průmyslová keramika

CASTABLES FOR CEMENT KILN LININGS

Průmyslová keramika, spol. s r.o. a public limited company specialized in industrial ceramics, is a long-established manufacturer of unshaped refractory products and refractory shapes for the linings of cement kiln lines. The beginnings of the product supplies almost coincide with the ongoing increase in consumption of so-called alternative fuels in the cement plants, resulting in a considerable change in refractories used.

PREHEATERS (CYCLONES), CONNECTING PIPES, DUCTS, CALCINERS, etc.

A1 - INSULATING CASTABLES

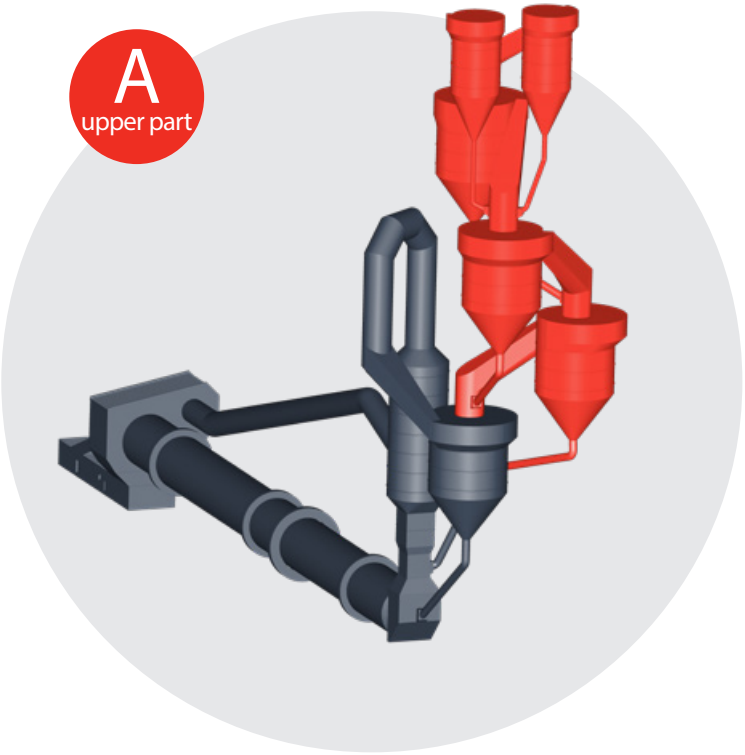
They represent materials that are most widely used for the back-end insulating layers. Insulating castables are usually applied by gunning method.

Conventionally used materials:

- IZOBET 1050/0.85T
- IZOBET 1100/0.9T

Recent trends include application of insulating castables with higher thermal conductivity in order to eliminate formation of concentration of alkalis at the joint between the dense lining and insulating lining, thus reducing corrosion of steel anchors in such areas. Gunning castables with higher density and improved thermal conductivity:

- IZOBET 1150/1.0T
- IZOBET 1200/1.3T
- IZOBET 1300/1.3T



A2 - DENSE CASTABLES COMPACTED BY VIBRATION

For the upper-stage cyclones, if they are not lined with clay bricks, fire clay castables with low or medium cement content are used:

- NOVOBET 1300
- MEBET 1350

For temperature ranges between 700 °C and 1000 °C, we would strongly recommend application of low-cement castables that are certified as alkali-resistant:

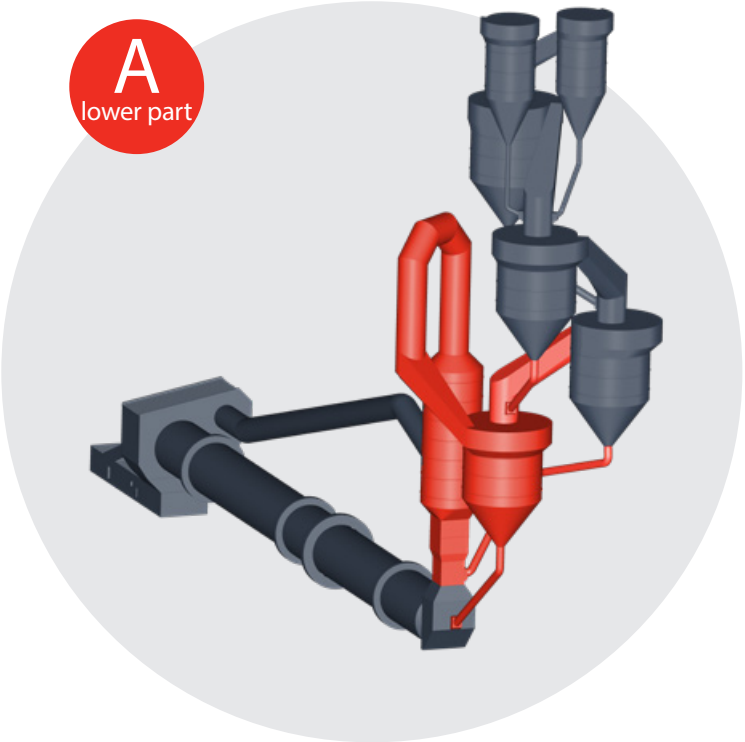
- NOVOBET 1350-RA
- NOVOBET 1450-RA

Lower-stage cyclone (C5), Riser, calciner, ducts, etc.
Areas exposed to build-ups, alkaline corrosion and other chemical corrosion. Mostly low-cement castables with SiC additive, always alkali-resistant. However, because oxidation of SiC may occur at higher temperatures, it is recommended that castables with high content of SiC are only applied to the areas covered up with build-ups.

- NOVOBET 1400-SIC-10-RA
- NOVOBET 1400-SIC-25-RA
- NOVOBET 1400-SIC-40-RA
- NOVOBET 1500-SIC-55-RA

Considering extensive combustion of alternative fuels, materials widely used for these component parts are low-cement castables (LCC) with significantly reduced SiC content, based on high-density zircon-corundum aggregates combined with aluminosilicates with high aluminium content.

- NOVOBET 1500-SIC-ZR-RA
- NOVOBET 1500-BZR-SIC
- NOVOBET 1600-AZR-SIC



A3 - DENSE GUNNING CASTABLES

Gunning castables are typically used for quick repair of linings only, e.g. during short-time shutdowns of the kiln.
Since the commonly used gunning castables have high cement content, they are not suitable for corrosive environment.
When applied in such areas, their lifespan is very short:

- ŽÁROBET TOR-1200-plast
- ŽÁROBET TOR-1400-plast

Durability of the gunned metallurgy lining can be extended by adding SiC, nevertheless, it does not withstand as long as vibrated LCC refractories:

- ŽÁROBET TOR-1400-SIC-25
- ŽÁROBET TOR-1600-A-SIC-10

!NEW!

Průmyslová keramika, spol. s r.o. succeeded in developing brand-new gunning LCC (low-cement castables) in a quality which is close enough to the vibrated castables, and most especially, in a processing quality that allows trouble-free gunning application. The said materials are being gradually applied in various cement plants for several years.

- NOVOBET TOR-1450-RA
- NOVOBET TOR-1400-SIC-25
- NOVOBET TOR-1450-SIC-ZR-RA

A4 - HOT DISC

Considering the lining, it is a relatively complex equipment set. Conditions prevailing therein are a combination of environments that can be found in waste incineration plants and cement kilns. Loads in this section include chemical corrosion, abrasion and even temperature changes from time to time.

For the most demanding application areas (walls):

- ULTRABET 1700-KZCr

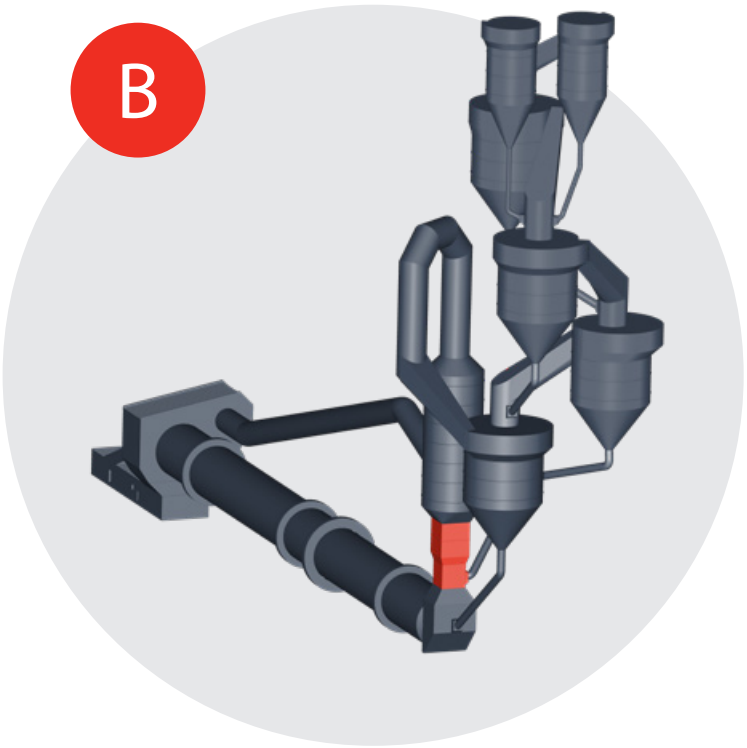
For the other application areas such as ceilings:

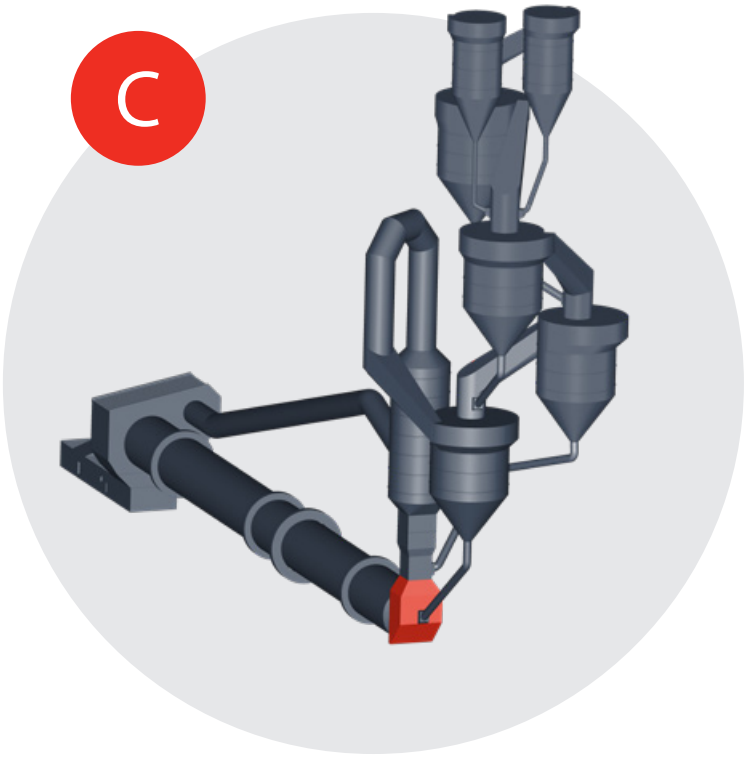
- NOVOBET 1450-RA

B - TIRE INFEED (gravity flow channel)

Area stressed by abrasion and temperature changes.
Therefore, abrasion resistant bauxite castables with high amount of steel needles are to be used:

- NOVOBET 1550-B-FS6





C - INLET CHAMBER (i.e. chute and side walls)

Similar conditions as in the lower-end sections of the preheater system, alkaline corrosion, possible occurrence of build-ups and abrasion.

Again, alkali-resistant LCC refractories with SiC additive should be used:

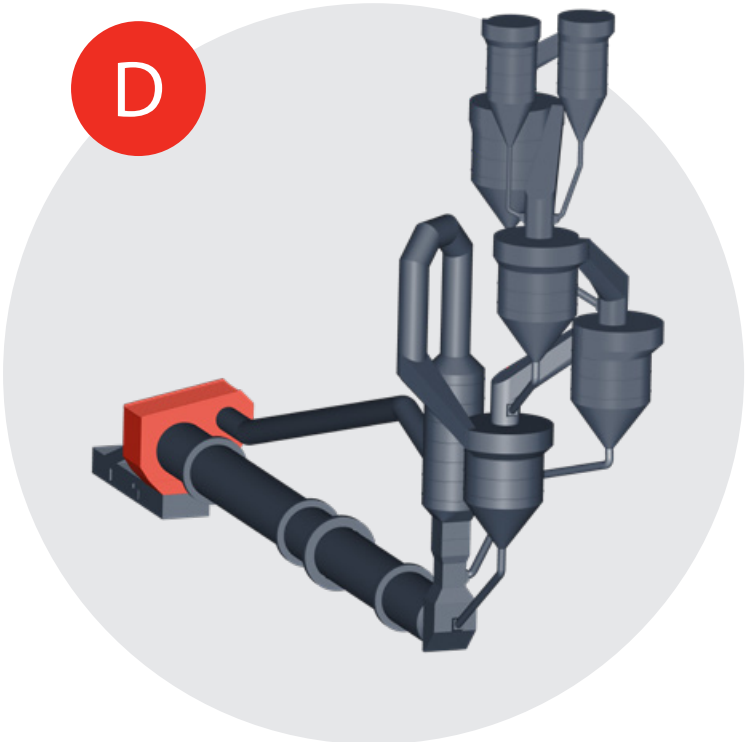
- NOVOBET 1400-SIC-25-RA
- NOVOBET 1400-SIC-40-RA

The walls can also be constructed by fixing the prefired refractory shapes.

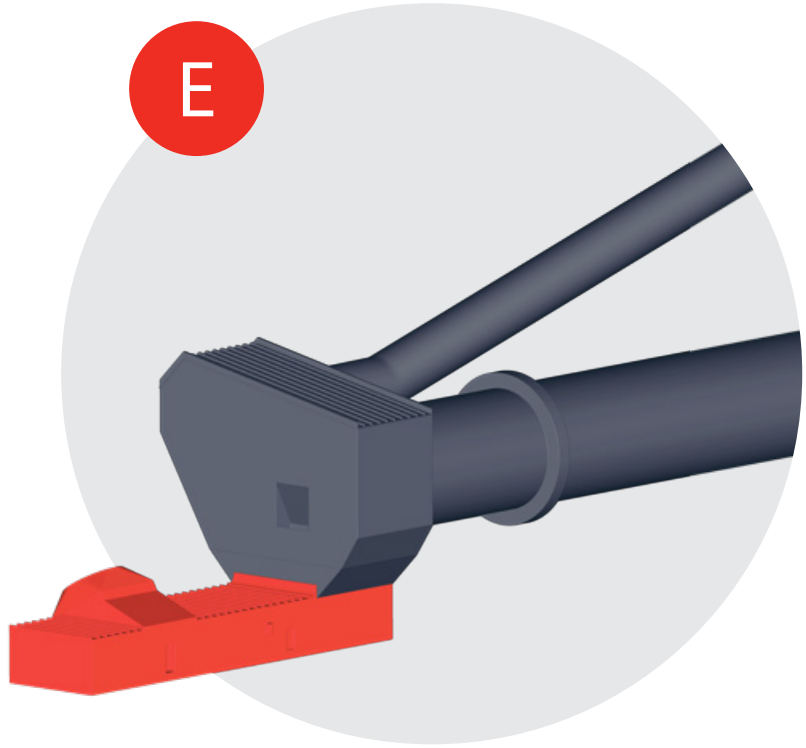
D - KILN HOOD

Depending on the experience and requirements of the cement plant, different materials are used:

- NOVOBET 1450-RA
- NOVOBET 1400-SIC-10-RA
- NOVOBET 1500-SIC-ZR-RA



E - COOLER



E1 - CEILING BEND AT THE INLET INTO THE COOLER

Extremely stressed areas due to build-ups, alkaline corrosion and temperature changes:

- NOVOBET 1500-SIC-ZR-RA
- NOVOBET 1600-AZR-SIC

E2 - INCLINATION INTO COOLER (walls and chute)

Area stressed by abrasion and partially by temperature changes:

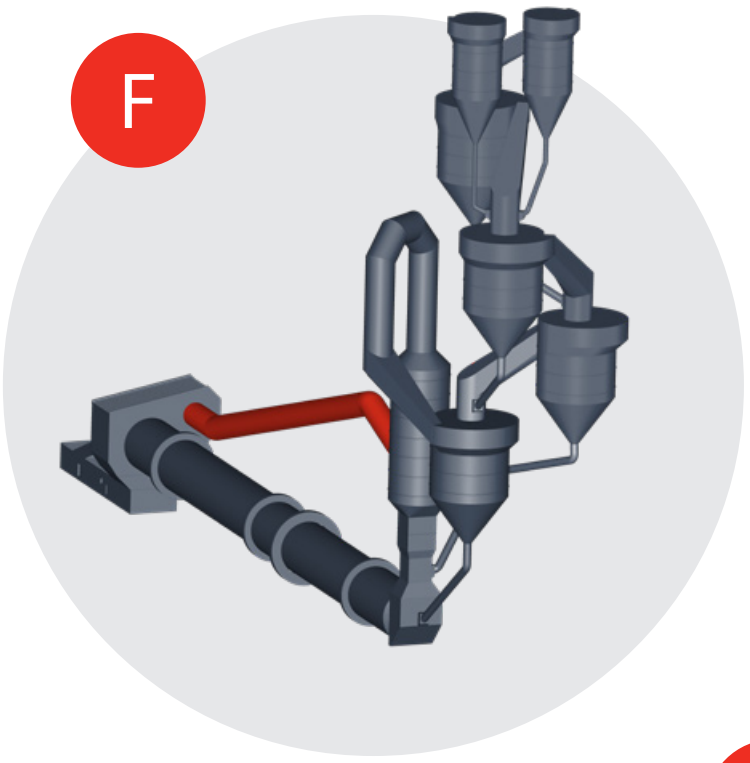
- NOVOBET 1600-B-SIC-10

E3 - BRIDGES INSIDE THE COOLER (protective refractory strip at the joint between the cooler wall and grates)

Segments stressed by abrasion and primarily by temperature changes due to blowing of cooling air through the cooler grate. Bauxite castables with high amount of steel needles:

- NOVOBET 1600-B-SIC-10-FS (2-4)
- NOVOBET 1550-B-FS (2-4)*

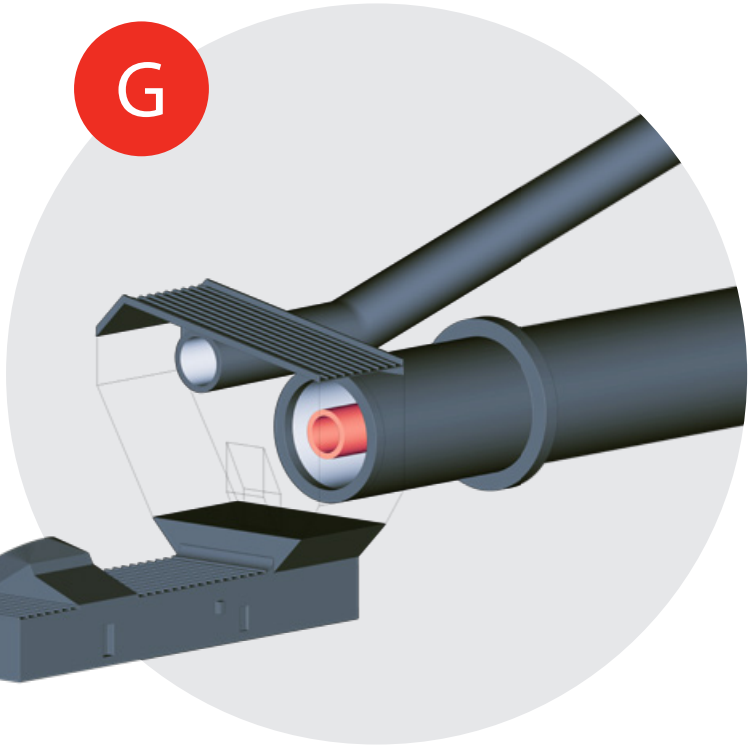
*range of mass addition of the needles



F - TERTIARY AIR DUCT

Load imposed on the lining due to abrasion of dust particles in the duct bends and bulkheads, occurrence of alkalis, abrasion-proof material:

- NOVOBET 1600-B-SIC-10 (alkali-resistant)
- NOVOBET 1450-RA



G - BURNER

Currently, we would recommend the following shell lining:

Tip (front part) of the burner:

- ULTRABET 1700-ZM-FS-3

Rear part typically of alkali-resistant castable:

- NOVOBET 1450-RA

!NEW!

H - QUICK REPAIR

Faults may occur whenever during operation of the cement line. The line is to be shut down for a short period of time to make a quick repair and ensure return to the operating temperature within the shortest possible time to make the operation shutdown as short as possible. Unfortunately, hydraulically bonded castables, when being heated up for the first time, require a slow rise in temperature so that water can be easily removed from the lining. Depending on the thickness of the lining, this process may take up to several days. Several years ago, Průmyslová keramika, spol. s r.o. has included chemically bonded castables of UNIBET series into its production range. They do not require any gradual drying. After many successful applications in other heat plant sets, we started using them in the cement kiln lines two years ago. There are already successful applications in the preheater systems, kiln hoods, etc.:

- UNIBET 1450-RA
- UNIBET 1550-BZS
- UNIBET 1600-AZS

each of them with the liquid bonding agent REFRAFIX PX.

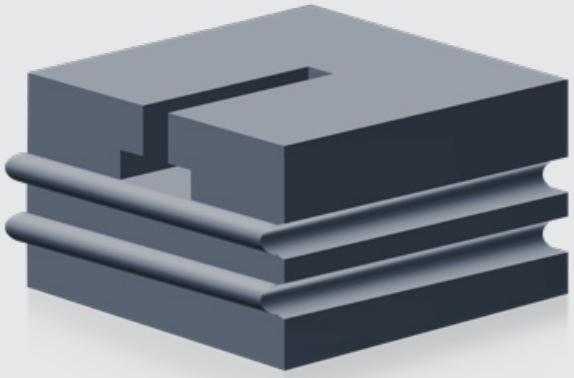
J - APPLICATION OF PREHEAT REFRACTORY SHAPES

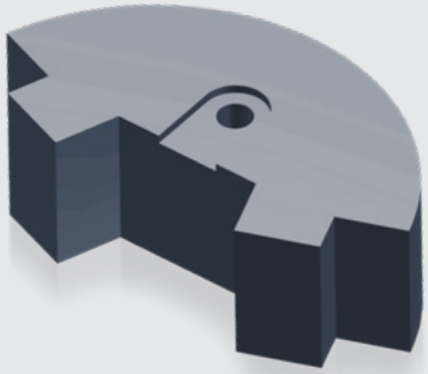
The advantages of incorporating refractory shapes into the linings of a cement kiln line are as follows:

- The shape is manufactured using an optimized manufacturing technique under ideal conditions.
- The shape is pre-heated, and therefore it does not require any slow drying, thus eliminating cracking and blasting away during the initial heating up of the plant set.
- Refractory shapes can be produced even in larger dimensions than fired products, and thus the installation can be speeded up.
- The shapes use a somewhat different fastening system than monolithic refractories, and therefore the risk of collapse of the lining due to corrosion of steel anchors is eliminated.

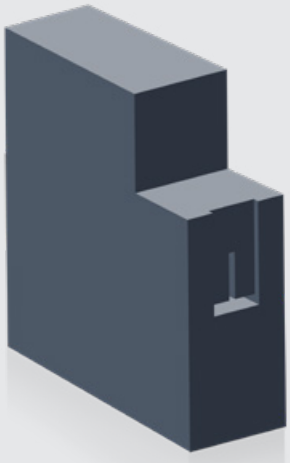
EXAMPLES OF DIFFERENT REFRACTORY SHAPES:

Preheater system lining

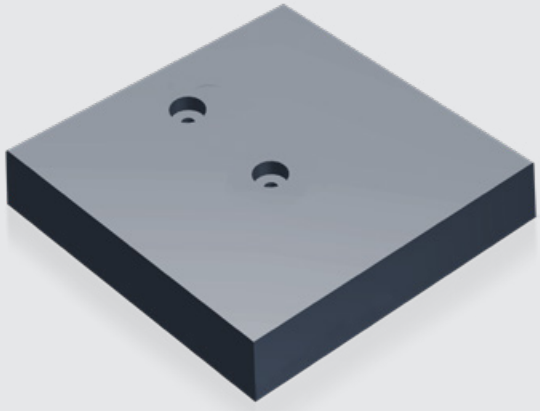




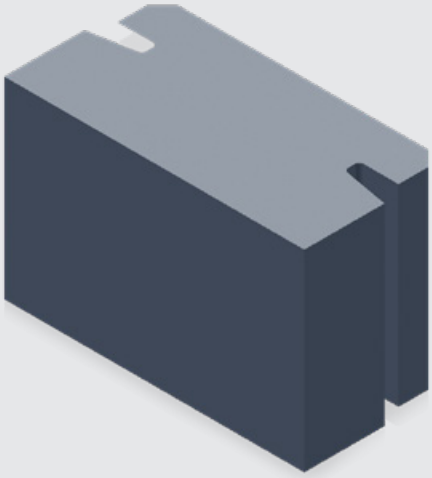
Kiln hood lining

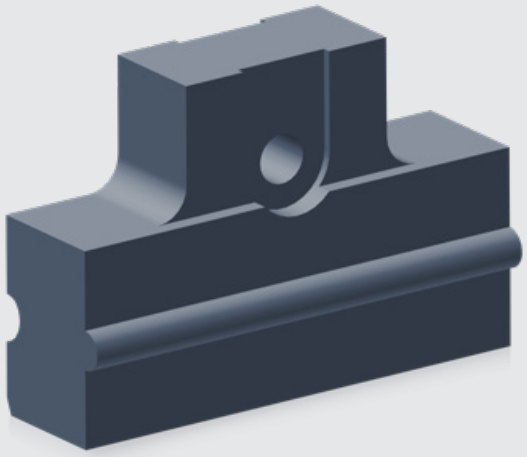


Cooler chute lining



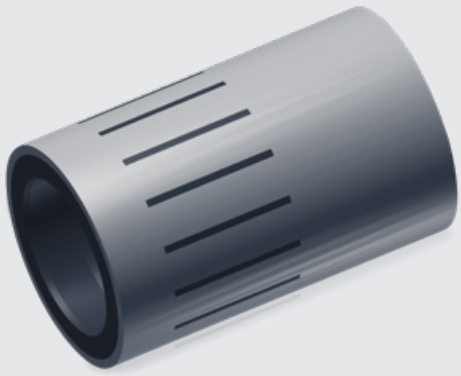
Cooler ceiling lining





Lining of a HOT-DISC segment

Burner lining



The materials referred to in this prospectus represent only the most widely used castables for linings of cement kilns. Průmyslová keramika, spol. s r.o. offers in its production program wide range of unshaped materials, with which can respond to specific requests of its customers.

INSULATING CASTABLES

Castable			IZOBET 1050/0.85T	IZOBET 1100/0.9T	IZOBET 1150/1.0T	IZOBET 1200/1.3T	IZOBET 1300/1.3T
Type of castable			ICG	ICG	ICG	ICG	ICG
Main raw material base			perlite	perlite	expanded clay	light-weight fireclay, perlite	light-weight fireclay, perlite
Classification temperature		°C	1050	1100	1150	1200	1300
Al_2O_3		%	30.5	37	32	35	40
SiO_2		%	37	34	41	46	44
CaO		%	19.5	22	13	10.5	10
SiC		%	-	-	-	-	-
ZrO_2		%	-	-	-	-	-
Mixing water		L/100kg	via nozzle	via nozzle	via nozzle	via nozzle	via nozzle
Bulk density	110°C	$kg.m^{-3}$	880	960	1100	1360	1360
	800°C	$kg.m^{-3}$	800	900	1050	1300	1300
		$kg.m^{-3}$	800	900	1050	1300	1300
Compressive strength	110°C	MPa	4.0	6.0	7.0	10.0	8
	800°C	MPa	3.0	4.0	5.0	8.0	6
	KT°C	MPa	2,0	2,0	4.0	5.0	8
Apparent porosity	800°C	%	60	56	45	40	-
	KT°C	%	68	65	55	45	-
Permanent linear change	800°C	%	-0.5	-0.6	-0.3	-0.3	-0.4
	KT°C	%	-1.0	-1.5	-1.0	-0.4	±1.5

Abbreviations and symbols used: CT – classification temperature

DENSE GUNNING AND LOW-CEMENT CASTABLES

Castable			ŽÁROBET TOR-1200-plast	ŽÁROBET TOR-1400-plast	ŽÁROBET TOR-1400-SIC-25	ŽÁROBET TOR-1600-A-SIC-10	NOVOBET TOR-1400-SIC-25	NOVOBET TOR-1450-RA	NOVOBET TOR-1450-SIC-ZR-RA
Type of castable			DG	DG	DG	DG	LCC-G	LCC-G	LCC-G
Main raw material base			fireclay	low-ferrite fireclay	low-ferrite fireclay, SiC	andalusite, SiC	synthetic alumino-silicate materials, SiC	low-ferrite fireclay	low-ferrite fireclay, SiC, zircon
Classification temperature		°C	1200	1400	1400	1600	1400	1450	1450
Al_2O_3		%	34	46	32	53	34	40	35
SiO_2		%	45	39	29	28	35	51	39
CaO		%	9.5	10	9.5	4	2.5	2.5	2.5
SiC		%	-	-	25	10	25	-	9
ZrO_2		%	-	-	-	-	-	-	10
Mixing water		L/100kg	via nozzle	via nozzle	via nozzle	via nozzle	via nozzle	via nozzle	via nozzle
Bulk density	110°C	$kg.m^{-3}$	2050	2060	2210	2400	2150	2170	2320
	800°C	$kg.m^{-3}$	1970	1920	2070	2310	2100	2120	2380
	KT°C	$kg.m^{-3}$	1960	1900	2100	2300*	2110	2120	2320
Compressive strength	110°C	MPa	50	75	60	70	45	55	55
	800°C	MPa	35	55	45	55	65	75	55
	KT°C	MPa	15	40	30	70*	60	65	50
Apparent porosity	800°C	%	29	27	26	23	19	18	16
	KT°C	%	28	28	24	18*	18	16	16
Permanent linear change	800°C	%	-0.3	-0.2	-0.2	-0.2	-0.2	-0.3	-0.2
	KT°C	%	-1.0	+0.9	±0.4	+0.6*	-0.8	-0.8	-0.5

Abbreviations and symbols used: CT – classification temperature, RA – resistant to alkalis, *determined at 1500 °C
Note: On castables with SiC content, firing to CT was done under reducing conditions

CAST DEFLOCCULATED CASTABLES – PART 1

Castable			MEBET 1350	NOVOBET 1300	NOVOBET 1350-RA	NOVOBET 1400-SIC-10-RA	NOVOBET 1400-SIC-25-RA
Type of castable			MCC	LCC	LCC	LCC	LCC
Main raw material base			fireclay	fireclay	fireclay	fireclay, SiC	low-ferrite fireclay, SiC
Classification temperature		°C	1350	1300	1350	1400	1400
Al_2O_3		%	42	42	36	38	32
SiO_2		%	46	48	49	44	37
CaO		%	5.2	2.9	1.8	1.8	2
SiC		%	-	-	-	-	25
ZrO_2		%	-	-	-	-	-
Mixing water		L/100kg	8.3 – 9.0	7.2 – 7.8	5.2 – 5.8	5.0 – 5.6	5.5 – 6.0
Bulk density	110°C	$kg.m^{-3}$	2260	2220	2250	2260	2240
	800°C	$kg.m^{-3}$	2160	2170	2220	2240	2230
	KT°C	$kg.m^{-3}$	2110	2090	2200	2180	2210
Compressive strength	110°C	MPa	70	65	80	80	65
	800°C	MPa	60	70	90	100	85
	KT°C	MPa	50	60	80	75	50
Apparent porosity	800°C	%	20	17	13	13	14
	KT°C	%	20	16.5	12	13	15
Permanent linear change	800°C	%	-0.2	-0.3	-0.2	-0.2	-0.2
	KT°C	%	±0.5	-0.5	+0.4	+1.1	+0.7

Abbreviations and symbols used: CT – classification temperature, RA – resistant to alkalis
Note: On castables with SiC content, firing to CT was done under reducing conditions

CAST DEFLOCCULATED CASTABLES – PART 2

Castable			NOVOBET 1400-SIC-40-RA	NOVOBET 1450-RA	NOVOBET 1500-SIC-ZR-RA	NOVOBET 1500-BZR-SIC	NOVOBET 1500-SIC-55-RA
Type of castable			LCC	LCC	LCC	LCC	LCC
Main raw material base			SiC, low-ferrite fireclay	low-ferrite fireclay	synthetic alumino--silicate materials, SiC, zircon	bauxite, SiC, zirconia materials	SiC, low-ferrite fireclay
Classification temperature		°C	1400	1450	1500	1500	1400
Al_2O_3		%	26	40	40	63	26
SiO_2		%	28	50	37	12	28
CaO		%	1.8	1.8	2	1.8	1.8
SiC		%	40	-	8,5	7,5	40
ZrO_2		%	-	-	8	11	-
Mixing water		L/100kg	5.8 – 6.4	5.6 – 6.2	5.0 – 5.6	5.0 – 5.6	5.8 – 6.4
Bulk density	110°C	$kg.m^{-3}$	2310	2280	2410	2800	2310
	800°C	$kg.m^{-3}$	2280	2260	2390	2760	2280
	KT°C	$kg.m^{-3}$	2250	2290	2370	2730	2250
Compressive strength	110°C	MPa	60	80	85	100	60
	800°C	MPa	85	90	100	130	85
	KT°C	MPa	40	100	105	130	40
Apparent porosity	800°C	%	16	13	15	14	16
	KT°C	%	16	11	15	14	16
Permanent linear change	800°C	%	-0.2	-0.2	-0.3	-0.2	-0.2
	KT°C	%	+0.9	-1.1	-0.5	+0.5	+0.9

Abbreviations and symbols used: CT – classification temperature, RA – resistant to alkalis
Note: On castables with SiC content, firing to CT was done under reducing conditions

CAST DEFLOCCULATED CASTABLES – PART 3

Castable			NOVOBET 1550-B	NOVOBET 1600-AZR-SIC	NOVOBET 1600-B-SIC-10	ULTRABET 1700-ZM	ULTRABET 1700-KZCr
Type of castable			LCC	LCC	LCC	ULCC	ULCC
Main raw material base			low-ferrite fireclay	andalusite, SiC, zirconia materials	bauxite, SiC	zircon mullite, mullite	corundum, Cr_2O_3, zircon
Classification temperature		°C	1550	1600	1600	1700	1700
Al_2O_3		%	76	49	75	63	85
SiO_2		%	18	25	8	24	7
CaO		%	12.5	1.8	1.8	0.7	0.7
SiC		%	-	7,5	10	-	-
ZrO_2		%	-	11	-	9,5	3
Mixing water		L/100kg	5.0 – 5.6	5.0 – 5.5	4.5 – 5.0	4.0 – 4.6	4.0 – 4.5
Bulk density	110°C	$kg.m^{-3}$	2840	2790	2860	2640	3150
	800°C	$kg.m^{-3}$	2790	2750	2830	2610	3090
	KT°C	$kg.m^{-3}$	2290*	2760*	2730*	2610*	3130*
Compressive strength	110°C	MPa	100	90	90	50	50
	800°C	MPa	130	120	110	70	90
	KT°C	MPa	130*	120*	85*	120*	150*
Apparent porosity	800°C	%	12	14	13	11	12
	KT°C	%	13*	15*	15*	14*	13*
Permanent linear change	800°C	%	-0.2	-0.2	-0.2	-0.1	-0.2
	KT°C	%	+0.4*	+0.4*	+0.7*	-0.3*	-0.4*

Abbreviations and symbols used: CT – classification temperature, RA – resistant to alkalis, * determined at 1500 °C
Note: On castables with SiC content, firing to CT was done under reducing conditions

CHEMICALLY BONDED CASTABLES

Castable			UNIBET 1450-RA	UNIBET 1550-BZS	UNIBET 1600-AZS
Type of castable			CBC	CBC	CBC
Main raw material base			fireclay	bauxite, SiC, zirconia materials	andalusite, SiC, zirconia materials
Classification temperature		°C	1450	1550	1600
Al_2O_3		%	43	66	53
SiO_2		%	49	18	26
CaO		%	-	-	-
SiC		%	-	5	10
ZrO_2		%	-	7.5	7
Mixing liquid		kg/100kg	REFRAFIX PX; 12 - 13	REFRAFIX PX; 10	REFRAFIX PX; 11
Bulk density	110°C	$kg.m^{-3}$	2120	2810	2660
	800°C	$kg.m^{-3}$	2070	2770	2640
	KT°C	$kg.m^{-3}$	2060	2730*	2550*
Compressive strength	110°C	MPa	60	80	80
	800°C	MPa	40	55	50
	KT°C	MPa	85	80*	85*
Apparent porosity	800°C	%	17	16	17
	KT°C	%	15	14*	16*
Permanent linear change	800°C	%	-0.3	-0.2	-0.2
	KT°C	%	+0.5	-0.6*	-0.5*

Abbreviations and symbols used: CT – classification temperature, RA – resistant to alkalis, * determined at 1500 °C
Note: On castables with SiC content, firing to CT was done under reducing conditions

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