

## Economic Wear Protection in Coal fired Power Plants Worldwide



*A typical application in power plants is pulverized fuel piping, here protected by ABRESIST*



*Service by Kalenborn: rebuilding a grinding table with KALMETALL-W 100*

### Reduce Costs and Avoid Downtime

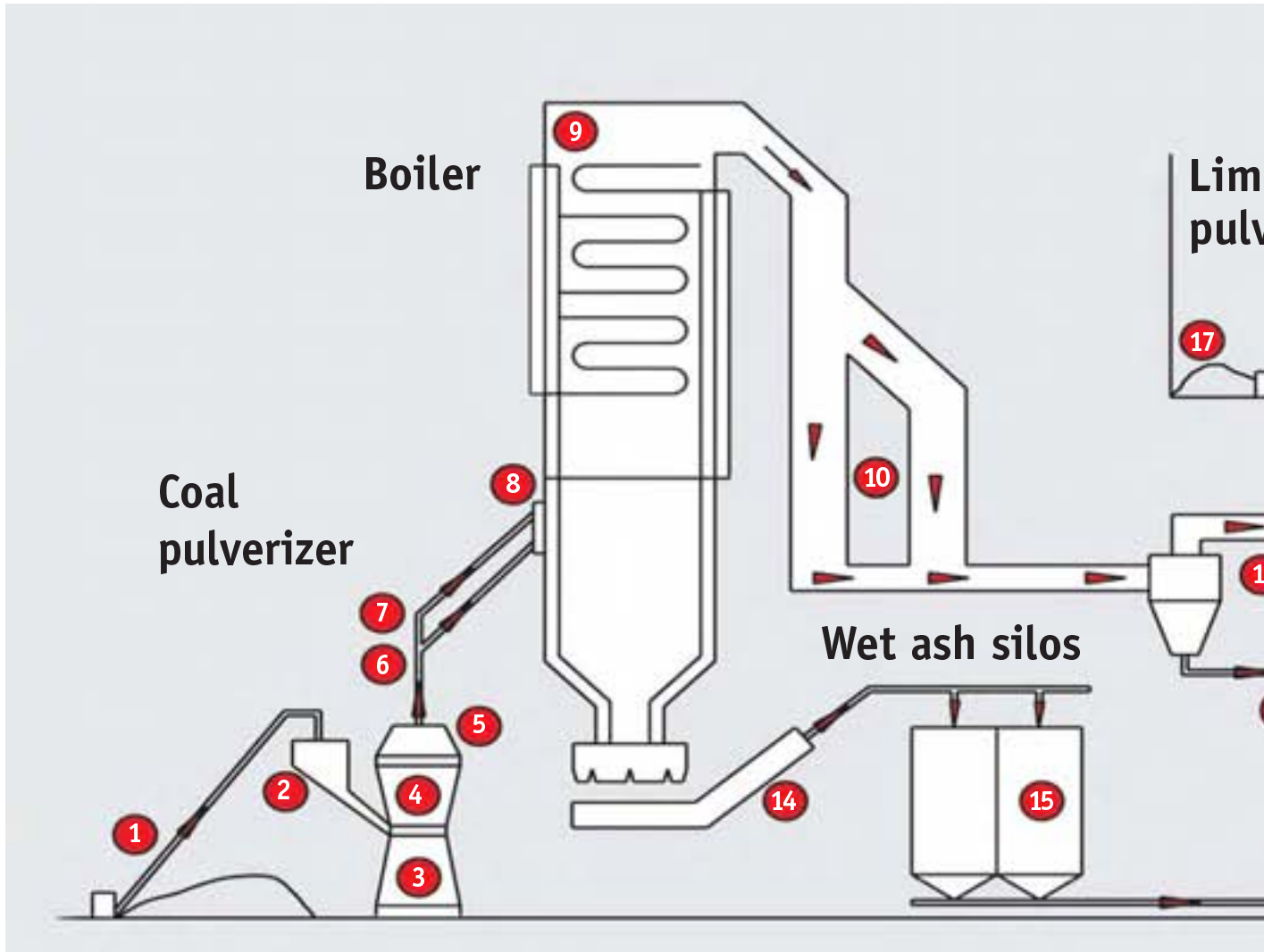
Large quantities of bulk material are handled in the conveying and storing systems of coal fired power plants. Unless they are suitably protected these systems will experience frequent failure requiring repair or replacement. Kalenborn offer the complete array of wear protection materials including not only ceramic and metallic materials but also plastics and rubber.

In addition, Kalenborn have extensive experience in the field of slide promotion. Interruptions of material flow inside of bunkers and silos must be avoided and Kalenborn cover the entire material range with plastics as well as metallic and ceramic materials.

In any case we can supply a tailor-made solution for your particular problem. Our experts are prepared to be of assistance.

Material Handled / System	Plant Component	Lining Material as Wear Protection / Slide Promotion*
<b>COAL</b>		
<b>1 Bunkers</b>		ABRESIST, KALEN*, KALCERAM*, KALINOX*
<b>2 Coal transport</b>	Transfer chutes	ABRESIST, KALOCER, KALMETALL-W, KALEN*
	Pyrite pipes	ABRESIST, KALCOR
<b>3 Coal pulverizers</b>	Ball mills - feeding - housing	KALMETALL-C, KALMETALL-W, KALCOR KALMETALL-C, KALMETALL-W
	Roller mills - side walls/housing - rolls, tables - separators	KALMETALL-W, KALMETALL-C KALMETALL-W, KALMETALL-C ABRESIST, KALOCER, KALSICA, KALMETALL-W, KALCRET
<b>4</b>		
<b>5</b>	- Pneumatic discharge	KALCRET, ABRESIST, KALMETALL-W
	Hammer mills - housing - hammers	KALMETALL-C, KALMETALL-W KALMETALL-C
<b>6 Coal feeding</b>	Pneumatic	ABRESIST, KALCRET, KALCOR, KALOCER, KALMETALL-C, KALMETALL-W
	Mechanical	ABRESIST, KALCOR, KALOCER, KALMETALL-C, KALMETALL-W
<b>7</b>	Coal distributor	KALSICA, KALMETALL-W
<b>8 Pulverized coal burners</b>	Lances	KALSICA, KALMETALL-W
	Reflectors	KALSICA, KALMETALL-W
<b>9 Fly ash</b>	Protection of boiler tubes	KALSICA
<b>10</b>	Housing	KALCRET, KALSICA, KALMETALL-W
<b>11</b>	Cyclones – dust collection	KALCOR, KALCRET, KALMETALL-W
<b>12</b>	Pneumatic transport	ABRESIST, KALCOR, KALOCER
<b>13</b>	Silos	ABRESIST, KALEN*
<b>14 Wet ash (Bottom ash)</b>	Wet ash removal systems	ABRESIST, KALOCER, KALMETALL-W
	Chain conveyors	ABRESIST, KALOCER
	Granulators	ABRESIST, KALMETALL-W
<b>15</b>	Silos	ABRESIST
	Mixers (w. fly ash)	ABRESIST, KALMETALL-W
<b>16</b>	Hydraulic transport	ABRESIST
<b>DESULPHURIZATION</b>		
<b>17 Limestone</b>	Bunkers	ABRESIST, KALEN*
<b>18</b>	Limestone grinding mill - feeding	ABRESIST, KALCRET, KALMETALL-W
<b>19</b>	Pneumatic transport	ABRESIST
<b>20</b>	Silos	ABRESIST, KALEN*
<b>21</b>	Mixers	ABRESIST, KALMETALL-W
<b>22 Gypsum</b>	Stores (silos, bunkers)	ABRESIST, KALEN*

# Reliable Control of Wear Problems

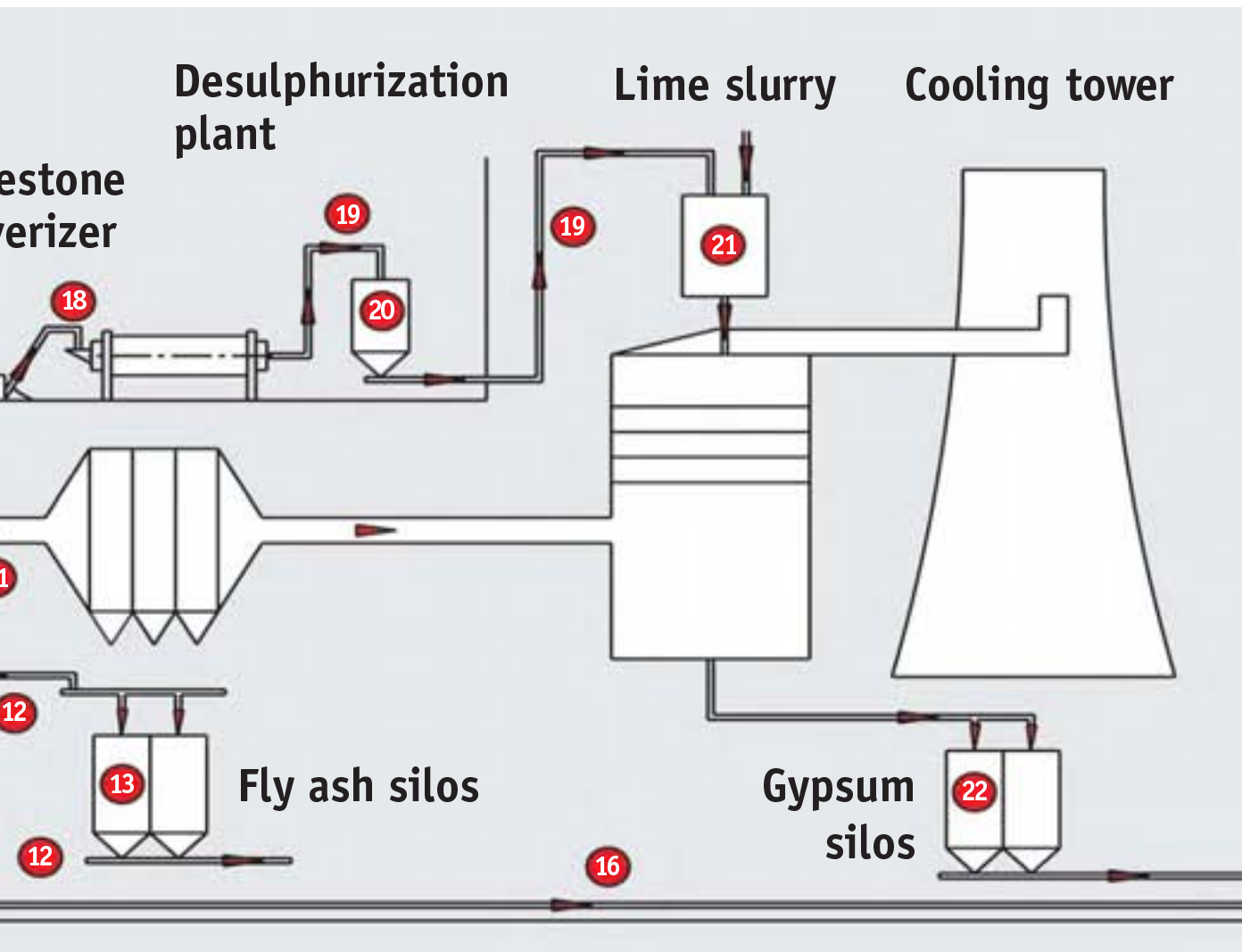


*Coal bunkers require a reliable material flow. This is ensured by the use of KALEN slide promotion plastics. Slide promotion steel - perhaps combined with KALEN - will be best in case of more intense wear.*

*Reliable wear protection is of particular importance for trouble-free continuous operation of the coal injection. These PF-bends are made of plates with hard overlay welding.*



# Work with Kalenborn for Your Optimal Solution



*Fly ash pipes are among the plant components that are particularly endangered by wear. Kalenborn offer a variety of materials to ensure optimal service lifetimes: **ABRESIST** fused cast basalt, **KALCOR** zirconium corundum and **KALOCER** high alumina ceramics.*

***ABRESIST** fused cast basalt is the accepted standard for piping in wet ash pipe systems all over the world. The picture shows a plant in India.*





## Pipes, Components and Service



*Wear protection for hydraulic and pneumatic pipes*



*Extended service life of plant components*



*Kalenborn Service solves wear problems on site*

### Optimal Solution for Every Plant Component

Plant components are at risk in all power plant systems, especially in coal storage and coal transport. This includes coal pulverizing and injection into the boiler, dust collection and ash removal including fly ash and wet ash. The situation is similar for limestone and gypsum in desulphurization systems.

Service lifetimes of many years are often achieved with the following materials:

- ABRESIST fused cast basalt
- KALCOR zirconium corundum
- KALCOR-S sintered zirconium corundum
- KALOCER high alumina ceramics
- KALCRET hard compound
- KALSICA silicon carbide ceramics
- KALMETALL-C hard casting
- KALMETALL-W hard overlay welding
- KALINOX slide promotion steel
- KALEN slide promotion plastics

In addition, material combinations have been very successful in practice. They enable both technically and economically optimal solutions.

### Wear Protected Components

Components	Lining Material
<b>Cyclones</b>	ABRESIST, KALCOR, KALOCER, KALSICA, KALMETALL-W
<b>Fan housings</b>	KALOCER, KALCRET, KALMETALL-W, KALMETALL-C
<b>Fan rotors</b>	KALOCER, KALMETALL-W
<b>Gates</b>	KALOCER, KALCOR, KALSICA, KALMETALL-W, KALCRET
<b>Hydraulic conveyors</b>	ABRESIST, KALCOR, KALOCER, KALCRET
<b>Mechanical conveyors</b>	ABRESIST, KALOCER, KALCRET, KALMETALL-W, KALMETALL-C
<b>Nozzles</b>	KALOCER, KALSICA
<b>Pneumatic conveyors</b>	ABRESIST, KALCOR, KALOCER, KALCRET, KALMETALL-C, KALMETALL-W
<b>Pumps</b>	KALSICA
<b>Separators</b>	ABRESIST, KALCOR, KALOCER, KALSICA, KALMETALL-W
<b>Transfer stations</b>	ABRESIST, KALOCER, KALMETALL-W
<b>Valves and fittings</b>	KALOCER

## Coal Handling, Coal Pulverizing ...



*Coal transfer equipment is protected with ABRESIST fused cast basalt or KALOCER high alumina ceramics (example: Philippines)*

*Impact coal pulverizers operate in lignite fired power plants; the impact plates have been lined with KALMETALL-W 100*



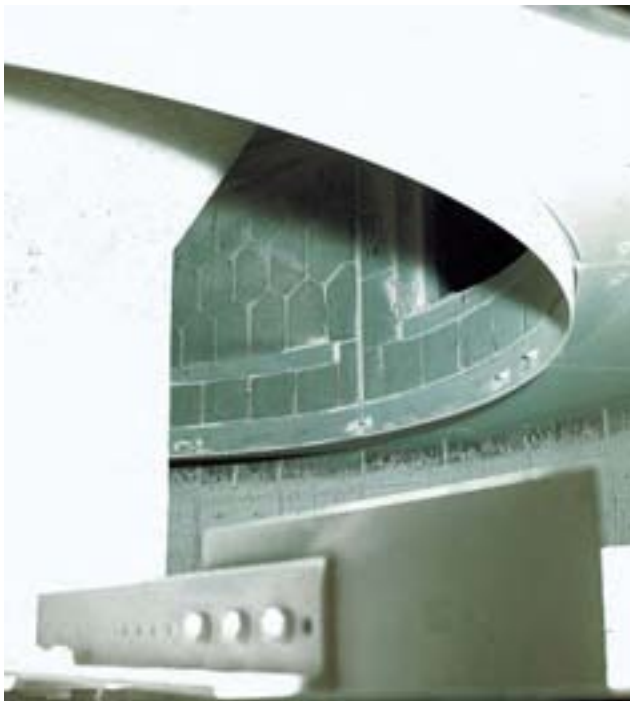
*Kalenborn also supply grinding rolls and grinding tables for coal pulverizing; the picture on the left shows regeneration of a worn grinding roll with KALMETALL-W 100; the cast grinding roll made of KALMETALL-C 155 on the right is a new piece (both have a diameter of 1,500 mm)*

*Coal bunkers lined with KALEN slide promotion plastics ensure a reliable material flow*



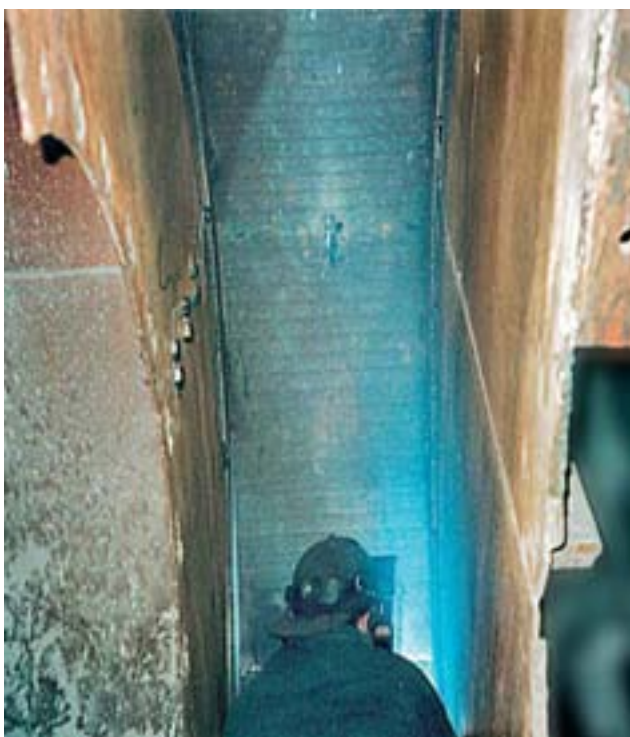


## ... to Coal Injection



*Time-tested wear protection material for separators set up in coal pulverizing systems is ABRESIST fused cast basalt with references all over the world*

*Separators are frequently protected by KALMETALL-W hard overlay welding or by KALCRET hard compound (pictures) installed without joints*



*Housing of a pulverized coal fan protected with KALMETALL-W 100; the diameter is 2,600 mm*



*Pulverized coal burner made with plates of KALMETALL-W 100 hard overlay welding ready for installation*

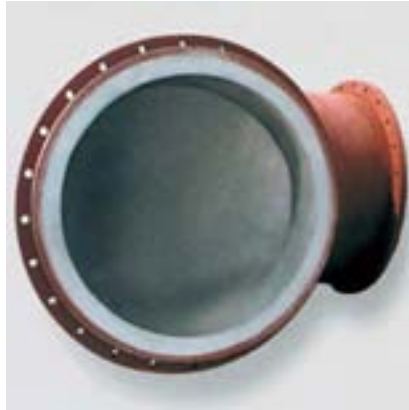


*Weight saving design of a separator cage with KALSICA-A silicon carbide ceramics; alternative linings are KALMETALL-W and KALOCER mosaics*

**Solutions for Pulverized Fuel Transport**

Kalenborn have extensive experience and offer a complete range of solutions for PF-pipe. With diameters between 400 and 800 mm many possible combination linings have been used in practice.

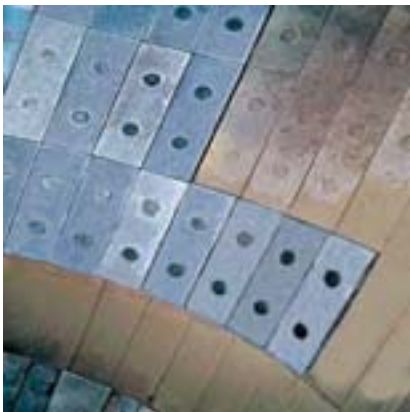
Depending on the specific operating conditions (such as particle size, ash portion, volume to be conveyed and transport velocity) successful designs have achieved service lifetimes of more than 10 years.



*Jointless lining with KALCRET hard compound - also possible with asymmetric cross section*



*Material combinations of KALCOR and ABRESIST provide economic wear solutions*



*Lining of a PF-pipe with KALMETALL-C*



*KALCOR zirconium corundum lining and unlined transition elements; 488 mm diameter*



*KALCOR-S allows the use of large lining segments, thin walls and homogeneous structure*



*Long lifetimes at favorable costs are achieved with KALMETALL-C hard casting; this example shows 518 mm diameter bends up to 700 kg weight*





*KALMETALL-W hard overlay welding enables the production of self-supporting structures for PF-bends without an additional lining*



*Typical solution for PF-bends: pipe-bricks made of KALOCER high alumina ceramics*



*PF-distribution boxes protected with KALCOR for large area lining and KALOCER to ensure maximum wear resistance*



*PF-distributor made of KALSICA-N silicon carbide ceramics*



*Reflectors of PF-burners protected by KALSICA-N (photo) or KALMETALL-W*



*PF-burner lined with KALMETALL-W*

**Ash Handling and Flue-Gas Desulphurization**

*Solution adopted for economizer tubes to handle large dust quantities: tube protecting shapes made of KALSICA silicon carbide ceramics*



*When particularly high dust loads occur, the waste gas ducts are protected by KALCRET hard compound or KALMETALL-W hard overlay welding*



*Chain conveyors for wet ash removal are efficiently lined with ABRESIST fused cast basalt; KALCOR, KALOCER or KALMETALL-W can be used as well*



*Time-tested materials for fly ash pipes: ABRESIST, KALCOR or KALOCER*



*Limestone may have a very abrasive effect on FGD systems; a typical lining material is ABRESIST*



*Sticky FGD gypsum is stored in bunkers; KALEN slide promotion plastics ensure trouble-free discharge*



# Specialist in Wet Ash Pipes

In the last 50 years Kalenborn have supplied many thousands of meters of wet ash pipes to plants all over the world, normally lined with ABRESIST fused cast basalt. This material has proven to be an excellent choice for this particular application.

ABRESIST combines the properties of high wear resistance and high corrosion resistance. The service lifetimes of these piping systems frequently cover more than 20 years. There is no other material that has reached similar service lives in practice.

Kalenborn offer wet ash pipes of many different configurations with inside diameters between 200 and 500 mm. The steel casing can also be efficiently protected against corrosion.

The pipes are usually joined by flanges. However, any type of coupling is feasible. In addition, welded and screwed joints have proven successful in practice.



*Wet ash pipe in North America; the pipes are flanged together*



*Pipes in Australia; the pipes are connected by "Victaulic" couplings*



*Erection of wet ash pipes in Malaysia (350 mm diameter)*



*Long pipes require the use of expansion joints for compensation of length*



*Pipe for several units running to the central disposal site in Brasil*



### Wear Resistant Linings

Lining	Material Hardness		Process Parameters					Impact wear resistance	Remarks
	Mohs(1)	Vickers HV (2)	Max. conveying velocity m/sec	Material density g/cm <sup>2</sup>	Max. temperature (3)		Thermal shock resistance		
					°C	°F			
KALSICA-S silicon carbide ceramics	9.3	(2,300)	35	>3.0	1,000	1,832	++++	++	For extreme applications
KALOCER high alumina ceramics	9.1	(2,100)	>30	>3.0	350	662	0	+	Standard tiles, thin wall cylinders and tiles
KALCOR zirconium corundum	9	(2,000)	>30	>3.0	800	1,472	++	++	Large tiles, shaped elements, great wall thickness
KALSICA-N silicon carbide ceramics	8.8	(1,800)	>25	>3.0	1,000	1,832	+++	+	Good temperature resistance/thermal shock resistance
KALCOR-S sintered zirconium corundum	8.5	(1,600)	>25		800	1,472	+++	++	Economic KALCOR
KALCRET-B hard compound	8.1	(1,250)	22	≤3.0	800	1,472	+++	+	Supplied in bags, no joints, high temperatures
ABRESIST fused cast basalt	8	(1,140)	22	≤3.0	350	662	0	+	Flow volumes up to 3.0 g/cm <sup>3</sup> , up to 22 m/sec, limited temperatures
KALMETALL-W 100 hard overlay welding	(7.5)	700	20	-	350	662	++	++	Impact resistant, low weight
KALMETALL-C hard casting	(7.2)	580	20	-	350	662	++	+++	Impact resistant, economic in case of large quantities
KALCERAM hard ceramics	6	(500)	-	-	350	662	0	+	Bunker lining, slide promotion

(1) The Mohs scale is applicable only to ceramic materials - no more than comparison values for other materials (values given in brackets)

(2) The Vickers HV values are only valid for metallic materials - no more than comparison values for other materials (values given in brackets)

(3) The specified temperatures refer to standard applications; other temperatures must be agreed upon with the technical departments of Kalenborn

### Slide Promotion Linings

Lining	Slide Promotion	Max. Temp.		Wear Resistance	Remarks
		°C	°F		
KALEN slide promotion plastics	+++++	80	176	+	No corrosion, very smooth surface, low weight
KALINOX slide promotion steel	+++	550	1,022	++	Slide promotion in case both sliding wear and sticking problems exist
KALCERAM hard ceramics	+++	350	662	+++	Slide promotion and more efficient wear protection
ABRESIST fused cast basalt	+++	350	662	++++	Good material flow in case of hard, abrasive conveyed material

# Proven Kalenborn Offerings



## ABRESIST fused cast basalt

Mineral protection made of cast basalt to protect against abrasive wear.

Advantages: high wear resistance, permanent smooth surface, no corrosion.



## KALMETALL-W hard overlay welding

Tough basic body and hard overlay welding with primary chromium carbides.

Advantages: highly wear resistant, good resistance against impact wear, self-supporting structures.



## KALCOR zirconium corundum

Cast or sintered material made of alumina and zirconia oxide.

Advantages: high wear resistance, resistant against high temperatures, corrosion resistant.



## KALMETALL-C hard casting

Different materials characterized by corresponding resistance against abrasion and impact wear.

Advantages: alloy matched to the specific application, of advantage in case of larger quantities.



## KALOCER high alumina ceramics

Special oxide ceramics for plant components subject to extreme wear.

Advantages: high wear resistance, permanent smooth surface, no corrosion.



## KALCRET hard compound

Cement bonded compound for jointless protection to be trowelled, cast or sprayed-on.

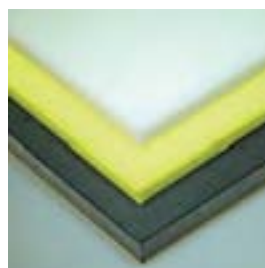
Advantages: high wear resistance and compressive strength, jointless, temperature resistant.



## KALSICA silicon carbide ceramics

Suitable for plant components that are exposed to extreme wear and/or high temperatures.

Advantages: highly wear resistant, resistant against thermal shocks and producible with narrow dimensional tolerances.



## KALEN slide promotion plastics

Range of different polyethylene (PE) and polyurethane (PU) materials.

Advantages: good durability, free of corrosion, smooth surface.

### Advantages of Lining Materials

#### Ceramic wear protection

- very good abrasion resistance
- tile, cylindrical or jointless lining
- temperatures up to 1,000 °C / 1,832 °F

#### Metallic wear protection

- good resistance against sliding and impact wear
- thin walls, self-supporting structures
- good thermal shock resistance

#### Plastic lining

- excellent slide promotion
- good resistance against impact wear
- low weight

#### Material combinations

- optimal wear protection for every application
- optimized lining cost
- optimized weight

## Optimal Solution for all Requirements



*Kalenborn supply wear protected plant components. In addition we provide for regeneration of worn components - here a grinding table of a coal pulverizer.*



*Material combinations allow safe and economic operation of PF-pipes. Here a combination of KALCOR zirconium corundum and KALOCER high alumina ceramics.*



*Reliable protection of pipe. ABRESIST fused cast basalt as time-tested solution for the transport of wet ash in the USA (250 mm diameter).*



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