pressure equipment should be run up slowly to the operating state while all components are heated at the same time as possible.

9. Operation

Intended use

This pressure equipment may only be used for the intended purpose. Changes must be approved by the manufacturer.

The specified maximum permissible values for pressure (PS) and temperature (TS) must not be exceeded. The values can be found on the nameplate or on the construction drawing. If these values are not available, the following key values taken from the design pattern testing by TÜV SÜD Chemie Service are valid:

Temperature -10...+200°C

Pressure -1...+1 bar

Permitted incident overload: 3 bar / 200°C / 72h

For special designs of vacuum expansion joints ask manufacturer for key values.

Application limits

The installation of safety devices against overheating/overpressure and the protective measures to be taken are the responsibility of the operator.

Resistance

Only the operating media approved for PTFE/PFA on the resistance list may be used. The customer/operator is responsible for the chemical resistance of the material used to the fluids handled in the pressure equipment. The operator must check whether the lining material is suitable for the medium used.

Changing the operating fluid must not adversely affect the safety and durability of the pressure equipment.

10. Maintenance and inspection

Ferritic flanges are usually provided with a special protective primer to prevent corrosion, as well as a top coat. As long as this protective layer is not damaged, external corrosion can usually be ignored (depending on ambient air conditions). The protective layer must be checked regularly to ensure that it is not damaged.

The expansion joint must be checked for corrosion and damage at regular intervals, especially in an aggressive environment.


If there are no malfunctions that indicate leaks in the pressure equipment and no intervention is made on the equipment that will likely cause contamination, no maintenance on the pressure equipment is required. If any leaks can be detected, the component must be taken out of service immediately.


Maintenance work is essentially limited to cleaning.

Maintenance work may only be carried out by trained specialist personnel.


It should be noted that pressure equipment is used for the flow of highly aggressive medium and by means of diffusion this medium can accumulate between the lining and the steel support.

The service life of the expansion joint is 5 years. After this time, the expansion joint must be replaced.

 In the event of a malfunction, the expansion joint must be replaced!

 Only absolutely chloride-free acids may be used for chemical cleaning of apparatus parts made of austenitic stainless materials!

Approval from the manufacturer must be obtained for repairs.

 Before opening, the pressure equipment must be de-pressurised. If pipes from incoming and outgoing media are not dismantled, they must be closed by plug-in disks for safety reasons.


Bolts and nuts should be checked for suitability and replaced if necessary. The material for bolts and nuts must be the same as the original. Other materials require the consent of the pressure equipment manufacturer!

Only clean and greased threads, in conjunction with the correct tightening torque, provide the required bolt prestressing.

The bolts are to be tightened crosswise by means of a torque wrench in 3 stages with the torque corresponding to the bolt material:

- | | |
|---------|-----------------------------|
| 1. Step | 40% of the required torque |
| 2. Step | 80% of the required torque |
| 3. Step | 100% of the required torque |

Inspection

 The pressure equipment should be checked for leaks at regular intervals. External, internal and strength tests are to be carried out within the time periods and by persons who comply with the relevant national legislation.

11. Decommissioning / disposal

It is the responsibility of the operator to dispose of the system in an environmentally friendly manner after operation, especially components that have been contaminated during operation.

12. Maintenance and checking of the clamping rings

General information

The vacuum expansion joints differ with regard to the clamping rings as follows:

Size smaller than DN400

- There are no spring washers under the screws of the clamping rings
- The clamping rings were designed with a reduced sheet thickness (M10)
- The expansion joints were tempered at 200°C and then the clamping rings were tightened again.

Size from DN400

- Spring washers are placed under the screws of the clamping rings
- The clamping rings were made in standard sheet thickness (M12)

All vacuum expansion joints were checked for leaks 1 day after the clamping ring screws had been re-tightened at 3 bar for 15 minutes. Normally, the clamping rings are ready for use when leaving the factory, so that the clamping ring screws do not need to be re-tightened.

If there is a leak during commissioning, especially after the first temperature change, proceed as follows:

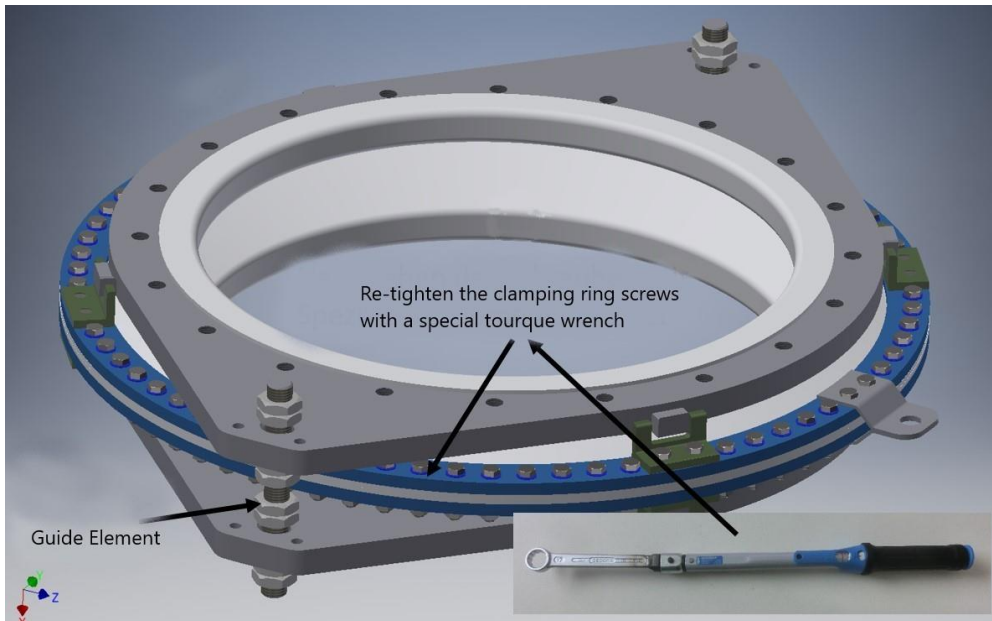


Figure 12.1: Re-tighten the clamping ring screws with a special torque wrench

Before re-tightening, the guide element must be dismantled from the connection flanges.

Diameter nominal	Flange thickness [mm]	no. of bolts	Dimension bolts	required tightening torque [Nm]	strength class bolts
DN100	12	30	M12	42	8.8
DN 150	12	38	M12	31	8.8
DN 200	15	44	M12	42	8.8
DN 250	15	36	M12	62	8.8
DN 300	15	44	M12	58	8.8
DN 350	15	50	M12	62	8.8
DN 400	15	56	M12	64	8.8
DN 450	15	64	M12	67	8.8
DN 500	15	66	M12	62	8.8
DN 600	15	64	M16	111	8.8
DN 700	15	72	M16	108	8.8
DN 800	15	78	M16	108	8.8

Table 12.1 Torque for clamping ring screws, Source: Tightening torques for clamping rings of vacuum expansion joints Rev 4

For tightening, it is recommended to apply only approx. 50% of the torque specified in the data sheet (see table 12.1) of the expansion joints. In this case, the flow initially required during factory assembly has already taken place. 100% of the specified torque may only be used in case of persistent leakage.

Note: Ask manufacturer for required torques if expansion joint is not listed in table 12.1.

When the clamping ring bolts are designed with spring washers (\geq DN400), the tightening force is first corrected (due to the relaxation of the PTFE) by the spring washer. Re-tightening is only required after further setting.

Special torque wrench

A calibration diagram is included with the special torque wrenches supplied. This diagram shows the value to be set on the torque wrench and the target value. As the special socket wrench is longer than the standard torque wrench, the torque is greater due to the longer lever arm.

Maintenance intervals

It is recommended, especially if the system temperature changes repeatedly, to check the clamping rings once a year and, if necessary, to re-tighten them according to the above scheme.