

THE REFRACTORY LEADING COMPANY

# **CHALLENGES FOR THE WORLD'S BEST**





# CHALLENGES OF KR

KR has been putting sweat and energy into the production and supply of refractory products that can be conducive to the productivity of iron/steelmaking, glass, and cement industry. KR's challenges and passion are now lighting up to be a leading company in the refractory industry.

## NEW CORPORATE IDENTITY

KR's new octagon symbol stands for safety, fundamentals, and perfection to reflect a corporate integrity based on a new and perfect foundation and the commitment of keeping on challenges for better future. The KR Green Color is to contain a good corporate image concerned with environment.

New Brand



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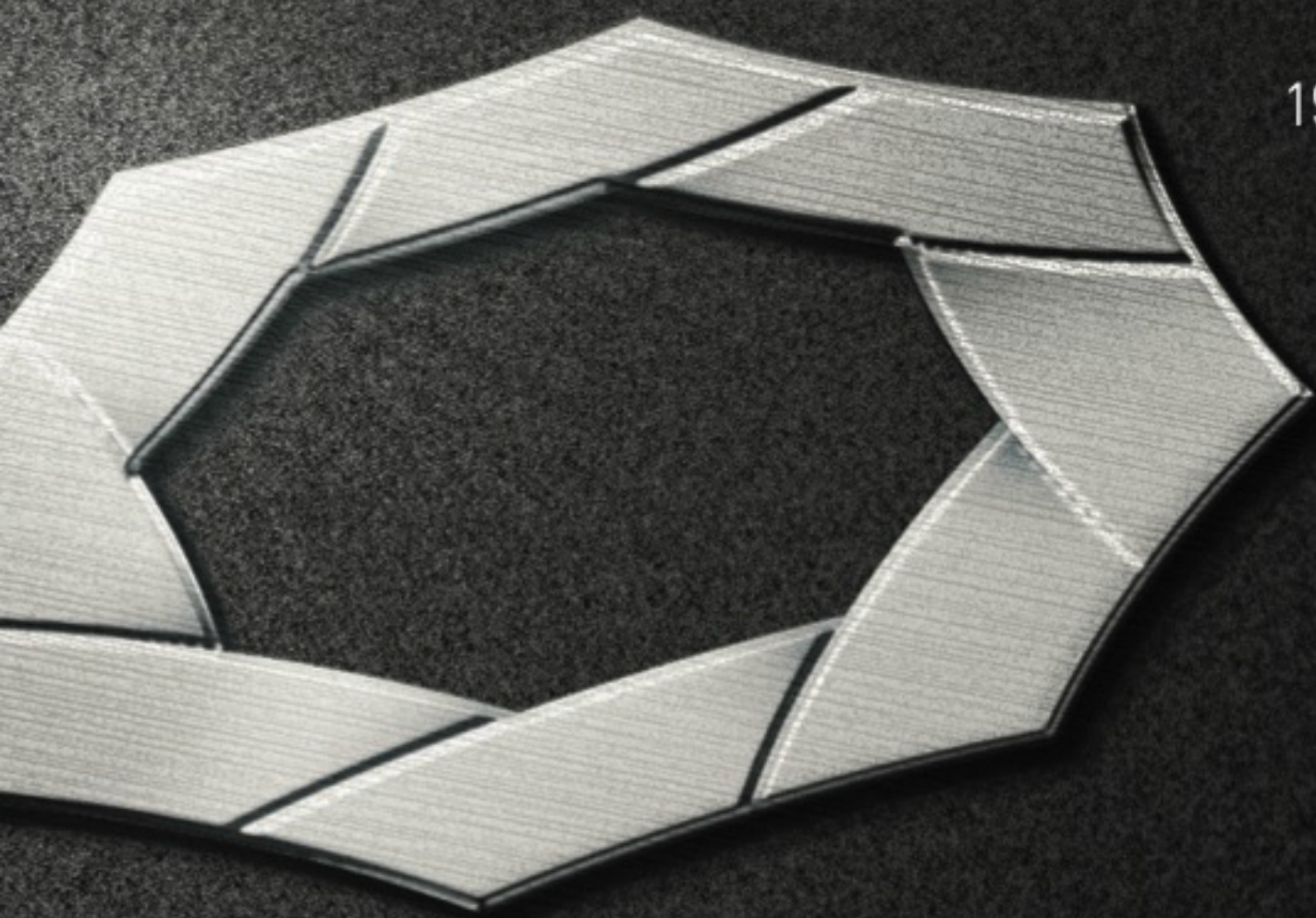
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# CHALLENGES FOR THE GREAT VALUE

It has been 40 years since we set out to do refractory business with a spirit of challenge and commitment of taking the lead in this industry, and we could be a well-recognized manufacturer of refractory products. And we'll challenge, with the same mind as we stepped into this industry, for better value that can change the future.

# HISTORY OF CHALLENGES



- |       |        |  |
|-------|--------|--|
| 1970s | 72. 04 | Established Ahsung Chemical Industrial Company   |
| 1980s | 85. 09 | Built a factory for Unburned Shaping Refractories.<br>(Started to produce refractories for EAF, L/F, and L/D)  |
|       | 88. 09 | Incorporated to Ahsung Co.,Ltd   |
|       | 89. 08 | Built #2 factory at Bonsan-ri, Jinyeong-eup, Gimhae-si, Gyeongsangnam-do<br>(Started to produce Unshaped Refractories for Steelmaking)                             |
| 1990s | 95. 03 | Signed a technical tie-up agreement with LAFARGE (France)<br>to develop Unshaped Refractories for Steelmaking  |
|       | 95. 11 | Signed a technical tie-up agreement with KAWARO(Japan)<br>to develop Shaped Refractories for L/F   |
|       | 95. 12 | Signed distributorship agreement with BAKER REF (USA) (DOLOMITE etc)   |
|       | 96. 07 | Signed capital investment agreement with Korea Development<br>Bank and made a paid-in capital increase (Paid-in Capital: KRW1.1 billion)                           |
|       | 96. 10 | Main factory at Gimhae (Built mass production line of<br>Shaped Refractories for L/F ladle and EAF)  |
|       | 98. 07 | Made Industry-Academy-Research Joint Technical De<br>velopment Agreement (Appointed by Small & Medium<br>Business Administration) (Gyeongsang National University) |
|       | 98. 10 | Made a paid-in capital increase (KRW1.1billion → 1.4billion)   |
|       | 99. 12 | Acquired I.S.09002 Certificate   |
| 2000s | 00. 12 | Unshaped Refractories (Succeeded in making home production<br>of T/D Coating material)   |
|       | 02. 05 | Changed a corporate name to KOREF Co.,Ltd  |
|       | 02. 07 | Started to construct production facilities for acid/neutral<br>refractories within Jinyeong Factory (For iron & steelmaking)                                       |
|       | 03. 01 | Constructed production facilities for acid/neutral refractories<br>within Jinyeong Factory (Building area: 1781 m <sup>2</sup> )                                   |
|       | 03. 12 | Acquired I.S.O Certificate (ANAB)  |
|       | 04. 08 | Appointed as the Most Promising Small Business by Busan Bank   |
|       | 07. 03 | Awarded a citation as a honest taxpayer from Gimhae Tax Office   |
|       | 09. 06 | Appointed as the Most Promising Small Business by<br>Korea Development Bank  |
| 2010s | 10. 02 | Acquired Samhwa Chemical IND Co.,Ltd   |
|       | 10. 11 | Signed a mutual cooperation agreement for joint growth with POSCO  |
|       | 11. 03 | Chosen as a certified supplier of Hyundai Steel Co.,Ltd (Filler club)  |
|       | 11. 04 | Appointed as BS DIAMOND GROUP  |
|       | 11. 09 | Enrolled in Venture Business List<br>(Small & Medium Business Corporation)   |
|       | 13. 08 | Changed a corporate name to KR Co.,Ltd   |
|       | 14. 05 | Selected as the best company to work "small & medium<br>Business Corporation"  |
|       | 14. 07 | Designated as an excellent company in Gyeongnam-do<br>that wants to get a job  |
|       | 17. 03 | Established KRS Hotel Corporation  |
|       | 17. 09 | ISO 9001 Quality Management System Certification   |
|       | 17. 11 | MAINBIZ (Korea Management Innovation Small Business Association)<br>Certification  |



'KR will be a reliable and  
warm-hearted enterprise  
that fulfills human-centered business  
and corporate responsibilities  
towards community'

# CHAIRMAN'S MESSAGE

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For 40 years from Ahsung Chemical Industrial to the current KR, we have devoted ourselves to development and production of the best refractories through incessant research and change efforts, and could have enough capability and specialization to construct furnaces.

Now, KR is striving to strengthen a global competitiveness so as to hold a dominant position among competition with overseas products, including low-priced Chinese products, by means of R&D investment expansion, acquisition of core technologies, and production of better production etc.

Based on specialization of fusing technology that our affiliated company KRM has retained, we could mass-produce fused Mgo- Magnesia and Mgo single crystal, and build production line for fused aluminum and fused spinel, through which we could be equipped with a powerful leadership enough to lead the refractory industry in Korea.

Today's KR is entirely attributable to the efforts and commitment of all

employees and executives. A distinctive competitiveness, sustained growth, and expansion of business have stemmed from their immeasurable efforts, so we're trying to create an energetic and rewarding workplace where management and labor can engage in open-minded business and all individuals can put their abilities to good use.

KR is aiming to get business growth through 'Human-Centered Management' based on flexible communication, through which to be a wise enterprise that can light up the future of people. In addition, KR will be a 'Reliable and Warm-hearted Enterprise' that perform corporate responsibilities for better community.

With this sound corporate culture and reliable business structure, KR will keep working on advanced management and try to accomplish customer satisfaction with products. KR is preparing to jump up to the level of international company that can make you feel proud of us in the world market and doing our utmost efforts to return your steady support and trust towards KR.

Thank you so much  
Kim, Dae Sung | Chairman

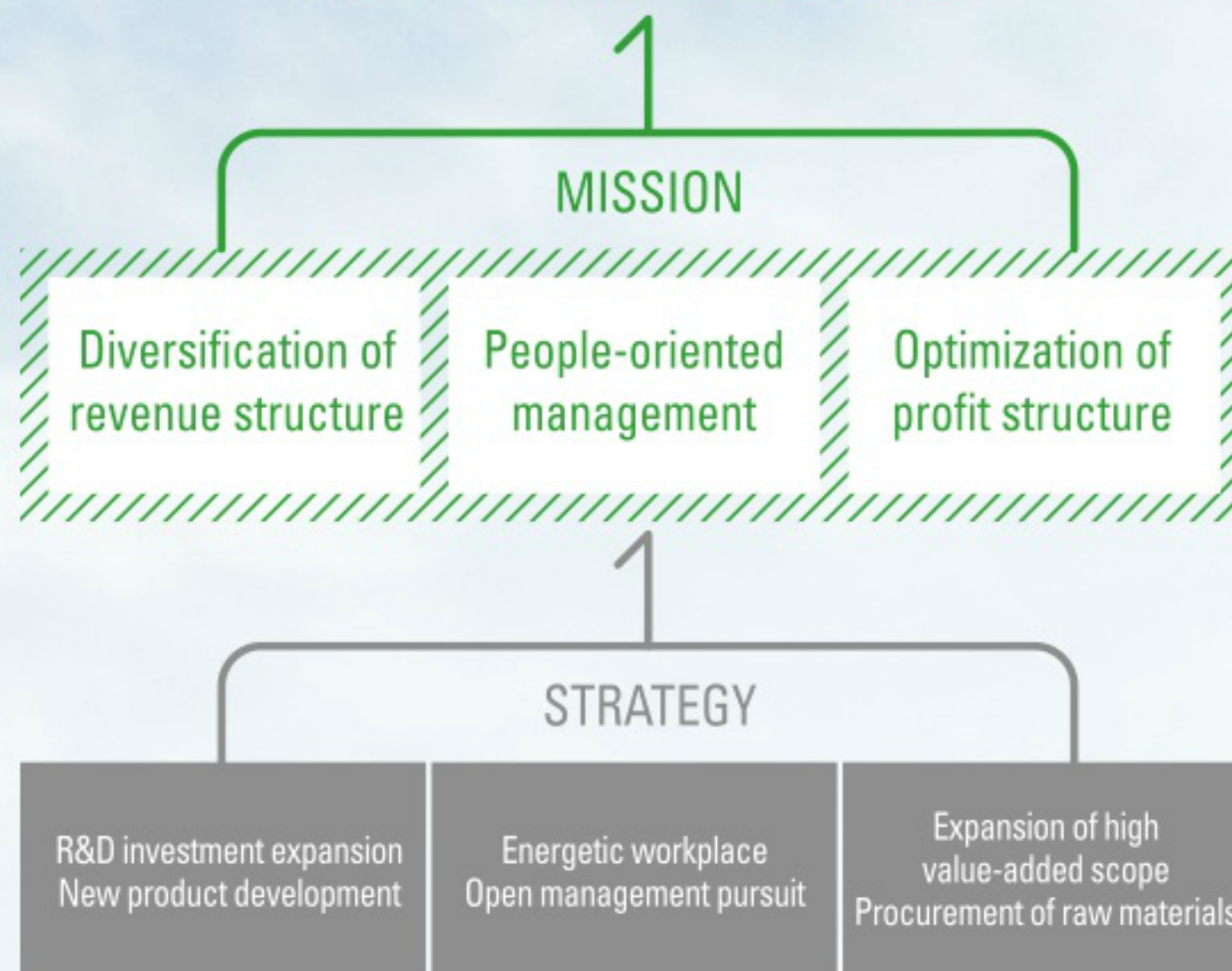
KR is planning to produce refractories domestically by strengthening technical development & research facilities. A bold investment and incessant challenges to create optimization of overall profit structure are now paying off. KR is aiming to be a good enterprise that practices human-centered open management, takes corporate responsibilities socio-environmentally, and creates a positive value for better future and the next generation.

# CHALLENGES FOR THE NEW VISION

## Vision

'CHALLENGES FOR THE WORLD'S BEST' KR will jump up to be the world's best refractory manufacturer through people-oriented corporate culture and proactive management policy.

## CHALLENGES FOR THE WORLD'S BEST



## Corporate Culture



### Flexible Communication

To create a vibrant and energetic workplace where all individuals can make the most of their abilities, we are growing the enjoyment of challenges and accomplishments through horizontal communication system.



### Human Resources

We're supportive of all talented individuals who make efforts to create future value through education programs so that they can make their dream come true with sustained growth of company.



### Social Contribution

By making a corporate financial foundation secure and engaging in social contribution activities, we're fulfilling corporate social responsibilities towards community and residents.

KR's sustained development is attributable to trust and affection that all customers have provided to KR. In addition to their affectionate encouragement, KR is now spreading around the world by strengthening R&D investment and facilities, expanding refractory productivity, and aggressive marketing activities.

# CHALLENGES FOR THE CUSTOMER TRUST





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## Place of business

### Factory

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Main office & # 1 Factory (Shaped refractories)

1538beon-gil, Gimhae-daero, Hannim-myeon, Gimhae-si, Gyeongnam, Korea  
T. +82-55-346-1191 F. +82-55- 346-1610

# 2 Factory (Unshaped refractories)

26, 86beon-gil, Bonsan-ro, Jinyeong-eup, Gimhae-si, Gyeongnam, Korea  
T. +82-55-343-6533 F. +82-55-343-6532

#3 Factory (Unshaped refractories)

Scheduled to be constructed in 2019

Within the premises of Songsan Industrial Complex at Songsan-myeon,  
Dangjin-si, Chungnam, Korea

### Offices

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Dangjin office

238, Daeseom-gil, Dangjin-si, Chungcheongnam-do, Korea  
T. +82-70-4863-3584 F. +82-41-358-6000

Pohang Office

53, 314beon-gil, Cheolgang-ro, Nam-gu, Pohang-si, Gyeongbuk, Korea  
T. +82-54-278-8484 F. +82-54-278-3348

Incheon Office.

9-4, Whasu-ro 73 beon-gil, Dong-gu, Incheon Metropolitan City, Korea  
T. +82-32-875-2787 F. +82-32-875-2787

### Affiliated Company

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KRM main office & # 1 factory

(Production of new iron/steel materials, Raw refractory materials)  
53, 314beon-gil, Cheolgang-ro, Nam-gu, Pohang-si, Gyeongbuk, Korea T.  
+82-54-278-8484 F. +82-54-278-3348

KRM #2 Factory

2-22, Cheonbuk Sandan-ro, Cheonbuk-myeon, Gyeongsangbuk-do, Korea  
T. +82-54-744-5043 F. +82-54-744-5045

KR TECH (Furnace Construction)

836-1, Noksan-dong, Gangseo-gu, Busan, Korea  
T. +82-51-207-1010 F. +82-51-207-1033

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## Annual Productivity

**25,000**  
**ton**



Shaped refractories

**50,000**  
**ton**



Unshaped refractories

**15,000**  
**ton**



Special refractories

A close-up, side-profile photograph of two industrial workers. The worker in the foreground is wearing a bright yellow hard hat and orange safety glasses, looking down intently. The worker behind him is wearing a white hard hat. Both are wearing dark blue work shirts with reflective silver stripes. The background is blurred, showing industrial equipment.

# CHALLENGES TO OVERCOME THE LIMITATIONS OF REFRACTORIES

KR keeps on challenging towards development of top-notch refractories that can get over the limit of durability featured by existing refractories. KR's challenges will enhance the value of customer's choice.



layar

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# CHALLENGES FOR THE INDUSTRIAL DEVELOPMENT

Refractories are both foundation and prime mover that could have a basic industry, such as iron/steelmaking, glass , and cement industry, take a great step forward.

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## REFRACTORIES

Refractories are key materials used widely in various industries that need a high temperature, such as iron/steelmaking, cement, nonferrous metal, and glass industry etc. Refractory is composed of nonmetallic oxide that does not easily melt in a high temperature, requiring different chemical, physical, thermal properties as to its use and condition. It is divided into acid, neutral, and basic refractories by chemical compositions, and classified into shaped and unshaped refractories by different shapes. KR has built a consistent infrastructure of 'refractory raw materials – refractory products – furnaces', which results in a stable supply and construction of high-quality refractories to users.

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### Market for KR Refractories

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#### ironmaking



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#### Blast Furnace

Alumina- Silicon Carbide- Carbon Trough Refractory Castable by the Molten Metals of Hot Iron Runner

#### Torpedo Ladle Car

Alumina-Silicon Carbide- Carbon Lining Bricks, and Alumina Castable for Repairs

#### Converter

Magnesia-Carbon Brick(major axis) for Furnace Body Lining, and Gunning Repair Material

#### Charging/Teeming Ladle

Alumina-Silicon Carbide – Carbon, Magnesia- Carbon Lining Brick, and Castable for Inflow Work

#### RH (Ruhrstahl Heraus)

Upper & lower vessel, Magnesia-Carbon for Dip Tube, Chrome Lining Brick and Castable, Gunning Repair Material

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#### steelmaking



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#### Electric Arc Furnace

Magnesia- Carbon Furnace Body Lining Brick, and Dolomite Bottom Ramming Material, Gunning Repair Material, 소천정용 Pre-Cast Block

#### Ladle Furnace

Magnesia-Carbon for Slag Line, Alumina-Magnesia-Carbon Lining Brick for Metal Line, Purging Plug Set & Castable, Mortar

#### Continuous Casting

Castable Inflow & Coasting Material, Alumina-Magnesia- Carbon Lining Brick

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#### cement, nonferrous metal, and glass industry



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#### Other Air Heating Furnaces, Incinerators

Other Castables & Lining Bricks



# CHALLENGES FOR THE INNOVATION

Forty years of manufacturing know-how and KR's own technology are combined to produce Shaped and Unshaped Refractories, which reflects well on KR that is emerging as the promising company in refractory industry.



## Shaped Refractory

#1 Factory



## Products

### Shaped Refractories

#1 factory mainly makes carbon-containing unburned refractories. Hot mixing(mulling) process of high-purity materials is followed by high vacuum forming process, which makes a compact structure of refractory with good hot-processing properties. It is used as an essential material for Converter, Ladle, and Torpedo ladle car in iron-making process, and Electric arc furnace, Ladle, and Tundish in steelmaking process.

#### Main Items



Al<sub>2</sub>O<sub>3</sub>-MgO-C

MgO-C

Al<sub>2</sub>O<sub>3</sub>-SiC-C

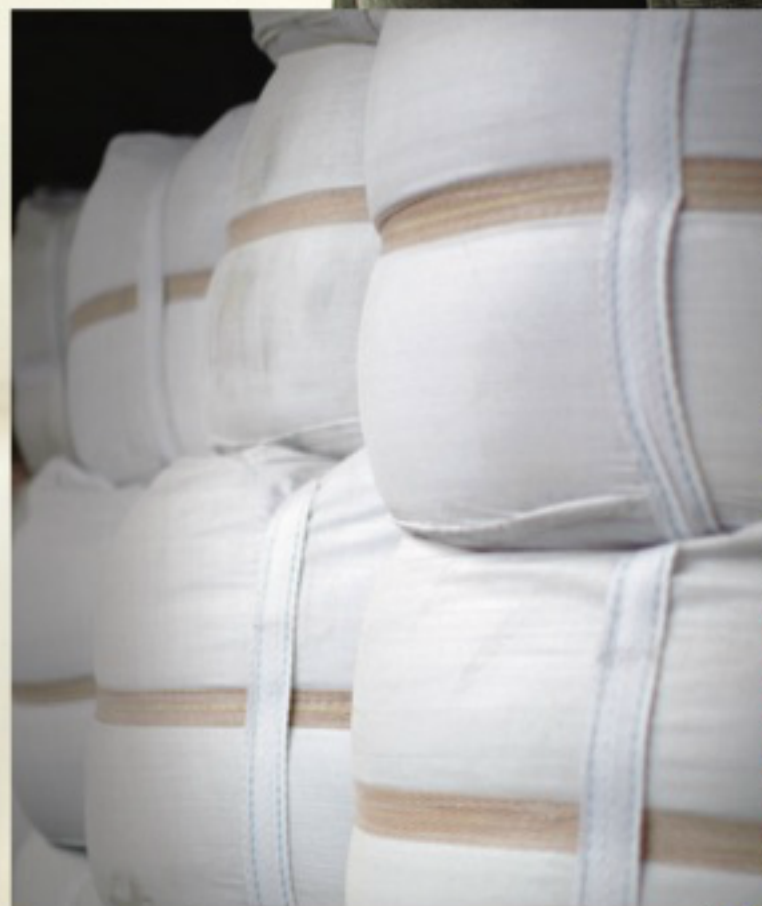
### Special Refractories

KR is not only developing new technologies through technical and selling tie-up agreements with overseas well-known firms, but also specializing in production of special refractories needed in iron/steelmaking process.

#### Main Items

Purging Plug, Sliding Gate, and then some





# CHALLENGES FOR THE INNOVATION

Forty years of manufacturing know-how and KR's own technology are combined to produce Shaped and Unshaped Refractories, which reflects well on KR that is emerging as the promising company in refractory industry.



## Unshaped Refractory

#2 Factory



## Products

### Unshaped Refractories

#2 factory produces a wide variety of acid, neutral and basic unshaped refractories. The use of self-developed special binder improves the properties and performance of refractory, which is well received by customers. Powder type with good workability, such as castable and spray material, and casting block specially designed for deformed structure etc are widely used in industry.

#### Main Items



Gunning (Normal)



Gunning (Sea-water)



Coating (Wet type)



Coating (Dry type)



Ramming (Dolomite)



Castable



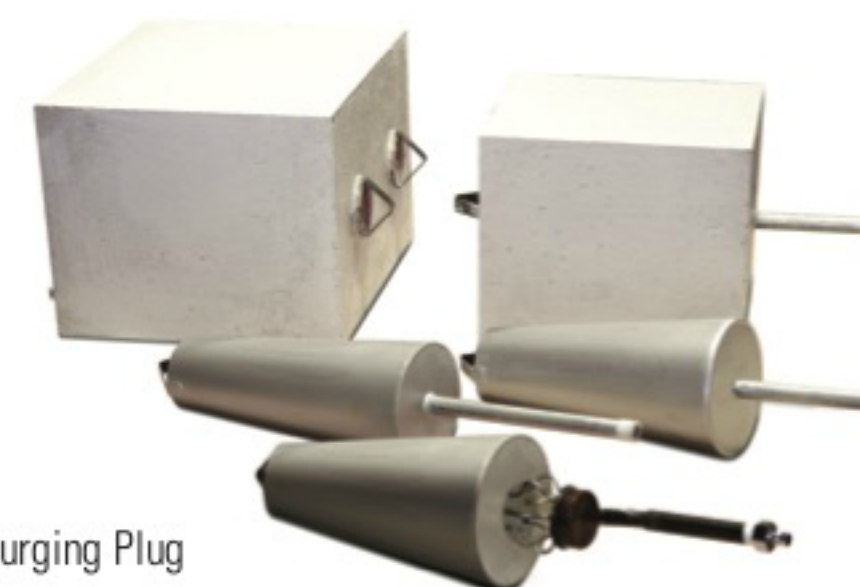
Slip Casting Castable



Mortar



Casting Block



Purging Plug

# CHALLENGES FOR NEW POSSIBILITIES

KR, with top-notch skilled personnel and plenty of construction experiences, has built furnaces for iron/steelmaking industry, of which specialized constructability is well recognized in this industry. KR's challenges for development of better and more durable furnace still keep going on.



## Furnace Maintenance

Industrial Site



## Main Working Process

KR has established a well-structured furnace building system in which KR is directly engaged in construction of furnace and takes responsibility of its maintenance. With the best skilled workers, equipment, and many years of experiences, KR has successfully performed construction and maintenance of refractories used in key facilities of iron/steelmaking process, such as E.A.F, Ladle, Tundish etc.



Working Site



# CHALLENGES FOR THE CREATIVITY

R&D Center to enhance a competitive edge and high value-added technology.

It deals with various materials, with a simple but definite principle of 'Whatever it is, the foundation has to be solid'. KR believes that the world's best technology is derived from the simple principle.

## R&D Center

Front view



R&D Center has concentrated on a sustained technological development, quality stability of products, and future growth of refractory technology.

To enable the use of refractories in the optimum condition, it runs stage-by-stage quality inspection on raw materials, semi-products, and products, and various physicochemical tests on them. Furthermore, for more powerful technical competitiveness in future, KR's efforts and investment to develop/research new materials and products will keep going on.

## Machine & Equipment



Compression tester



High temperature furnace



XRF



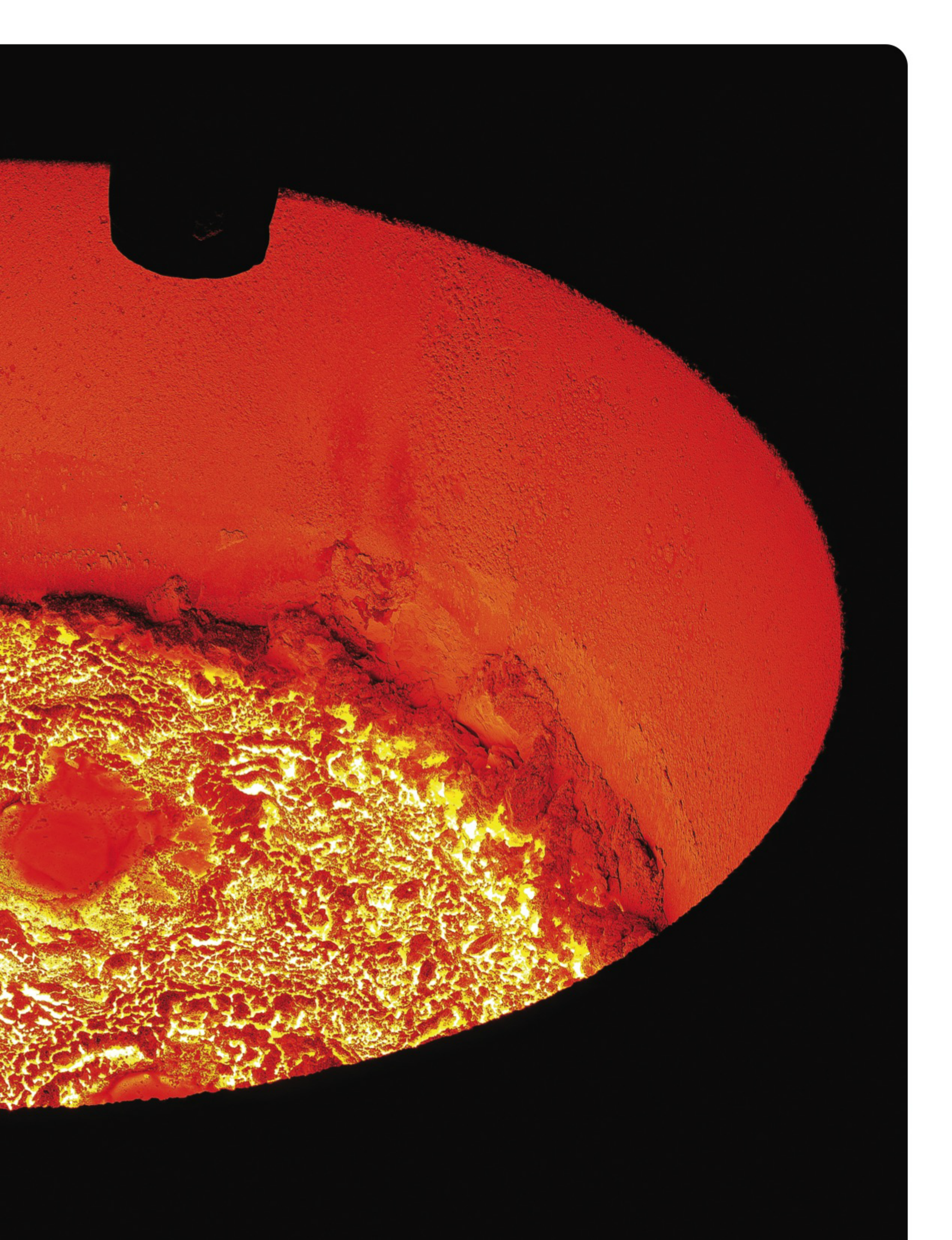
Pretreated melting apparatus for samples

# CHALLENGES FOR THE DEVELOPMENT OF STEEL INDUSTRIES

KRM, KR's affiliated company, has successfully developed a breakthrough product that can be another step towards advancement of iron/steel and refractory industry.

We have made high-grade fused magnesia clinker, fused alumina, and fused spinel by ourselves.







# CONSTANT

KRM, a specialized manufacturer of new iron/steel materials, has retained the only outstanding technology to domestically produce complete refractories in the country. KRM's technological advancement is an outcome of incessant challenges towards better future.



## KRM

New Iron /  
Steel Material Business



KRM, capable of making fused magnesia from seawater, has made it possible to get away from import-dependency on raw materials and optimize the quality of refractories with high-purity materials. In addition, KRM has succeeded in developing a new material of high-purity Mgo needed in high-tech electronics and superconductor technology, which could lead to home production and commercialization of Mgo Powder to coat electric steel sheet.

## Products

### Fused Products



White Fused MgO 99%



White Fused MgO 98%



White Fused Al2O3



Brown Fused Al2O3

※ Fused Spinel, Single Crystal MgO, and then some

### Powder product



Mgo for electric steel sheet

※ Flame retarding material,  
Activated Mgo, and then some.

### Unshaped refractory



Stamp for induction furnace

※ Electric furnace dry stamp,  
and then some.

Shaped refractories

Properties		Al2O3-SiC-C Brick		
		KR-TPA	KR-TPB	KR-CLA
Apparent Porosity (%)		7.5	6.8	7.2
Bulk Density (g/cm³)		2.95	2.97	2.95
Cold Crushing Strength (kg/cm²)		520	580	480
Chemical Analysis (%)	Al2O3	67.5	70.8	60.3
	SiC	10.5	10.6	7.8
	F.C	12.5	12.8	11.2
Application		Metal Line for TLC	Slag Line for TLC	Charging Ladle

Properties		MgO-C Brick				
		Converter			RH	
		MG-18AB	MG-18AP	MG-15BRS	KR-3RH	KR-7RH
Apparent Porosity (%)		2.9	3.0	3.9	3.4	3.2
Bulk Density (g/cm³)		2.97	2.96	2.95	3.15	3.10
Cold Crushing Strength (kg/cm²)		450	440	350	600	550
Chemical Analysis (%)	MgO	78.0	76.0	77.0	90.0	88.0
	F.C	17.2	17.0	15.0	3.2	7.2
Application		Barrel	Bottom Knuckle	Cone	Lower Part Snorkel	Upper Part Lower Part

Properties		MgO-C Brick					
		E.A.F		Ladle			
		ESM-20H	ESM-15H	LFS-15	LFS-8	LFF-12	LFP-10
Apparent Porosity (%)		5.0	5.0	5.0	5.0	5.0	7.0
Bulk Density (g/cm³)		2.95	2.92	2.95	2.97	2.85	2.80
Cold Crushing Strength (kg/cm²)		350	370	370	380	320	300
Chemical Analysis (%)	MgO	76.0	78.0	78.0	82.5	76.0	76.0
	F.C	18.0	15.0	15.0	8.2	12.0	10.0
Application		Hot Spot	Side Wall	Slag Line		Flange	Permanent

Properties		Al2O3-MgO-C Brick				
		Ladle			Tundish	
		LFL-8AC	LFL-8ACB	MAC-8	KR-IP	LFL-8ACT
Apparent Porosity (%)		7.0	7.0	5.0	6.0	8.0
Bulk Density (g/cm³)		3.10	3.15	3.10	3.15	3.10
Cold Crushing Strength (kg/cm²)		450	500	400	550	500
Chemical Analysis (%)	Al2O3	70.0	76.0	24.3	75.0	70.0
	MgO	15.0	12.0	59.2	13.0	15.0
	F.C	10.0	7.0	8.1	10.0	10.0
Application		Metal Line	Bottom	Boundary Line	Impact Pad	Wall

## Unshaped refractories

Properties		Items	Gunning Mass					
			Spray Mass			Shot Create		
			Gunnite-85	Gunnite-90S	SP-CV	SP-RH	SH-TLC	SH-TLA
Bulk Density (g/cm³)			2.20	2.30	2.04	2.40	2.70	2.80
Chemical Analysis (%)	MgO		85.0	90.0	83.0	89.0	-	6.0
	Al2O3		-	-	-	-	76.0	85.0
	CaO		1.8	1.3	1.0	1.5	-	-
	Fe2O3		1.2	1.1	-	-	-	-
	SiO2		-	-	5.2	5.5	-	-
	SiC		-	-	-	-	15.0	-
	CaO		-	-	2.9	-	-	-
Application			E.A.F (DBM)	E.A.F (Sea-water)	Converter	RH Snorkle	TLC	Teeming Ladle

Properties		Items	Stamp Mass			Coating Mass	
			Dolma-85KR	MgO-ST	KAS-85	ATD-M90	ATD-MD90
Tapping Density (g/cm <sup>3</sup> )			2.60	2.55	2.90	1.60	2.11
Chemical Analysis (%)		MgO	68.0	82.0	11.0	86.0	86.5
		SiO <sub>2</sub>	-	-	-	-	4.3
		Al <sub>2</sub> O <sub>3</sub>	-	-	88.0	-	-
		CaO	24.0	6.0	-	2.0	2.1
		Fe <sub>2</sub> O <sub>3</sub>	3.3	4.0	-	-	-
Application			E.A.F Bottom (Dolomite)	E.A.F Repair (MgO)	Induction Furnace	Tundish Wall (Slurry type)	Tundish Wall (Dry type)

Properties		Items	High Alumina Castable					SiC Castable
			MCR-95CT	MCR-85CT	HACT-180	HACT-170	HACT-160	SFC-60
Max. Limited Temp. (°C)			1,800°C	1,700°C	1,800°C	1,700°C	1,600°C	1,600°C
Bulk Density (g/cm <sup>3</sup> )			3.10	2.80	2.85	2.35	2.20	2.60
Chemical Analysis (%)		Al <sub>2</sub> O <sub>3</sub>	95.0	85.0	93.0	65.0	53.0	25.0
		SiO <sub>2</sub>	-	3.0	-	30.0	40.0	-
		SiC	-	-	-	-	-	60.0
Application			General Uses					Cement

Items Properties		Slip Casting Castable				
		LC-TLA	LC-LAB	Tunda-65	Tunda-65NC	MC-85RHA
Bulk Density (g/cm³)		3.10	3.10	2.60	2.70	3.10
Chemical Analysis (%)	Al2O3	88.0	95.0	65.0	74.0	92.0
	SiO2	-	-	30.0	20.0	-
	MgO	5.5	-	-	-	5.0
Application		Teeming Ladle	Ladle Bottom	Tundish	Tundish (Non-Cement)	RH Snorkle

Properties		Items	Special Casting Block				
			MORO-90	WB-90	TD-DAM	LANCE-CV	IMP-CLA
Cold Crushing Strength (kg/cm <sup>2</sup> )			800	500	600	500	350
Bulk Density (g/cm <sup>3</sup> )			3.10	3.00	2.50	2.85	2.40
Chemical Analysis (%)		Al <sub>2</sub> O <sub>3</sub>	90.0	90.0	65.0	87.0	60.0
		SiO <sub>2</sub>	-	-	30.0	7.0	25.0
		MgO	3.0	4.0	-	-	-
		SiC	-	-	-	-	10.0
Application			E.A.F Roof	P/P W/B	Tundish Dam	Converter Lance	Charging L/D Impeller

Properties		Items	Mortar			Blast Furnace Trough		
			MM-1	AM-17S	Ultra-3000	Trough-M	Trough-T	Trough-S
Chemical Analysis (%)		Al <sub>2</sub> O <sub>3</sub>	-	95.0	48.0	72.0	78.0	53.0
		SiO <sub>2</sub>	-	-	-	3.0	-	2.0
		MgO	97.0	-	-	-	5.0	-
		SiC	-	-	-	17.0	9.0	35.0
		Fe <sub>2</sub> O <sub>3</sub>	-	-	1.8	-	-	-
Application			MgO-C Brick	AMC Brick	Sealing	Main Trough	Tilting Trough	Slag Trough

※ For other detailed technical information than the above items, see a website online.

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