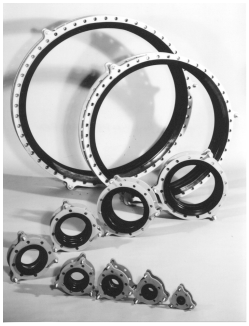


Bellows
User Instructions and Technical Guide

Introduction

CRP's range of bellows are fabricated according to the most modern manufacturing standards and are subject to strict quality controls.

General Product Description

Bellows consist of steel flanges at either end of a convoluted PTFE tube. They can have various types of internal and external reinforcement rings or shells to provide pressure and vacuum performance characteristics. The PTFE bellows themselves can have different wall thicknesses and numbers of convolutions to provide suitable characteristics for different joint configurations. They are available across a range of sizes, with whatever flanges the piping system requires.

A key feature of CRP bellows is that they are made from PTFE paste extruded tube. The convolutions are produced from this raw material by temperature and pressure, not by machining from a solid component. This provides a homogenous product structure, ideally suited for the requirements of the application.

End Caps

End caps serve to protect the sealing surfaces of the bellows against mechanical damage and prevent the flared liner lifting off the flange. They should only be removed shortly before mounting. If they are removed for inspection purposes, they must be replaced immediately.

Quality Assurance

All bellows are tested at 30 bar (g) for sizes up to and including DN 150 (6"). Larger sizes undergo a crush test and are sample tested at 10 bar (g). All bellows are tested by compressing them to their minimum axial length, and all receive a comprehensive visual inspection.

Type Testing

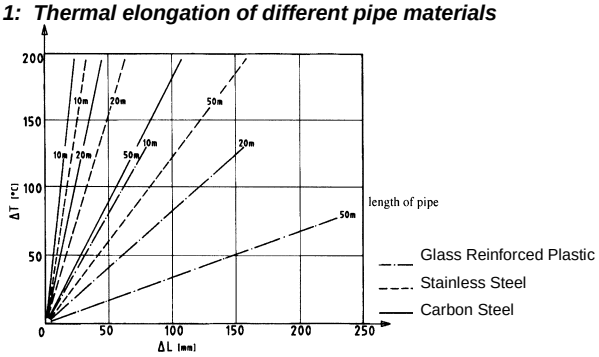
Long term testing has been undertaken on CRP's range of bellows including 100,000 hour operating tests under static conditions and 1,000,000 cycle dynamic tests.

Vacuum resistance and flex have been tested for the full range of operating conditions, as has resistance to thermal shock. Physical testing has been backed up by design calculation including finite element analysis of the spring function and stress levels within the bellows.

Functions of Bellows

Bellows are designed to compensate for relative movements of piping, or to protect connecting nozzles against the application of force. These movements may be caused by changes in ambient or operating temperatures, vibration of equipment etc. For example, figure 1 demonstrates the influence of heat on the elongation of PTFE lined steel pipes. Heat elongation of some pipe lengths of other materials are also shown.

Figure 1: Thermal elongation of different pipe materials



The type and extent of compensation required depends on the pipe materials used, temperature variation and the pipe work layout, i.e. type, quantity and positioning of the fixing points and supports. Key to the bellows configuration are the pressure reaction forces, the inherent resistance of the bellows, and the frictional forces resulting from the pipe supports to the pipe positioning. The axial pressure reaction force can be calculated as a product of maximum internal pressure and effective cross-section of the bellows.

The cross-sections for our types of bellows are shown in table 1, which also indicates the spring rates for the calculation of the shifting forces depending on type of bellows. Please contact us for further information concerning spring rates for lateral and angular movements and their operating temperatures.

Table 1: Values of spring rates and effective cross-sectional areas of types KP3, KD10 and KD25 bellows

		Effective diameter of bellows in cm^2			Axial spring rate in N/mm ± 20%, T = 20°C		
NB	**DN**	**KP3**	**KD10**	**KD25**	**KP3**	**KD10**	**KD25**
1"	25	8			15		
1½"	40	20	28	28	23	90	150
2"	50	31	40	41	27	55	174
2½"	65	47	65	64	34	84	146
3"	80	70	86	84	42	89	163
4"	100	100	133	136	62	84	210
5"	125	161	194	197	66	94	258
6"	150	222	270	275	77	113	275
8"	200	363	450	444	98	147	372
10"	250	594	685	688	125	174	440
12"	300	754	938	918	155	207	514
14"	350	1046	1109	1088	184	227	489
16"	400	1288			206		
20"	500	2041			254		

Bellows Types

Several types of bellows are available, as detailed below. The piping design and layout will define which type is most appropriate

Multipurpose Bellows can compensate for all movements under limited conditions. Due to the combined strains, the maximum shifting forces for single loads are not valid. Exact figures can be provided on request.

Axial Bellows are used for the compensation of length alterations in piping and of vibrations (general compensation).

Lateral Bellows are used for the compensation of movements from the pipe axis.

Angular Bellows facilitate pipe movements. Coupled as double-jointed systems, they allow more lateral compensation than single lateral bellows.

Special CRP Bellows

Products are not limited to the standard catalogue and a range of special items can be produced including:

- Bellows to compensate for movement in one direction only – axial, lateral or angular.
- Reducing bellows for differing flange sizes.
- Differing flange specifications at each end, e.g. ASME and DIN.

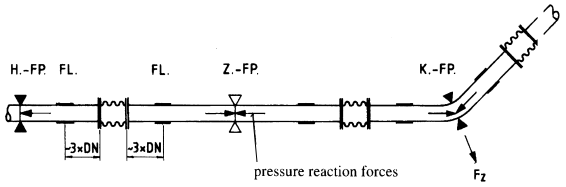
Bellows Fixing

Limit bolts are fitted to bellows prevent over-extension during operation. They are not force transmitting in the sense of articulated bellows. In case of vibrations lock-nuts or adhesive nuts should be used on the limit bolts.

Bellows are designed to compensate for movements during operation. They are not suitable for the compensation of defects in installation or design.

The type and position of fixing points is important. These are divided into main (H.-FP) and knee fixing points for the compensation of pressure reaction and centrifugal forces and intermediate fixing points (K.-FP) for mainly pressure relief, whilst the guide bearing (FL) serves mainly for the stability of the pipe position. An example is shown in figure 3.

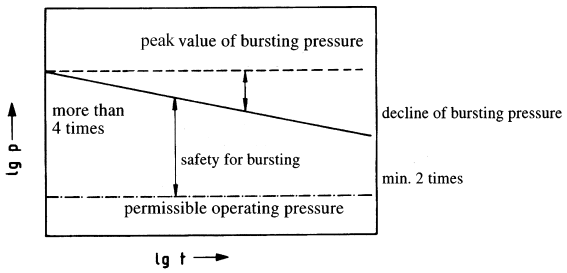
Figure 3: Example of bellows arrangement



Between two fixing points, only one bellows should be installed. The installation of several bellows may cause instability, for example missing fixing points can lead to an over-extension and bursting of the bellows.

The distances between bellows and fixing points should be kept small, i.e. about three pipe diameters. So, any compensation can be limited especially in the case of vibrations. With the use of angular bellows or double-jointed systems, the variation of the bend radius has to be observed when dimensioning the adjacent guide bearings. Lateral and angular bellows are pressure relieved, so the pressure reaction forces are taken by the articulation anchors. Upon installation of such bellows, the positioning of the axis of rotation has to be considered. In case of lateral and angular compensation, internal pressure will additionally deform the surface of the bellows convolutions. This has already been considered in the stress limits indicated for our bellows.

Figure 4: Behaviour of bellows during long-term stress



To evaluate the suitability of PTFE bellows, the long term behaviour of the material has been considered. Over a period of more than 10 years, the bursting limit reduces—this is shown in figure 4. This long time behaviour is considered in our safety assessment of our bellows.

General Remarks

The bellows are supplied pre-tensioned, i.e. in zero position with regard to axial compensation. After installation, the limit bolts have to be adjusted to the value of maximum extension.

Tension stresses should be avoided as bellows are not suitable for these strains. For protection against abrasive fluids or to avoid product build-up in the convolutions, protection sleeves can be used which simultaneously stabilise the bellows and greatly limit angular and lateral movement.

For bellows larger than DN 100, the length of connecting bolts has to be considered. The bolts must not protrude beyond the nuts, to avoid damage to the bellows.

The PTFE-flare face of the bellows serves as the sealing surface. For connecting to unlined flanges (i.e. to glass or steel/enamel), additional gaskets must be used. In the case of PTFE-lined components, this is not necessary.

For PTFE lined flanges the torque rates shown in table 2 are valid. Further information regarding PTFE-lining can be taken from our mounting instructions for piping. Please enquire.

Table 2: Torque Rates in Nm (DIN/ASME)

		DIN			ASME B16.5 Class 150	
NB	**DN**	**Torque in Nm**	**BOLTING PN10/16**		**Torque in Nm**	**BOLTING**
1”	25	25	4 x M12		15	4 x 1/2” UNC
1.25”	32	30	4 x M16		20	4 x 1/2” UNC
1.5”	40	35	4 x M16		25	4 x 1/2” UNC
2”	50	45	4 x M16		35	4 x 5/8” UNC
2.5”	65	45	4 x M16		40	4 x 5/8” UNC
3”	80	46	8 x M16		46	4 x 5/8” UNC
4”	100	55	8 x M16		55	8 x 5/8” UNC
5”	125	60	8 x M16		65	8 x 3/4” UNC
6”	150	80	8 x M20		85	8 x 3/4” UNC
8”	200	100	**8 x M20**	**12 x M20**	105	8 x 3/4” UNC
10”	250	85	**12 x M20**	**12 x M24**	110	12 x 7/8” UNC
12”	300	120	**12 x M20**	**12 x M24**	130	12 x 7/8” UNC
16”	400	170	**16 x M24**	**16 x M27**	180	16 x 1” UNC
20”	500	205	**20 x M24**	**20 x M30**	240	20 x 1.1/8” UNC
			PN10	**PN16**		

WARNING!

Accidents or operating failures may lead to sudden pressure shocks in the piping which exceed the maximum operating pressure as well as the bursting pressure.

In order to protect staff and equipment against those risks, we recommend the use of temperature and chemical resistant Safety Shields with all bellows.

As with all equipment used in process control installations the correct product to application selection is critical. This document is for guidance only. CRP will not take responsibility for the application engineering of bellows. CRP’s product warranty covers materials and workmanship only.

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