

## WEAR RESISTANT PIPE SYSTEMS



# WEAR RESISTANT PIPES

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# WEAR-RESISTANT PIPE SYSTEMS



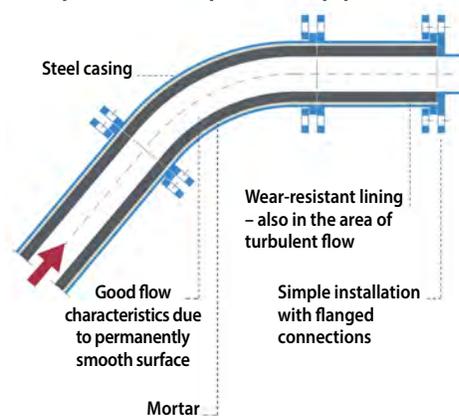
Pipe bend radius very strongly affects the extent of abrasion

Hydraulic and pneumatic pipe systems often have to withstand extremely harsh conditions. Conveying abrasive materials such as ash, sand or sinter dust subjects pipelines to acute levels of stress. Even thick-walled steel or cast iron pipes often show significant signs of wear in an extremely short period of time. Pipe bends, where flow is subject to heavy turbulence, are particularly susceptible to wear, often achieving a service life of only 1/20th that of the associated straight pipe runs.

Special piping design, speed of conveyance, cycle time, or special pipe dimensioning can keep the rate of wear in check to some degree, but in most cases these measures necessitate a simultaneous decrease in throughput or else piping design constraints makes it impossible to implement them within the available space. Good results regarding plant layout, throughput and service life can nevertheless be achieved by lining pipes and pipe bends with wear-resistant materials.

Hydraulic piping should be protected from wear along its entire length. In pneumatic conveyance systems, experience shows that most wear occurs in pipe bends and in the piping immediately beyond them. For this reason, wear-proof piping with internal lining is used at such locations. The right wear protection often comprises a combination of wear-resistant materials that safeguard the continuous production process. Depending on the specific requirements, Kalenborn lines pipes, pipe bends and cast pipe fittings with hard, elastic or spray-on materials and protects them from wear.

## Example of a wear-protected pipe bend





Installation of linings  
with cylinders

Kalenborn's standard range includes the following wear-resistant piping systems with standard diameters:

- ABRESIST pipes and pipe bends  
Fused cast basalt
- KALCOR pipes and pipe bends  
Zirconium corundum
- KALOCER pipes and pipe bends  
Alumina oxide ceramic



### Properties:

- Long service life
- Maintenance-free operation
- No unscheduled downtime
- No production outages
- Lightweight construction for low transport and installation costs
- Energy-efficient operation thanks to smooth material lining, and excellent throughput characteristics prevent pressure losses and blockages
- No contamination of the conveyed materials due to abrasion, mixture or corrosion
- Many materials physiologically harmless and therefore also suitable for food contact applications
- Kalenborn pipe systems are UV- and acid-resistant, i.e. suitable for demanding chemical applications

Along with DIN EN ISO 1127 and ASME-BPE 1997, Kalenborn has developed the standard Rd 6a: it uses strong linings to protect pipelines against wear and extend the service life of stressed components.

The specific design takes the following parameters into account:

- Pressure (PS)
- Temperature
- Lining material
- Steel pipe jacket
- Other factors / loads
- Seals and joining elements

# STANDARD RANGE BY PIPE STANDARD

The Kalenborn standard range includes ABRESIST, KALOCER and KALCOR pipes and pipe bends. There are many pipe standards for an extremely wide variety of applications. The following tables list Kalenborn standards for inner diameter and the recommended angle-radius combinations for pipe bends. Our standards are available on markets the world over. We gladly produce customer-specific pipe systems with larger diameters or special dimensions on request. Please do not hesitate to contact us.

Standard range to download:



## Standard according to DIN EN ISO

Wear protection				Casing (pipe)						Flange			
Nominal inner diameter IDVnom [mm]	ABRESIST		KALOCER		KALCOR		Nominal outer diameter ODVnom [mm]		Nominal wall thickness Thnom [mm]		Nominal size (with adapted inner bore, if necessary)		
							EN 10220 - Series		min.	max.			
	Series A	Wall thickness [mm]	Wall thickness [mm]	Wall thickness [mm]	1	3	EN 1092-1	EN 1759-1					
40	25		10	12,5	15	20 25		139,7		3,2	5	DN125	NPS5
50	25		10	12,5	17,5	20							
65	22,5	27,5	10	12,5	17,5	20 25							
80	21	25		12,5	15	20		168,3		3,2	5	DN150	NPS6
100	20	21	10	12,5	17,5	20							
125	21			12	15	20		219,1		3,6	5,6	DN200	NPS8
150	21			12,5	15	20							
200	21			12,5	15	20		273		4,5	5,6	DN250	NPS10
250	21			15	20	20 25		323,9		4,5	5,6	DN300	NPS12
300	21	29		15		25		406,4		4,5	7,1	DN400	NPS16
350	21	24				25		457		4,5	7,1	DN450	NPS18
400	21	23,5				25		508		5,6	8	DN500	NPS20
450	23					25			559	5,6	8	DN600	NPS24
500	22					25 30		610		6,3	10	DN600	NPS24
600	23,5					25		711		7,1	10	DN700	-

## Standard according to ASME

Cylinder Liners				Casing						Flanges
ID [inch/mm]	ABRESIST	KALOCER	KALCOR	OD [inch]			Wall thickness [inch]		Bolt circle [inch]	
Line A [mm/inch]	Wall thickness [mm/inch]	Wall thickness [inch]	Wall thickness [mm/inch]	1 NEW	2 OLD	3 Elbows OLD	min.	max.		
50 2"	25 1"	1" 1/2"	20 13/16"	5-19/16"	5-9/16"	5-9/16"	0,134	0,188	7-1/2"	
80 3"	25 1"	1" 1/2"	20 13/16"	6-5/8"	6-5/16"	6-5/16"	0,134	0,188	8-3/16"	
100 4"	21 13/16"	1" 1/2"	20 13/16"	6-5/8"	6-7/8"	6-7/8"	0,134	0,188	9"	
125 5"	21 13/16"	1" 1/2"	20 13/16"	8-5/8"	8-5/16"	8-5/16"	0,134	0,188	10-1/2"	
150 6"	21 13/16"	1" 1/2"	20 13/16"	8-5/8"	8-5/8"	9-1/8"	0,134	0,188	11-1/16"	
200 8"	21 13/16"	1" 1/2"	20 13/16"	10-3/4"	10-3/4"	11-1/4"	0,134	0,25	13-7/8"	
250 10"	21 13/16"	1" 1/2"	20 13/16"	12-3/4"	12-3/4"	13-1/4"	0,134	0,25	15-9/16"	
294 12"	21 13/16"	1" 1/2"	25 1"	14-1/2"	14-1/2"	15-1/4"	0,134	0,25	17-1/2"	
350 14"	21 13/16"	1" 1/2"	25 1"	17"	17"	17"	0,134	0,25	20-3/8"	
400 16"	21 13/16"	1" 1/2"	25 1"	19"	19"	19"	0,134	0,25	22-1/4"	
450 18"	23 29/32"	1" 1/2"	25 1"	21"	21"	21"	0,134	0,25	24-1/4"	
500 20"	23 29/32"	1" 1/2"	25 1"	23"	23"	23"	0,134	0,25	27"	

# Works standard according to Rd 6a

Wear protection		Casing (pipe)									Flange			
Nominal inner diameter IDVnom [mm]	KWN	ABRESIST			KALOCER		KALCOR		Nominal outer diameter ODVnom [mm]			Nominal wall thickness Thnom [mm]		Nominal size
		EN 10220 - Series									min.	max.		
Series A	Wall thickness [mm]	Wall thickness [mm]	Wall thickness [mm]	1	2	3	min.	max.						
40	25	10	12,5	15	20	25			127		3,2	5	DNK115	
50	25	10	12,5	17,5	20				139,7		3,2	5	DNK125	
65	22,5	27,5	10	12,5	17,5	20	25				159	3,2	5	DNK145
80	21	25		12	15	20								
100	20	21	25	10	12	17,5	20				177,8	3,2	5,6	DNK160
125		21		12	15	20					193,7	3,2	5,6	DNK175
150		21		12,5	15	20			219,1			3,6	5,6	DNK200
200		21		12,5	15	20			273			4,5	5,6	DNK250
250		21		15	20	20			323,9			4,5	5,6	DNK325
300	21	29		15		25			406,4			4,5	7,1	DNK375
350	21	24				25			457			4,5	7,1	DNK425
400	21	23,5				25			508			5,6	8	DNK475
450		23				25					559	5,6	8	DNK525
500		22				25	30		610			6,3	10	DNK575
600		23,5				25			711			7,1	10	DNK700

# Standard pipe bend configurations

ID	R 500	R 750	R 1000	R 1250	R 1500	R 1750	R 2000	R 2500	
[mm / inch]	15°   30° 45°   60° 75°   90°	15°   30° 45°   60° 75°	15°   30° 45°   60°	15°   30° 45°	15°   30° 45°				
40	1.6"								
50	3"								
65	2.5"								
80	3"								
100	4"								
125	5"								
150	6"								
200	8"								
250	10"								
300	11.8"								
350	14"								
400	16"								
450	18"								
500	20"								
600	23.6"								

Commercially available Kalenborn standard geometries  
Special geometries available on demand

# KALMETALL W standard (hard overlay welded pipes)

OD	Overlay welding [mm]	Wall thickness [mm]	DIN Flange PN 10	Lenght [m]	Pipe bend 30°	Pipe bend 45°	Pipe bend 45°	Radius	
88,9	3	6,3	DN80	0,5 - 1	30	45	90	R 500	R 1000
101,6	3	6,3	DN100	0,5 - 1	30	45	90	R 500	R 1000
101,6	4	6,3	DN100	0,5 - 1	30	45	90	R 500	R 1000
114,3	3	6,3	DN100	1 - 6	30	45	90	R 1000	R 1500
121,0	3,5	7,1	DN100	1 - 6	30	45	90	R 1000	R 1500
139,7		6,3	DN125	1 - 6	30	45	90	R 1000	R 1500
139,7	3	6,3	DN125	1 - 6	30	45	90	R 1000	R 1500
168,3	3	6,3	DN150	1 - 6	30	45	90	R 1000	R 1500
168,3	3,5	6,3	DN150	1 - 6	30	45	90	R 1000	R 1500
193,7	3	6,3	DN150	1 - 6	30	45	90	R 1000	R 1500
219,1	3	6,3	DN200	1 - 6	30	45	90	R 1000	R 1500
219,1	3	6,3	DN200	1 - 6	30	45	90	R 1000	R 1500
273	3,5	8,0	DN250	1 - 6	30	45	90	R 1000	R 1500
273	4	6	DN250	1 - 6	30	45	90	R 1000	R 1500
323,9	4	6	DN300	1 - 6	30	45	90	R 1000	R 1500
355,6	4	6	DN350	1 - 6	30	45	90	R 1000	R 1500
406,4	4	6	DN400	1 - 6	30	45	90	R 1500	R 2500
457	4	6	DN450	1 - 6	30	45	90	R 1500	R 2500
508	4	6	DN500	1 - 6	30	45	90	R 1500	R 2500
559	4	6	DN600 565,0 <sup>2)</sup> / 571,0 <sup>3)</sup>	1 - 6	30	45	90	R 1500	R 2500
610	4	6	DN600	1 - 6	30	45	90	R 1500	R 2500
711	4	6	DN700 <sup>1)</sup>	1 - 6	30	45	90	R 1500	R 2500

# ABRESIST PIPES AND PIPE BENDS

## Fused cast basalt

ABRESIST fused cast basalt has proven extremely effective as a protective lining in straight pipe elements and in pipe bends.

Installed pipe cylinders reduce wear significantly in both pneumatic and hydraulic conveyor lines.

After a short time in service, ABRESIST pipes and pipe bends feature an extremely smooth surface, thereby preventing blockage due to moist materials.

The corrosion-resistance of ABRESIST ensures that pipes and pipe bends are always ready for use, even after extended downtimes.

As an alternative to complete ABRESIST piping systems, depending on the intended purpose and on the free-flowing bulk goods, it is also possible to protect only specific partial sections subject to particularly high wear stress or to use a combination of wear-resistant materials.



*ABRESIST pipes and pipe bends protect against abrasion and corrosion*

## ABRESIST pipes over 610 mm in diameter

Kalenborn lines pipelines of more than 610 mm in diameter with individual fused cast basalt segments. Material thickness is determined by the severity of the operating conditions. Junctions, branches, round-to-square transitions and other geometrically complex cast or moulded pipe fittings are protected in the same way with surface-optimised linings.

*Even large-dimension pipes and complex cast or moulded parts can be durably lined with wear-resistant ABRESIST fused cast basalt.*

### Properties:

**Lining material: mineral wear protection made of ABRESIST (fused cast basalt)**

- Service temperature up to 350 °C
- High abrasive wear resistance
- Durably smooth surface
- No corrosion
- Limited resistance to chemicals and acids
- Excellent price/performance ratio in suitable applications



# KALCOR PIPES AND PIPE BENDS

## Zirconium corundum

Wear-proof KALCOR pipe systems are extremely abrasion-resistant, withstand service temperatures up to +400 °C, and also provide good resistance to temperature changes. The cast pipe cylinders are made of zirconium corundum with wall thickness as thin as 12 mm. Kalenborn also manufactures lined pipe bends from cast parts, thereby enabling the production of asymmetrical cross-sections.

Suitable flange connections make it easy to join KALCOR pipes and pipe bends to other existing lines.



*KALCOR pulverised coal pipe bends and welded transition pieces*

*Asymmetric cross-section of a KALCOR pipe made of cast parts*

### Properties:

- Ceramic wear protection made of cast KALCOR zirconium corundum
- Service temperature up to +400 °C
- Very hard and abrasion-resistant
- Temperature-resistant
- Corrosion-resistant

# KALOCER PIPES AND PIPE BENDS

## Alumina oxide ceramic

KALOCER pipes and pipe bends are lined with thin pipe cylinders made of special oxide ceramic and designed to withstand extreme wear and/or temperature stresses. The durably smooth surfaces promote flowability and prevent moist material from forming blockages. Its corrosion resistance ensures that KALOCER pipes and pipe bends are always ready for use, even after extended downtimes.

Depending on the stress loading, shape and diameter, Kalenborn produces not only KALOCER pipes and pipe bends with pipe cylinders, but also KALOCER pipes and pipe bends with cast parts (pipe bricks) or individual tiles.

*Pneumatic KALOCER pipes and pipe bends with thin-wall cylinders used to convey zinc oxides (ZnO) for a leaching unit.*



### Properties:

- Wear protection made of special KALOCER oxide ceramic
- Service temperature up to +400 °C
- High wear resistance
- Durably smooth surface
- Corrosion-resistant



*Pneumatic KALOCER transfer line with moulded components for conveying alternative fuel (demolition wood with sand particles) to a furnace, cross-section 203 mm.*

# KALMETALL PIPES AND PIPE BENDS

## Welded hard surfacing

Pneumatic and hydraulic conveying operations and dust removal subject pipe and channel elements to heavy wear. Making the associated components out of KALMETALL significantly extends their service life. The KALMETALL brand designates a range of hard-faced steel systems comprising a tough basic shell with hard-face welding. The basic material of the systems is the reinforcement substrate. It consists of standard steels, depending on the specific application.

The hard-face welding forms the wear layer. It consists of a C-Cr-Fe system with primary chromium carbides. This provides the extreme hardness of the hard-face weld, which can be up to 820 HV, depending on the alloy composition. The standard thickness of the hard-face welding ranges from 3 to 4 mm. Special thicknesses over 4 mm up to 18 mm are also available on request.

### Properties:

- Metal wear protection using hard-face welding
- Interior and/or exterior hard-face welding
- Uniform seamless and continuous spiral lining
- Extremely resistant to impacts and abrasion (depending on the alloy)
- Highly resistant to temperature changes
- Low weight and easy to join
- Low production cost, enabling rapid replacement of worn pipes
- Highly cost-effective self-supporting structures



*Automatic welding machine for lining the interior of a pipe  
Hard-facing of workpieces with cored wires and electrodes  
Pipe component weld joint*



*Pipe bends lined with KALMETALL in a de-dusting system application, the inner diameter is 400 mm, the system thickness is 8 + 5 mm.*





*Kalenborn special ducts and bends for a biosolids recycling plant: straight ABRESIST ducts and bends with KALOCER and KALCRET*

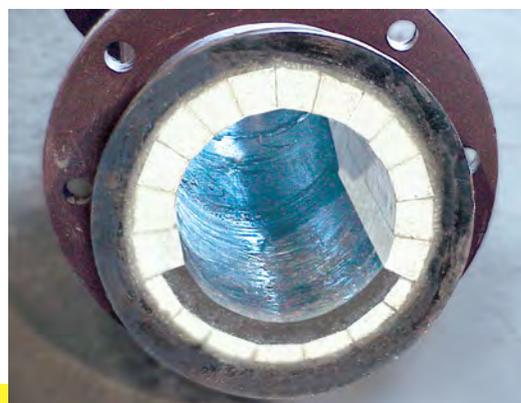


*Kalenborn pipe bends for a plastic waste shredder plant: combination of KALCAST hard castings and KALCRET hard compound*

## COMBINATION LINING

Optimal wear protection lining for pipes or bends can also consist of a combination of different materials. Kalenborn offers special pipes and bends, the lining of which is specifically designed for various stresses, such as in the example of a biosolids recycling plant. The ducting runs between the dryer, where the biosolids emerge at temperatures of 100° C or higher, and the baghouse, where the material cools and is separated.

As part of a complete system designed by an OEM, Kalenborn installed about 65 m<sup>2</sup> of 5-foot (1524 mm) diameter ducting. For optimal wear-resistance, Kalenborn installed ABRESIST fused cast basalt lining on straight runs, 25-mm KALOCER oxide ceramic on elbows, and KALCRET hard compound on the inside radius.



*Kalenborn pipe bends with the combination of KALMETALL hard-face welding on the exterior of the bend and KALOCER oxide ceramic as pipe brick configuration on the interior*

# KALBEND

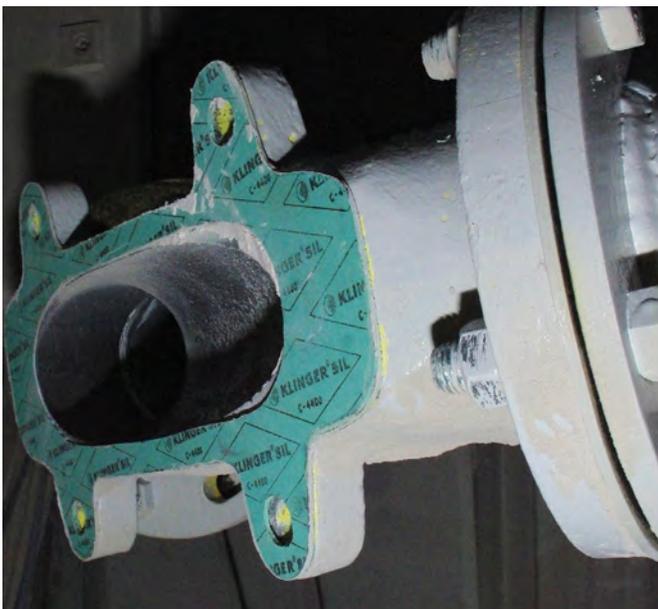
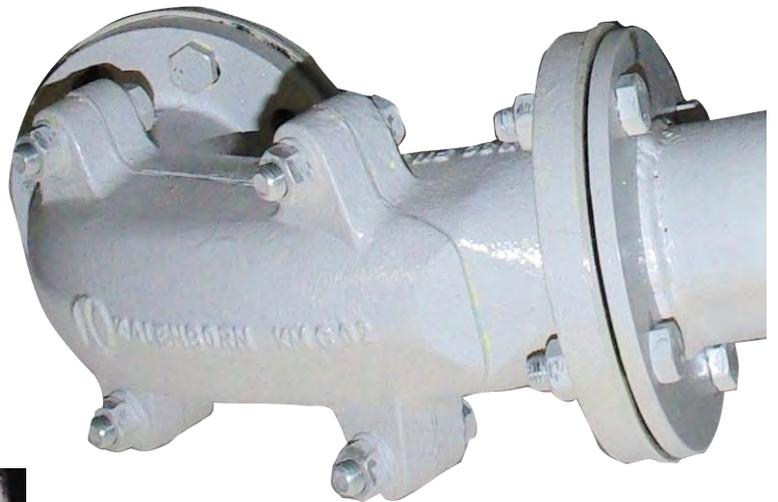
## Replaceable pipe bends

KALBEND is a wear-resistant and replacement pipe bend. In pneumatic conveyors that carry free-flowing bulk goods, including quartz sand, shotcrete, foundry sand and steel-works dust, most of the abrasive wear occurs in the outer radius of pipe bends. For this reason, Kalenborn developed the KALBEND wear-resistant and replaceable pipe bend. The outside of the bend can be opened with four bolts and removed.

The wear protection lining can be repaired quickly and easily or the worn elbow can be replaced by a new one. Unlike other conveyor pipe bend designs that rely on cushioning where flow changes direction, KALBEND does not impair the free-flowing bulk material. This eliminates the need for downtime for scheduled maintenance. The KALBEND system extends the service life of the pipe bend with minimal, cost-effective effort.

## Properties:

- Replaceable, wear-resistant pipe bend
- Extra strength in the wear zone
- Ni-hard for long service life
- 45 and 90 versions available
- Small radius for weight reduction
- Suitable for pressures up to 50 psi.
- 500 - 600 Brinell hardness



## Application areas:

- Steel, cement, stone, earthmoving and mining industries
- Ceramics and glass industries
- Chemical and food industries
- Foundry technology

# KALFLEX

## Tubing systems

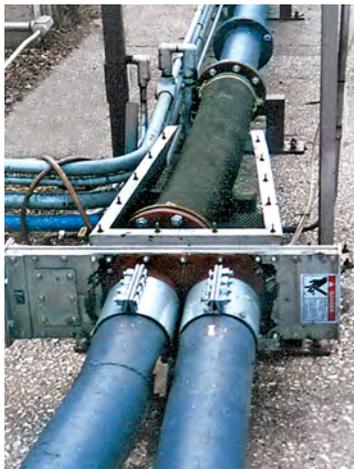
KALFLEX is flexible piping that can be easily installed with standard flanges. The core elements of the system are abrasion-resistant tiles or segments made of oxide ceramic or hard casting, which are inserted into one another and pushed flexibly into one another. The segments are enclosed in a rubber jacket containing a fabric insert, which ensures adequate stability and leak tightness.



*Diamond-shaped arrangement of ceramic tiles for very tight bending radii*

## KALFLEX with segments made of KALOCER ceramic

For applications subject to extremely harsh sliding wear conditions, segments can be made of high alumina ceramics. The inner diameter ranges from 50 to 125 mm. To meet static requirements, the KALOCER solution uses collars and flanges made of hard casting and/or steel.



*KALFLEX tubing system as part of a transfer tube in the USA*

## KALFLEX with segments made of KALCAST hard casting

The wear-resistant KALCAST segments are made of hard castings that provide protection against both impact and sliding wear. Diameters range from 19 to 200 mm.

## KALFLEX with diamond-shaped KALOCER ceramic

The outer sleeving of KALFLEX hoses is made of rubber. The embedded woven insert with steel spirals keeps them stable. The inner surface of the hoses has diamond-shaped ceramic plates made of KALOCER embedded into it as part of a vulcanisation process. This provides excellent protection against frictional wear and also makes it possible to arrange the tubing system with tight radii and sharp angles in any direction. The inner diameter ranges from 50 to 200 mm. KALFLEX with diamond-shaped KALOCER ceramic. The outer sleeving of KALFLEX hoses is made of rubber. The embedded woven insert with steel spirals keeps them stable. The inner surface of the hoses has diamond-shaped ceramic plates made of KALOCER embedded into it as part of a vulcanisation process. This provides excellent protection against frictional wear and also makes it possible to arrange the tubing system with tight radii and sharp angles in any direction. The inner diameter ranges from 50 to 200 mm.

## Properties:

- Inside diameter ranging from 19 to 200 mm
- Maximum temperature 110 °C
- Pressure up to 10 bar
- Used in diverter valves
- Used as vibration reducing elements
- Used as expansion joints
- Well-suited for use in tight spaces
- Compensation of load cells
- Rubber sleeving: weather-resistant and durable EPDM



*KALFLEX conveyor hose for dust recirculation in the steel industry*

# PIPE FITTINGS

## U-bends, tees, wyes and cross pieces

### Wear-resistant pipe fittings

In addition to wear-proof pipes, Kalenborn also produces the associated pipe fittings in an extremely wide range of geometries: From elbows to tees, wyes and cross pieces, all the way to U-bends.



*Wear-resistant pipe fittings in an extremely wide range of geometries*

# PIPE CONNECTIONS

## Flanges, couplings

### Flanged connections

Wear-resistant pipes are joined together and/or with normal steel pipe by means of fixed or loose flanges, depending on requirements.

Wear-proofed pipes can be connected to one another easily, provided that at least one side is equipped with a fixed collar and loose flange.

A transition flange with larger diameter bolt circle on the unlined pipe presents an alternative to the intermediate flange.

When connecting a lined pipe to a pipe, pump, etc., of differing dimensions, the connection is made using an intermediate flange.

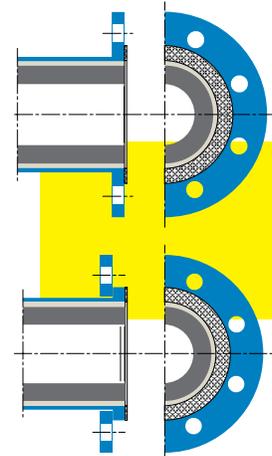
## Gaskets

With pipe fittings, the recommended dimensions of gaskets result from:

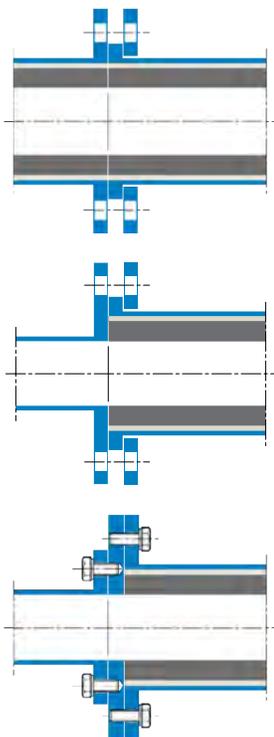
Outer diameter = outer diameter of collar

Inner diameter = outer diameter of steel pipe

Recommended minimum thickness: 2 mm. All conventional gasket materials can be used, depending on the load. Other forms and types of seals are possible.



*ABRESIST pipe with fixed flange  
ABRESIST pipe with fixed collar  
and loose flange*

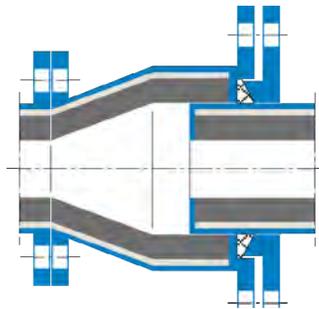


## Connections with expansion joints

To compensate for the changing length of longer pipelines, various types of wear-proof expansion joints are available.

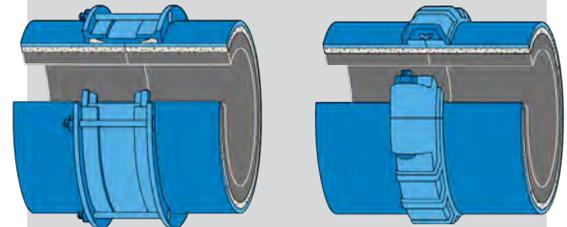


*Expansion joint in a hydraulic ash line*



## Couplings

Wear-proof piping can be joined with all standard coupling elements.



*Coupling with radial positive locking and coupling with axial positive locking*

## KALDETECT

### Wear protection monitoring

For critical applications, Kalenborn markets systems that indicate the possible wear of protective linings, thereby informing the operator in time to take necessary action. This applies to pneumatic conveyor systems, for example, where measures must be taken to prevent the release of toxic or environmentally harmful substances.



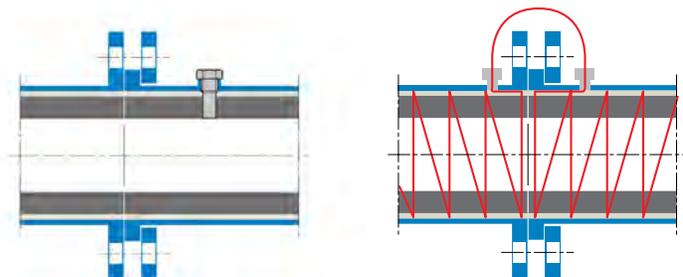
*KALDETECT in a German waste incineration plant*

### KALDETECT electrical

The exterior of the wear protection lining is equipped with a low-voltage measuring conductor. If the wear protection layer inside the piping wears through due to abrasion at any point, the conductor will be interrupted there. This triggers an alarm and – in combination with suitable evaluation logic – indicates the affected section of piping or automatically shuts the plant down. Wear protection monitoring is available for all materials and even for combined linings.

### KALDETECT mechanical

Support structure and wear protection lining are fitted with a removable pin installed in a threaded hole. Upon removal, the length of the pin indicates the thickness and condition of the protective lining.





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