

Mondi Štětí a.s.

STANDARD
ST 10.02.06
COMPENSATORS

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STANDARD

ST 10.02.06

COMPENSATORS

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It is intended as a construction standard and selection aid depending on medium.

Sheet 1 - 6 indented as an attachment for suppliers
Sheet 7 - 14 indented as an aid for calculation and construction

1 General

Purpose of the compensators is:

- ≡ to capture and balance axial (and radial) thermal expansion
- ≡ to balance axial, radial or angular (angled) deviances to connection pipe components
- ≡ to separate the moving aggregates from other system of line (Vibration, sound in the solid material)

According to these specific requirements compensators must be selected depending on medium.

There are no general standards for usage of aggregates. However, for Mondi is stated:

- ≡ ventilators are always equipped with compensators, in case they are connected with pipeline.
- ≡ centrifugal pumps only according to features and experience
- ≡ other aggregates according to manufacturer's regulations or experience
- ≡ always when the aggregate is assembled with vibration damping on the basis

Used compensators are divided according to media.

For chemical pipe-line no compensators are used, length balance and damping is executed via pipe-line or by pulsation damping equipment.

Pip-lines around compensators must be appropriately fixed in order to prevent eventual transmission of the pulsation impacts on pipe line.

In case of abrasive media or danger of crystal (Recaustification plant) In case of liquid media, compensators with the guide-pipe for bellows protection must be used.

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2 Aiding on selection

2.1 Evil-smelling

2.1.1 Evil- smelling gas from chemical regeneration operation, pulp mills

is intended mainly for ventilator separation from the other pipe system. Thermal expansion is balanced by bearing alignment (fixed and loose) and by guide pipe-line.

Execution

No air technical cloth filter compensators, but Teflon or Teflon coated compensators like for liquids, designed with inter- flange.

Flange 1,4436/ 17352/ or 1.4571/17348/ (galvanized, in case it is no other way it is supplied, with written permission and agreement)

2.1.2 Flue gases from the Boiler house, Recaustification plant

are intended for aggregates separation and absorption of the thermal expansion

Execution

Gas- tightness cloth with thermal resistance according to the place of use up to 1000° C. Execution with intermediate flange.

Flange material St 35 (dry area) or 1.4436 / 1.4571- 17352/17348.

2.1.3 Paper machines heat recuperation

are intended for ventilators separation and pipe-line system(vibration, sound in a solid material)

Execution

Gas tightness, or plastic cloth executed with intermediate flange.

From +/- 500 Pa with a plate or enforced cloth.
area.

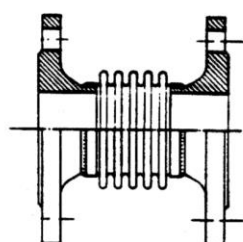
Material: Flange 1.4301- (17240) or Alu in wet surroundings, galvanized in dry surroundings

2.1.4 Steam

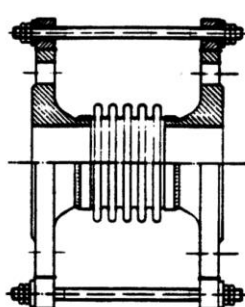
Compensators are used only in pressure system 3 bar / 12 bar for absorption of the thermal expansion. In the high pressure areas, thermal expansion meets pipe-line(sufficient amount of bends for expansion) and by pipe-hangers (spring hangers or spring supports).

According to the type of pipeline and arising expansion movement, the axial, lateral(side) or angular compensators are used.

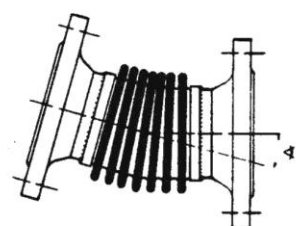
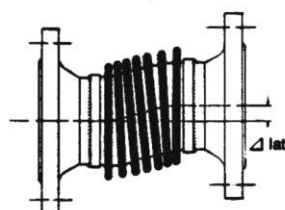
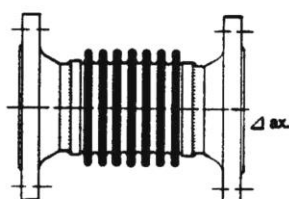
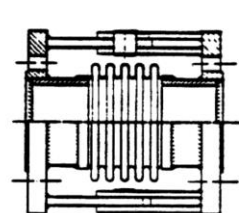
Axial-Kompensatoren



Lateral-Kompensatoren



Angular-Kompensatoren



Place of use will be agreed with organization /placement of the loose and fixed bearings.

Execution

Bellows of 1.4541,/17247) connection St 37.0/St 37.2 with welded ends or in execution intermediate flanges.

2.1.5 Vacuum exhaust pipe

To separate aggregates and pipe-line (vibration).

Execution

Steel compensators (because of under pressure) executed with intermediate flange, bellows 1.4541- 17247, flange 1.4301- 17240, selection see point 2.1.4.

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2.2 Liquid media

2.2.1 Water

Used in the first line to separate aggregates and pipeline

Execution

Bellows made of EPDM, natural rubber or of material 1.4571, intermediate flange version, heat - galvanized flange. In a Pulp mill, Recaustification plant – environment complete compensator (bellows and flange - if supplied) of material 1.4571 / 1.4436 - 17348/17352.

2.2.2 Cellulose

Use it only if it is necessary, then in execution as point 2.2.1. In cellulose factory where are MC pumps used is necessary each time use the compensator – material of compensator 1.4571.

2.2.3 Vapour condensate, acid weak liquors, acidic water, raw acid

Usage like 2.2.1.

Execution

Bellows made of Teflon or Teflon coated, Intermediate flange version, flange 1.4571 or 1.4436 (17348 or 17652), if not otherwise supplied, heat-galvanized. Temperature to 90°C.

2.2.4 Neutralized weak liquor

Usage like 2.2.1.

Execution

Bellows made of EPDM, intermediate flange version, flange 1.4571 / 1.4436 (17348/17352/ or if not otherwise supplied, heat galvanized. Temperature to 90° C.

In a Pulp mill, Recaustification plant – environment complete compensator (bellows and flange - if supplied) of material 1.4571 / 1.4436 - 17348/17352.

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2.2.5 Additional substances preparation

Usage like point 2.2.1

Because the additional substances tend to change in a short period of time, standard execution (EPDM) is not sufficient for some of them. Standard is valid for following versions:

Teflon bellows or Teflon coated, intermediate flange, heat galvanized flanges

2.2.6 Condensate

It is used only in case it is unconditionally necessary to separate aggregates and pipe-line system.

Execution

Steel compensators, intermediate flange, for selection see the point 2.1.4 (steam).

3 Recommended suppliers

Fa IWKA (Regulator a Compensators Slovensko s.r.o. :07/53418124)

Fa Witzenmann (Hydro) (Witzenmann Slovakia, s.r.o. ,Vlkanová 48/4711011)

Fa Haberkom

Fa Zebisch

4 Calculations and construction aiding

It is valid in the first line for steel compensators.

4.1 The specification of the grade of the nominal pressure

On the grounds of the maximum operational pressure and maximum operational temperature, the nominal pressure grade can be calculated by following DIN 2401 from the table:

4.2 Pipe-line, pressure grade

Extracted from DIN 2401, edition 1.66

Version: 00

Rohrleitungen, Druckstufen
 Auszug aus DIN 2401 Ausg. 1.66

„Die auszugsweise Wiedergabe erfolgt mit Genehmigung des Deutschen Normenausschusses“

Nenn- druck	Stahlrohrleitungen			Zulässiger Betriebsüberdruck der Rohrleitung in bar bei Temperaturen in C.															
	Nahtlose Rohre	Geschweißte Rohre	Flansche	20 (120)	200	250	300	350	400	425	450	475	500	510	520	530	540	550	
1	St 00	St 33	St 37-2	1	-	-	-												
	St 35	St 37-2		1	1	1	1												
2,5	St 00	St 33	St 37-2	2,5	-	-	-												
	St 35	St 37-2		2,5	2	1,8	1,5												
6	St 00	St 33	St 37-2	6	-	-	-												
	St 35	St 37-2		6	5	4,5	3,6												
10	St 00	St 33	St 37-2	10	-	-	-												
	St 35	St 37-2		10	8	7	6												
16	St 00	St 33	St 37-2	16	-	-	-												
	St 35	St 37-2		16	13	11	10												
	St 35,8	St 37,8	C 22 N	16	14	13	11	10	8										
25	St 00	St 33	St 37-2	25	-	-	-												
	St 35	St 37-2		25	20	18	16												
	St 35,8	St 37,8	C 22 N	25	22	20	17	16	13										
	15 Mo 3	15 Mo 3	15 Mo 3			25	22	20	19	18	17								
	13 CrMo 44	-	13 CrMo 44				25	24	23	22	21	20	18	15	12	9			
40	St 35	St 37-2	St 37-2	40	32	28	24												
	St 52	St 52-3	C 22 N	40	-	-	-												
	St 35,8	St 37,8		40	35	32	28	24	21										
	15 Mo 3	15 Mo 3	15 Mo 3			40	35	31	30	29	28								
	13 CrMo 44	-	13 CrMo 44				40	38	36	35	34	33	29	24	19	15			
64	St 35	St 37-2	R 42-2	64	36	29	24												
	St 35	St 37-2		64	50	45	40												
	St 52	St 52-3		64	-	-	-												
	St 35,8	St 37,8	C 22 N	64	50	45	40	36	32										
	15 Mo 3	15 Mo 3	15 Mo 3			64	56	50	47	46	45								
	13 CrMo 44	-	13 CrMo 44				64	61	58	57	56	53	47	40	32	25			
100	St 35	St 37-2	R 42-2	100	80	70	60												
	St 52	St 52-3		100	-	-	-												
	St 35,8	St 37,8	C 22 N	100	80	70	60	56	50										
	15 Mo 3	15 Mo 3	15 Mo 3			100	87	78	74	72	70								
	13 CrMo 44	-	13 CrMo 44				100	95	91	89	87	82	74	62	49	38			
160	St 35	St 37-2	R 42-2	160	130	112	96												
	St 52	St 52-3		160	-	-	-												
	St 35,8	St 37,8	C 22 N	160	130	112	96	90	80										
	15 Mo 3	15 Mo 3	15 Mo 3			160	139	125	118	115	112								
	13 CrMo 44	-	13 CrMo 44				160	153	146	142	139	132	118	100	79	62	46	35	
	10 CrMo 9 10	-	10 CrMo 9 10													70	61	52	

Sämtliche Drücke sind Überdrücke in bar.
 Die in der Tabelle eingetragenen Werkstoffe entsprechend der üblichen Anwendung und sind in den Maßnormen für Rohrleitungsteile enthalten; sie sind nicht bindend für die Werkstoffwahl. Wird davon abgewichen, so sind die angegebenen Werte für die zulässigen Betriebs-

All pressures are over-pressures, stated in bars. Materials shown in the table correspond to the regular use and are in dimension standards for pipe parts. They are not obligatory for material selection.

4.3 Pipe expansion specification

$$\Delta R = \frac{l \cdot \Delta t \cdot \alpha}{100}$$

ΔR ... pipe expansion [mm]
 l ... length of pipe between the fixed points [m]
 Δt ... temperature difference [°C]
 α ... temperature coefficient (from the table)

Temperature coefficient α :

For temperatures to [°C]	Heatproof steel of the pipe	Austenitic 1.4541/1.4878	Austenitic 1.4571
-190 to 0	-0,88	-1,42	-1,46
0 to 100	1,11	1,64	1,68
101 to 200	1,21	1,71	1,75
201 to 300	1,29	1,76	1,80
301 to 400	1,35	1,80	1,84
401 to 500	1,39	1,83	1,88
501 to 600	1,43	1,86	1,91
601 to 700	-	1,89	1,95
701 to 800	-	1,91	1,97

4.4 Compensator operation cycle

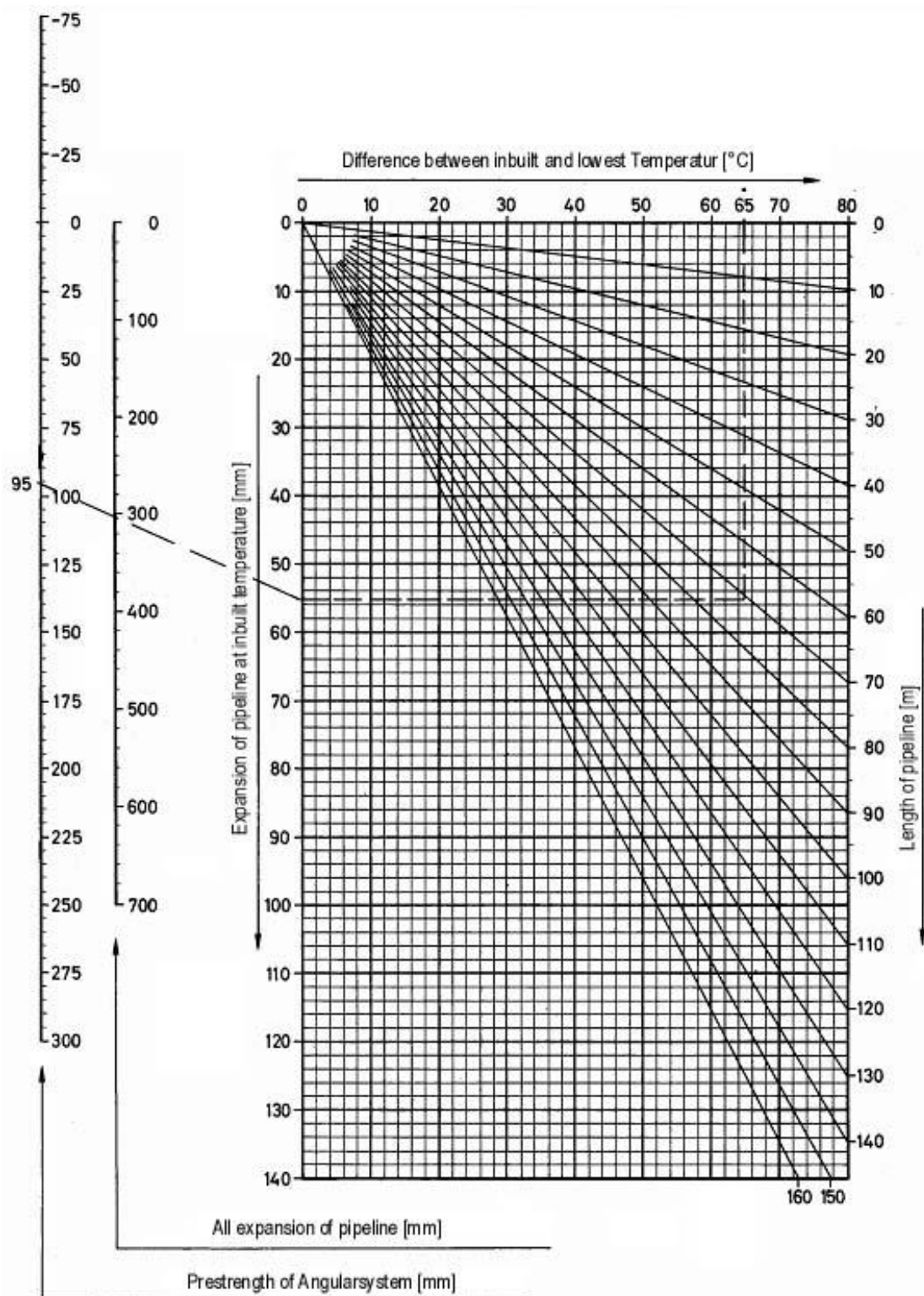
Expansion values stated in the table relate to the minimum operation life 1000 of the full alternated formations at maximum temperature 250 °C and pressure change to 10 bars, which are reached at start-up and stopping of the equipment. If there are more than 1000 double expansions calculated in ten years, maximum allowed expansion is reduced according to the following table in percent.

Corrosion, impacts, high compression stress have influence on operation life and compensator manufacturer should state suitable measures.

Double expansion	% from max.. allowed extension	Load change factor N _F
500	122	1.22
1.000	100	1.00
2.000	82	0.82
3.000	73	0.73
5.000	63	0.63
8.000	55	0.55
10.000	51	0.51
30.000	37	0.37
50.000	32	0.32
100.000	26	0.26
200.000	22	0.22
1.000.000	14	0.14

4.5 Prestressed diagram

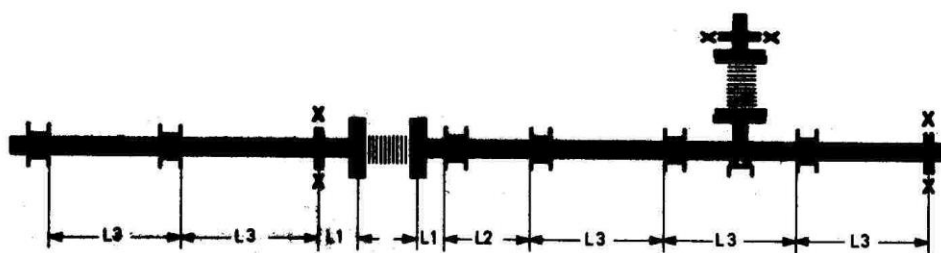
In order to fully use the ability of compensator to absorb expansion, it is necessary to stretch it 50% of the real expansion ΔR by its assembly. (detection according to 4.2) . Exact detection of the correct prestrength in (mm) at different temperatures will be identified from the following table :



4.6 Instructions for axial compensators installation

Axial compensators, when loaded by internal pressure, try to deviate. Therefore, in front of every compensator, a guide bearing must be placed.

Only one compensator between two fixed points may be placed. It is necessary to observe following distances between bearings:



$L_1 = \max. 2 \times \text{Rohrdurchmesser} + \frac{\Delta}{2}$
 $L_2 = 0,7 \times L_3$
 $L_3 = \text{normaler Rohrführungsabstand}$

Als Richtwert kann für die Größe
 von L_3 gelten:
 $L_3 = 400 \text{ DN [mm]}$

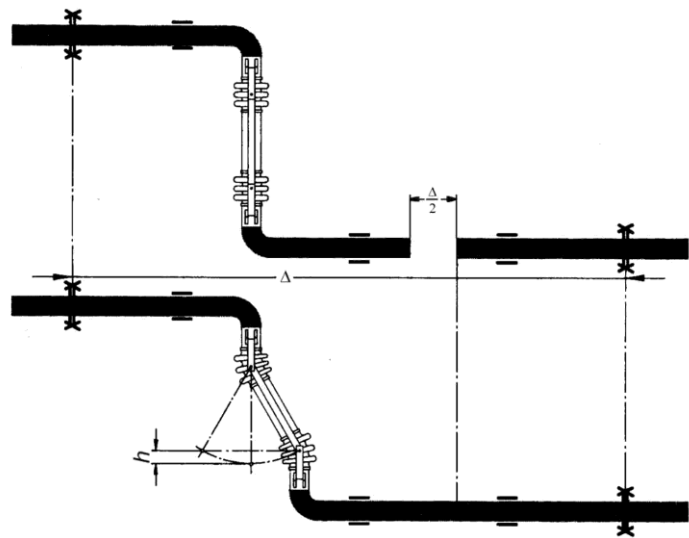
$L_1 = \max. 2 \times \text{pipe diameter} + \frac{\Delta}{2}$
 $L_2 = 0,7 \times L_3$
 $L_3 = \text{normal distance}$

As basic value can be valid
 for size L_3 :
 $L_3 = 400 \text{ DN [mm]}$

4.7 Instruction for installation of the angular compensators.

According to the organization, /see also point 4.7./ the change of pipe length must be increased, and must be calculated in angle. This must not exceed maximum change of angle as stated in table (for operation life is valid also point.4.3.)

Angular compensators must be protected with suitable guide bearings of the expanding pipe-line before the weight load.



4.8 Suitable angular - systems

Most often used angular systems

When planning pipeline components calculations" as a angular system, the following alignments are most often used: valid

Calculation of the angular-system : see the paragraph For installation, dimensioning of the fixed point, pipe installation, pipe assembly (slide,...), same instruction are as for angular compensators.

system	2 Z Two-angular Z bend system	3 L Three-angular L bend system	2 K Two-carding bend
expansion	For parts of the pipeline of the arbitrary length, when the stated way is used	suitable for compensation of the connecting pipe between tanks	Absorption of the s side to the circle plane in pipeline with short side (in low pressures or also ball journal compensators)

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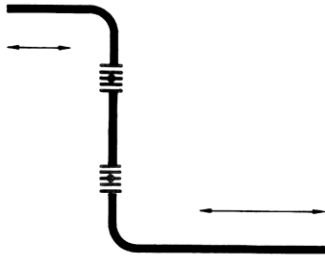
	2 S Two-angular-S-bend system	3 U three-angular -U-bend system	3 W three-angular- W-bend
	The whole line is used and biggest for great absorption of expansion from both directions	Especially for compensation of the long way pipeline	Compensating of the smallest pipelines and synchronize
	3 Z Three-angular-Z-bend system	3 KW Three-cardan W-bend system	3 KW Three-cardan-W-bend system
angular	Use of the expansive lines and Synchr. compensating of the arm line	To compensate space assembly pipes to boiler and machines.	from one comp. With ball journal Compensator and one pipe-
25.	as well as bend height of the side	Absorption of the expansion in 3	piece for pressure range to DN
connecting line(1)	deviation of the angle	plane. Two cardan-pipe parts and one pipe cardan piece belong	Inbuilt position of ball joints must be such, that virtual
the		to one 3 KW bend system.	via the two guide bars is lined parallel to axle of ball journal (2) of angular- pipeline piece

Version: 00

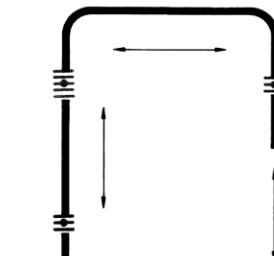
Die gebräuchlichsten Gelenksysteme

Bei der Einplanung von Rohrgelenkstücken als Gelenksysteme sind folgende Anordnungen am gebräuchlichsten:

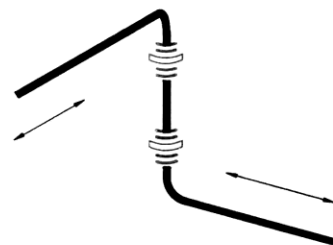
Die Berechnung der Gelenksysteme siehe Abschnitt „Berechnungen“. Bezüglich Einbau, Festpunktdimensionierung und Rohrführungen gelten die gleichen Hinweise wie bei den Gelenk-Kompensatoren.



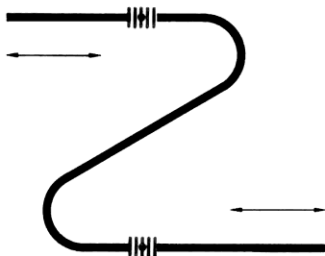
2 Z Zwei-Gelenk-Z-Bogensystem
Für Leitungsstrecken beliebiger Länge unter Ausnutzung gegebener Trassen.



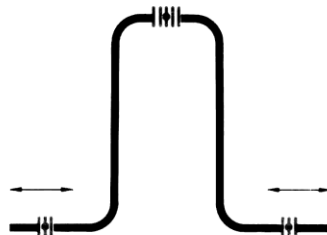
3 L Drei-Gelenk-L-Bogensystem
Geeignet zur Kompensation von Verbindungsleitungen zwischen Behältern.



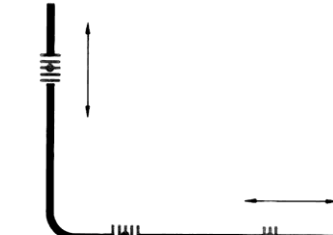
2 K Zwei-Kardan-Gelenk-Bogensystem
Dehnungsaufnahme seitlich in Kreisebene in kurzschenkelligen Leitungen (bei niedrigen Drücken evtl. auch mit Kugelgelenk-Kompensatoren zu erreichen).



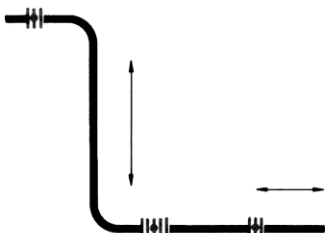
2 S Zwei-Gelenk-S-Bogensystem
Ausnutzung des gesamten Trassenschenkels für große Dehnungsaufnahme.



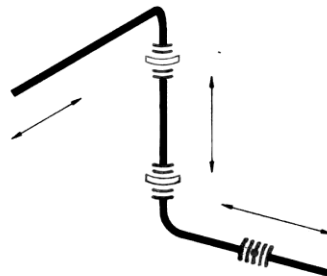
3 U Drei-Gelenk-U-Bogensystem
Vorzugsweise zur Kompensation langer Fernleitungsstrecken.



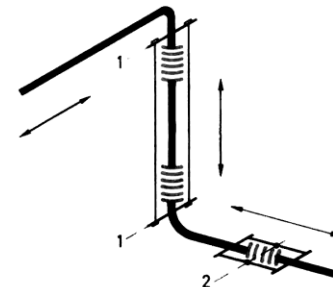
3 W Drei-Gelenk-W-Bogensystem
Kompensation größter und kleinster Rohrleitungsstrecken bei gleichzeitiger Dehnungsaufnahme aus zwei Richtungen.



3 Z Drei-Gelenk-Z-Bogensystem
Ausnutzung ausgedehnter Trassen und gleichzeitige Kompensation des Trassenschenkels sowie der sich ergebenden Bogenhöhe bei seitlichem Winkelausschlag.



3 KW Drei-Kardangelenk-W-Bogensystem
Zur Kompensation von räumlich verlegten Kessel- und Maschinenhausleitungen. Dehnungsaufnahme in 3 Ebenen. Zwei Kardan-Rohrgelenkstücke und ein Rohrgelenkstück gehören zu einem 3 KW-Bogensystem.



3 KW Drei-Kardangelenk-W-Bogensystem
aus einem Kugelgelenk-Kompensator und einem Rohrgelenkstück, für Druckbereichen bis DN 25. Die Einbauweise des Kugelgelenkes muß so sein, daß die über die beiden Zugstangen gedachte Verbindungslinie (1) parallel zur Bolzenachse (2) des Rohrgelenkstückes verläuft.

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4.9 The fixed point load

To calculate the fixed point load, which is different in all cases, it is necessary to find out in the calculation tables provided by the manufacturer(see also point 3-recommended suppliers), as well as special cases in relation to selection and organization..

4.10 Noise and vibration damping

To separate the moving aggregates from the rest of pipe system, the standard rubber compensators are used. Quality of which depends on the medium used.

If the operation temperature or pressure is too high, suitable steel compensators of noise must be used. External fixing of noise absorbs also reaction strength of pressure.

Compensators damp only the body noise. However, the noise transported in gas or liquid media remains non-affected.

For bearings organization the point 4.5 is valid.

It is valid in the first line for steel compensators.