

Shotcrete Refractories for Blast Furnace

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Abstract

Dry type gunning material was used in 1990s for blast furnace wall hot-repair, but wet-type gunning material (shot cast) is widely used nowadays due to less rebound loss which leads to less influence on slag and longer life of furnace.

Chosun Refractories used to apply two different wet-type gunning materials (cement bonding, colloidal silica sol bonding) to meet the customers' need, but recently we started using newly developed wet-type colloidal silica sol bond hot-repair material that has much less rebound loss, high anti-explosive and thermal spallingness.

Due to larger size of modern blast furnaces, there has been a high demand for high abrasion resistance material which led Chosun Refractories to develop several types of materials for shaft and bosh to achieve longer life of each area and now we are in a development stage for furnace life monitoring system.

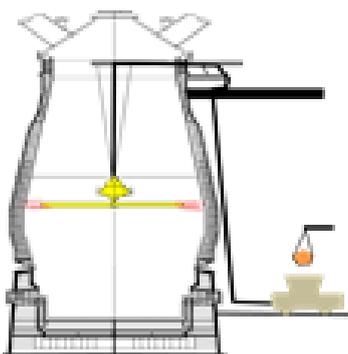
It should be emphasized that installation of the material is as equally important as the material itself. Chosun Refractories has successfully developed a shot cast machine and automatic installation system to accommodate the biggest blast furnace in the world (6,000 m³) and has more than 7,000 tons of installation reference worldwide.

Blast Furnace Body Repairing

Repairing methods

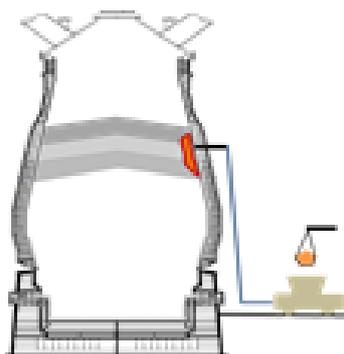
1. Shotcrete Repairing

- Suitable for large area repair
- High repairing efficiency
- Hot state repairing
- Using large equipment
- Long repairing time
- Longer time to recover to normal furnace condition



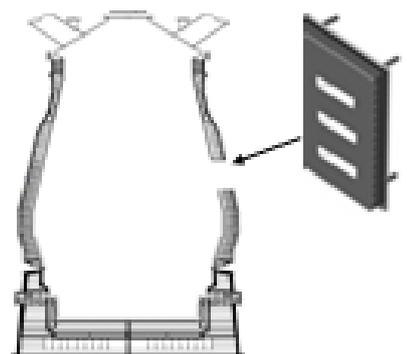
2. Injection Repair

- Selective small area repair
- Lower repairing efficiency than shotcrete
- Hot state repairing
- Small equipment
- Short repair time
- Short time to recover to normal furnace condition



3. Pre-Cast Panel Repair

- Selective small area repair
- Short repair time
- High repairing efficiency
- Weak on panel connecting area
- Longer time to recover to normal furnace condition



Shotcrete Repair System

1. Repair Material

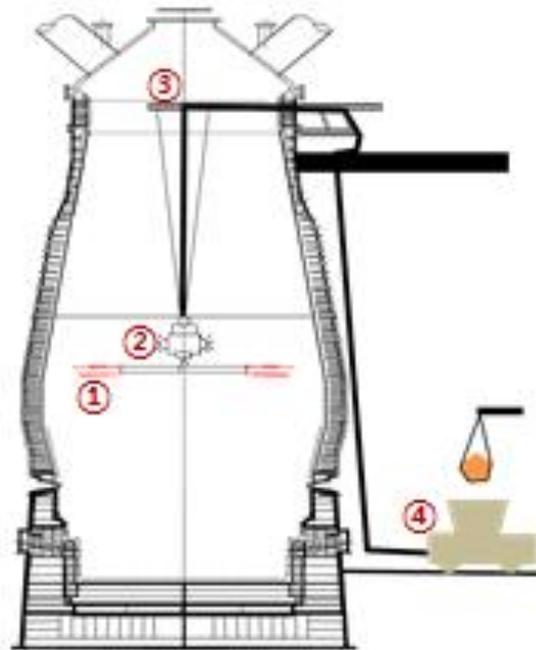
- Colloidal Silica Sol Bond
- $Al_2O_3-SiO_2$ / Al_2O_3-SiC

2. POD & Pipe

- POD
 - Connection between Leading-In-Pipe
 - Light & Camera installed
- Pipe & Nozzle
 - Material transport and spray
 - 360° Spray repair



Chosun Refractories Total Refractory Management



3. Boom Crane

- Utility Line (Air, hydraulic, Electricity) connect & support
- POD vertical movement



4. Mixer & Pump

- Mixing Repair material & Silica Sol
- Pumping repair material



Repair Material Characteristics

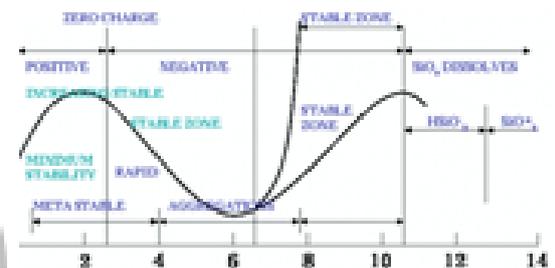
Product	ISC-A605	ISC-ASC605
Al_2O_3 (%)	61	47
Main Material	Mullite Alumina	Mullite SiC
Sol (%)	18	18
H.C.S @ 1200°C (kg/m ²)	1,271	1,189
Rebound loss (%)	10~15	7~10

- Apply Low Fe_2O_3 Mullite aggregate
- Silica Sol Bond
- High anti-erosion
- High resistance against CO Gas
- High adhesion



► Silica Sol Hardening Mechanism

1. Normal temperature : pH control (inorganic or organic acid addition)

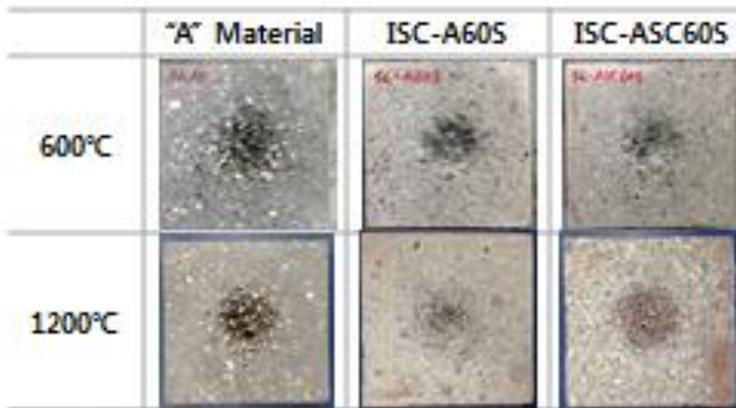
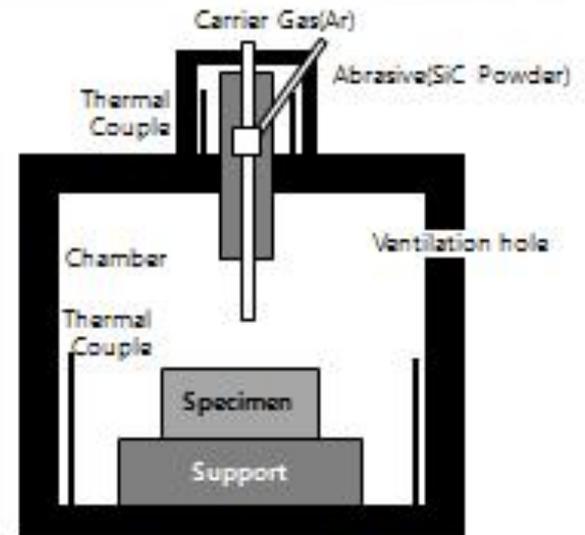
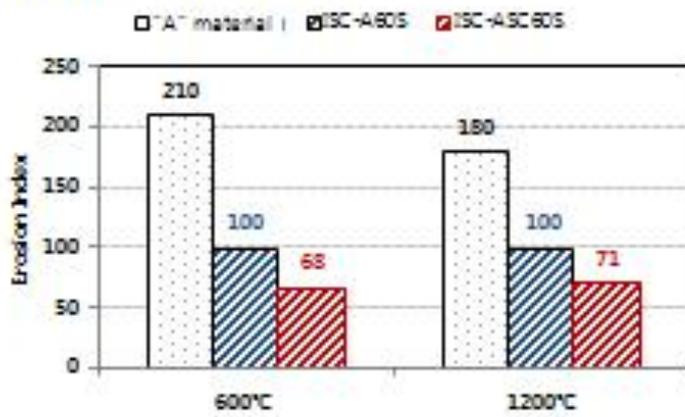


2. Hot temperature

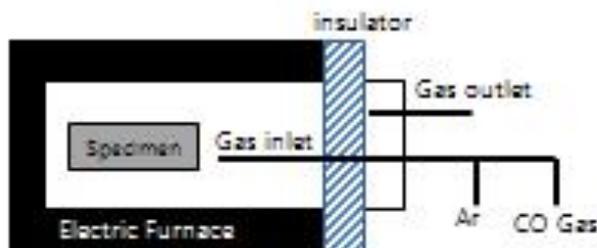
- 150°C : hardening
- 300~400°C : increase binding strength
- 1200°C : High strength pallet forming



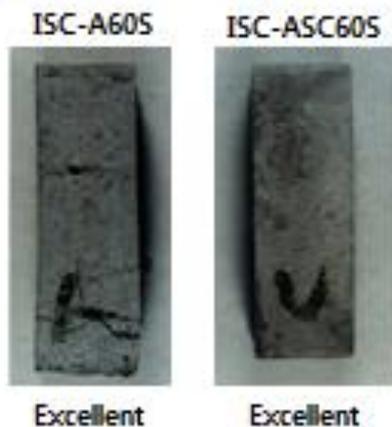
► Hot-state Erosion Test



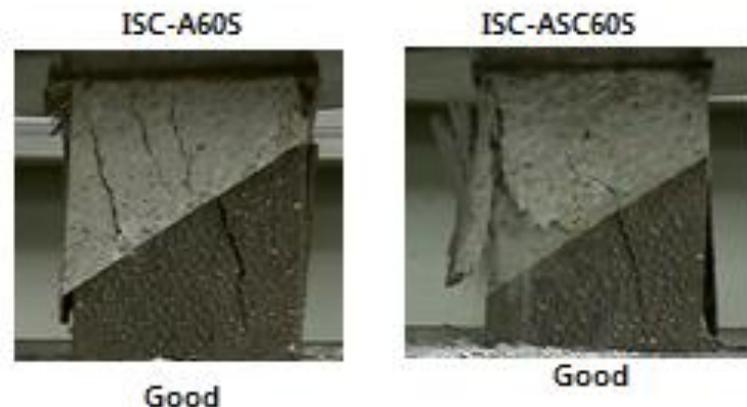
► Resistance Test against CO Gas



- Heating rate: 5°C/min
- 500°C ± 5°C x 200Hr in 2l/Hr of CO Gas



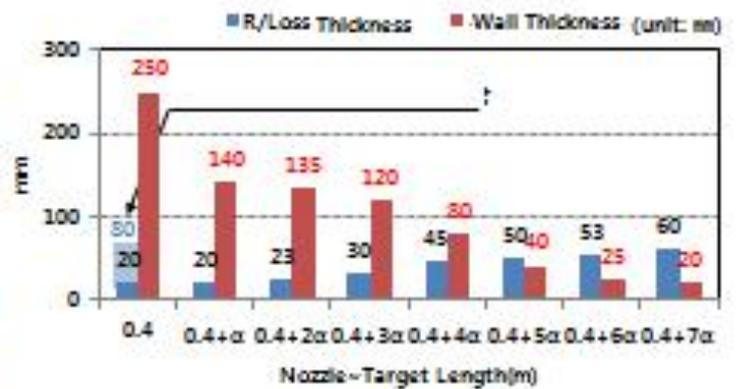
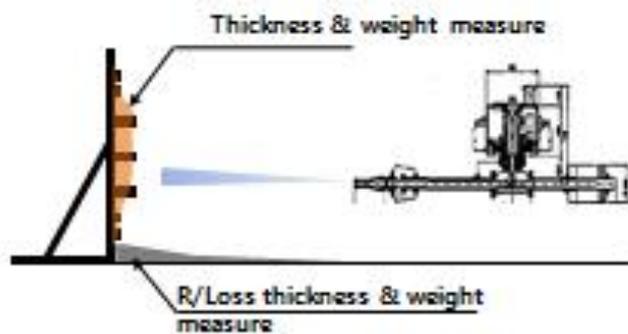
► SiC Brick Adhesion Test



► Simulation Test

- Rebound loss & optimum shooting length test

Method : ISC-ASC605



● Material Specification

Brand Name		ISC-A605		ISC-ASC705		ISC-ASC605	
		SPEC.	QUAL.	SPEC.	QUAL.	SPEC.	QUAL.
Chemical composition (%)	Al ₂ O ₃	55 ≤	60.6	60 ≤	66.4	60 ≥	47.3
	SiO ₂	30 ≤	36.8	-	9.2	-	23.7
	Fe ₂ O ₃	-	0.7	-	0.7	-	0.7
	SiC	-	-	15 ≤	20.0	18 ≤	24.9
Bulk Density	110°CX24Hrs	-	2.28	-	2.93	-	2.50
	1200°CX3Hrs	-	2.20	-	2.89	-	2.43
Cold Crushed Strength(kg/cm ²)	110°CX24Hrs	100 ≤	203	100 ≤	391	100 ≤	349
	1200°CX3Hrs	1000 ≤	1271	800 ≤	1235	800 ≤	1189
Linear Change (%)	110°CX24Hrs	-	-0.09	-	-0.10	-	-0.07
	1200°CX3Hrs	-1.0 ≤	+0.37	-	0.14	-	0.35
CO Gas Resistance	500°CX200Hrs	Excellent		Excellent		Excellent	
Application Area		Shaft, Belly		Belly, Bosh		Shaft, Belly	

Repair Equipment Characteristics

● POD / Pipe / Boom Crane

▶ Large Area Spray Capability

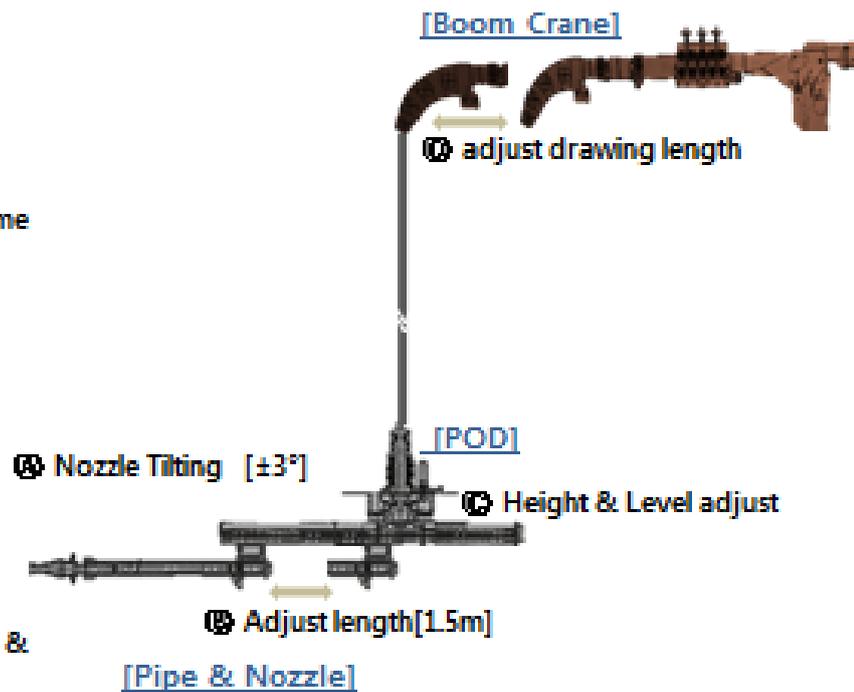
- Small BF to Bigger BF(6,000m³) Repair
- Below Belly to upper BF even Finex Dome repair

▶ Minimize Rebound Loss

- Optimum shot length finding
- Maximize Mixture & sintering agent

▶ Real-time Repair Quality Checking

- Real-time Spray repair & area checking & Monitoring



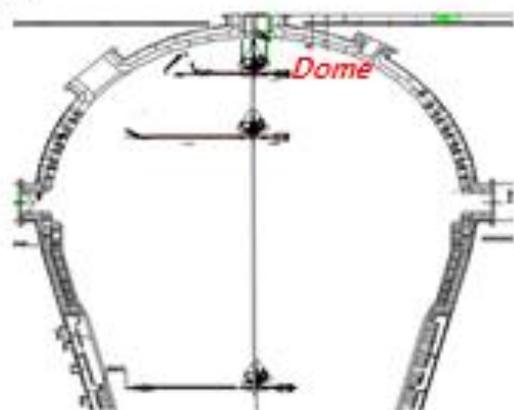
▶ 5,500m³ BF

- Bending & adaptable type



▶ Finex Dome

- Slop type



● Real-time monitoring System

- ▶ Monitoring with high resolution Camera



● Mixing & Pumping Equipment

▶ Maximize quantity and quality

- Mixing Capacity : 13~15ton/Hr
- Pumping capacity : 80m(Vertical), 150m(Horizontal)
- Mass quantity repair (48Hrs≤ Continuous repair)

▶ High durability

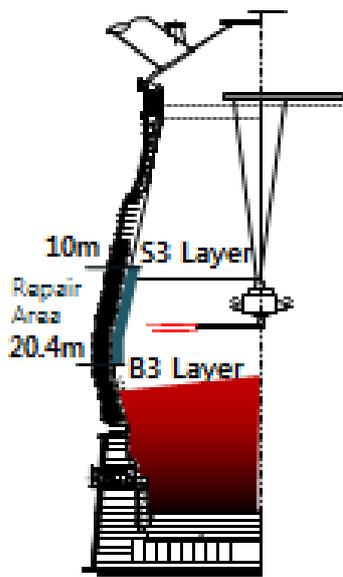
- Fine mixture of Silica Sol + Castable
- High durable Line Part

▶ Specification

- Size : 2,200(W) X 4,000(L) X 2,370(H)
- Power : AC 3Φ 440V X 60Hz
- Pressure : 144Bar



Shotcrete Repair Procedure



BF	3,950m ³ BF	
Repair quantity	180ton	
Repair Area	B3~S3 Layer	
Procedure	Procedure	Hour
	Stop BF blowing	4Hr
	M/H open	2Hr
	Install equipment	3Hr
	BF wall Cleaning	
	Shotcrete	18Hr
	Remove equipment	1Hr
Total	28Hr	
Capacity	10ton/Hr	
Rebound Loss(%)	10	



After wall Cleaning



Shotcrete

Shotcrete Reference

● Reference

1995~2015년					
Time	Inner Volume	# of BFs	# of Repair	Quantity (ton)	remark
1995~2005	1,000~3,000 m ³	2	14	329	Dry type (Cement Bond)
	3,000~4,000 m ³	6	40	3,294	
2005~2015	1,000~2,000 m ³	3	31	1,839	Wet type (Silica Sol Bond)
	2,000~3,000 m ³	2	16	1,055	
	3,000~4,000 m ³	5	19	2,967	
	4,000~5,000 m ³	3	14	1,917	
	5,000 m ³ ≤	2	2	188	