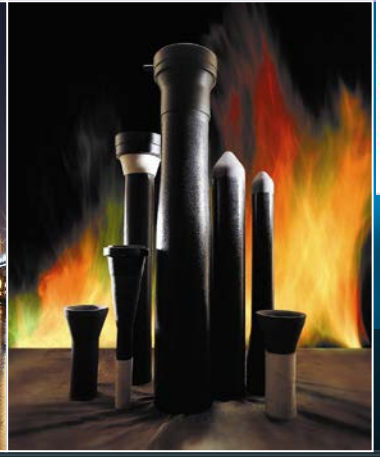
PR Brochure



Innovation for the Global Customers

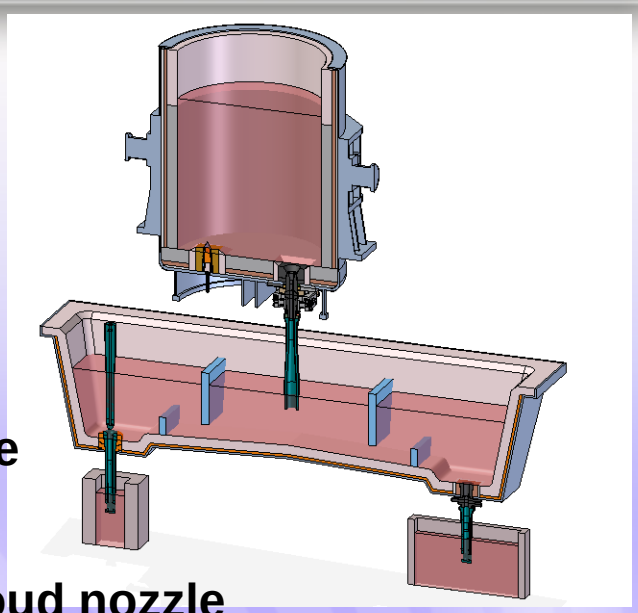
Keep your pride with "Chosun Refractories"

Refractories for Steel Making

Contents

Contents

Refractories for Continuous Casting



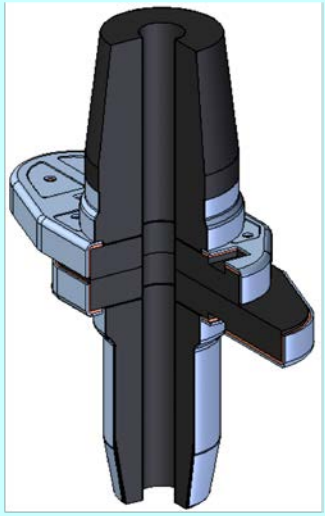
1. Ladle slide gate
2. Ladle shroud nozzle
3. Mono block stopper
4. T/D Slide gate
5. Submerged entry nozzle

1 Ladle slide gate

The slide gate refractories should be equipped with suitable designed feature, machinery precision durability and being subjected to severe operating conditions such as thermal shock and abrasion. In addition, it can control the pouring rate of molten steel to guarantee the safe operation.

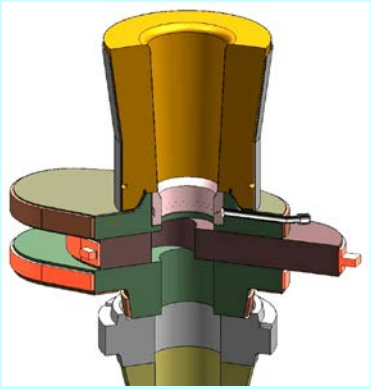
- Higher productivity.
- Energy saving.
- Better quality.
- Safety with reduced cost.

Ladle Sliding gate plate



- o Materials have high resistance to erosion oxidation and spalling
- o Cracks are prevented by the hot banding of thicks steel around the plate
- o Cracks and oxidation are prevented by the metal case of thicks steel around the nozzle

Tundish Sliding gate plate



- o Materials have high resistance to erosion oxidation and spalling
- o Cracks are prevented by the hot banding of thicks steel around the plate
- o Porous upper nozzle have small and uniform pores for prevented clogging

The type of sliding gate plate

Plate for generial ladle

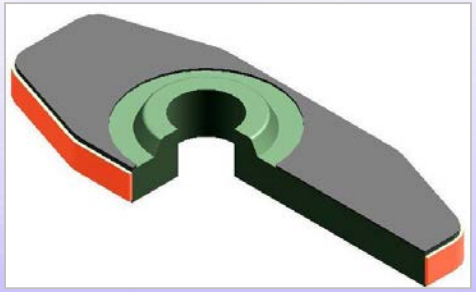


Plate for Closed Start

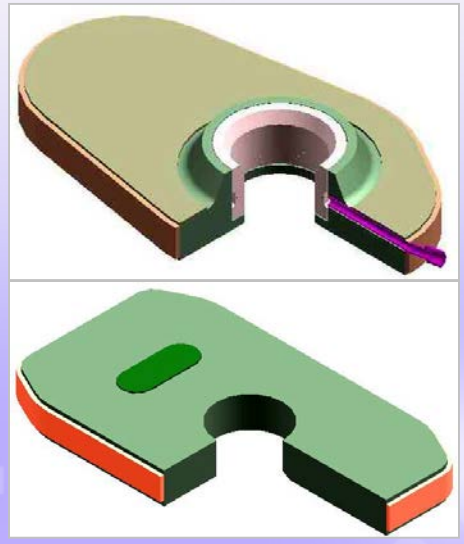
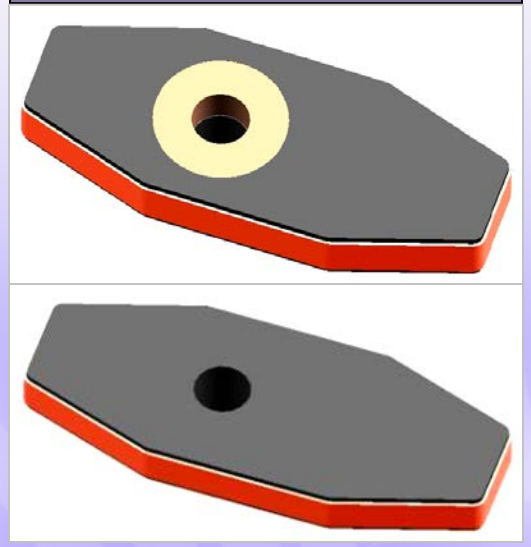
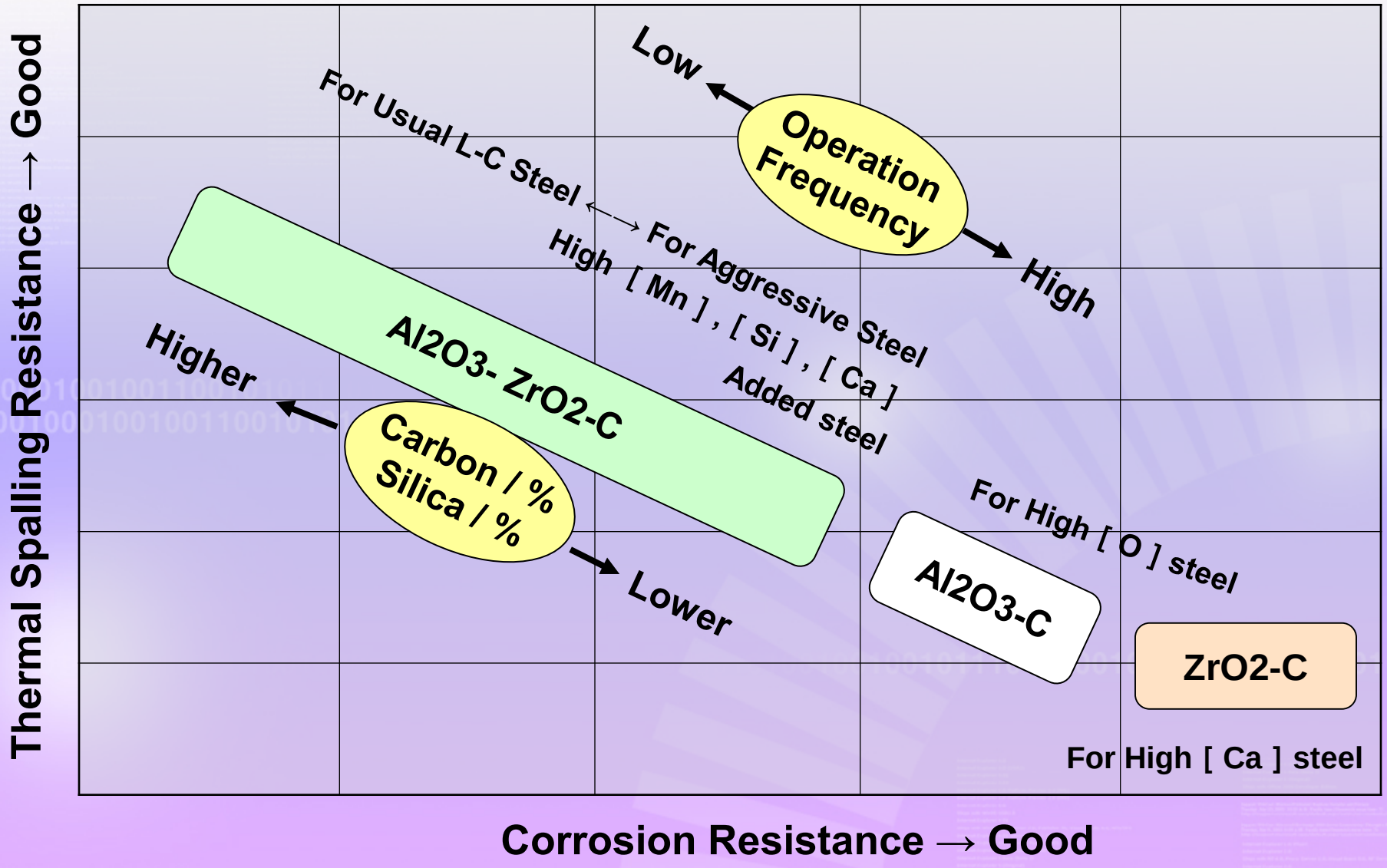


Plate for Special Steel

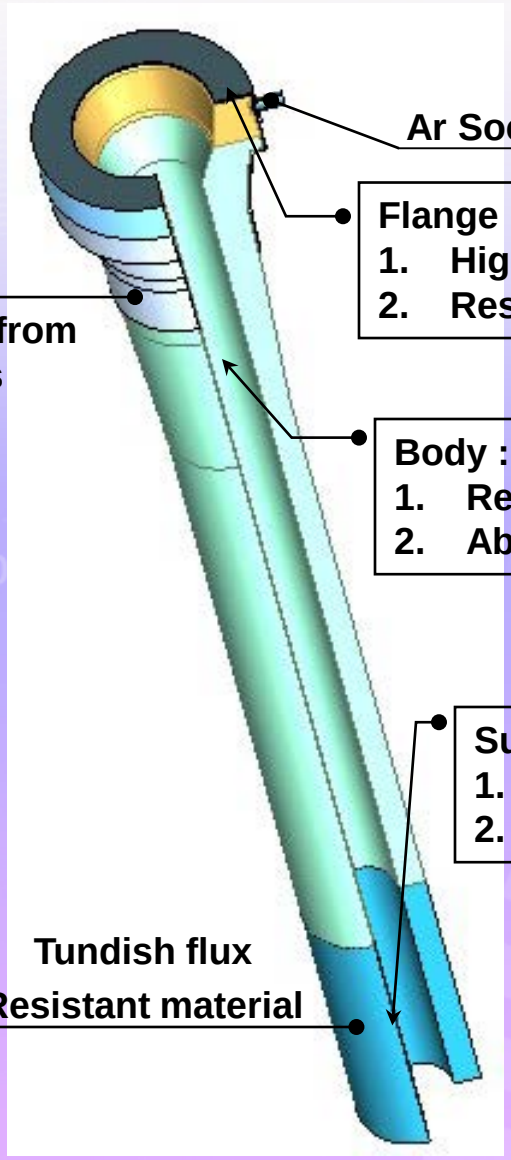


Technology	Plate for generial ladle	Plate for Closed Start	Plate for Special Steel
Application	Generial ladle & tundish	Tundish	Special ladle & tundish
Material base	Al2O3-ZrO2-C Al2O3-C	Al2O3-C Al2O3-ZrO2-C	Al2O3-C one body MgO-C insert ZrO2 insert
Argon blowing	-	Upper & Middle	-
Life (ch)	5~10	5~15	4~8

The map of material for sliding plate



2 Ladle shroud



Ar Socket : Air sealing by Ar gas

Flange :
1. High strength
2. Resistance to oxydation

Metallic Can :
Protect neck part from mechanical stress

Body :
1. Resistance to thermal shock
2. Abrasion resistance to moltel steel stream

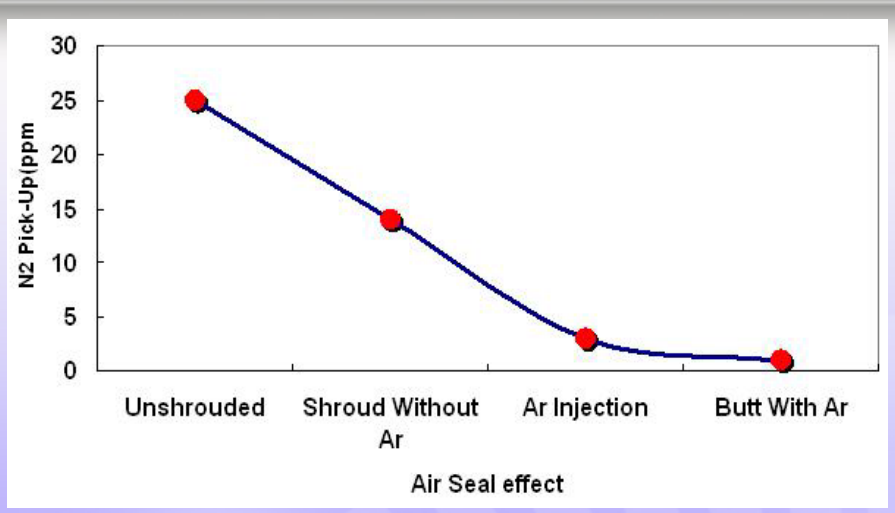
Submerged part :
1. Resistance to thermal shock
2. Corrosion resistance to slag

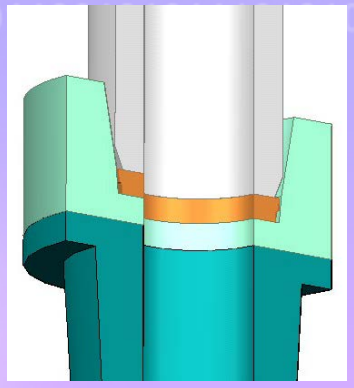
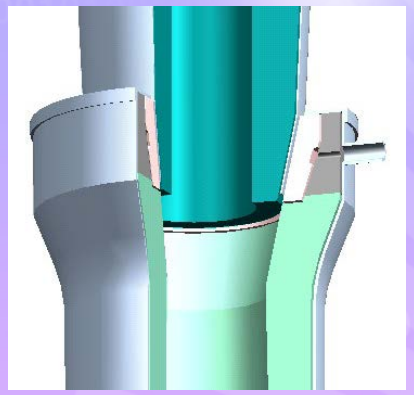
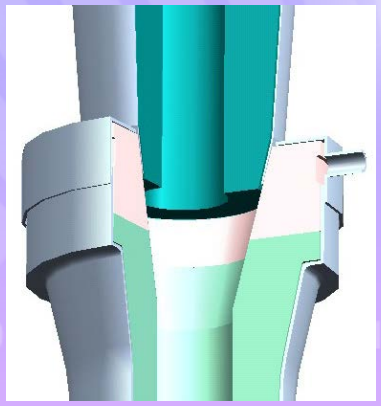
Tundish flux Resistant material

Air sealing at Ladle shroud

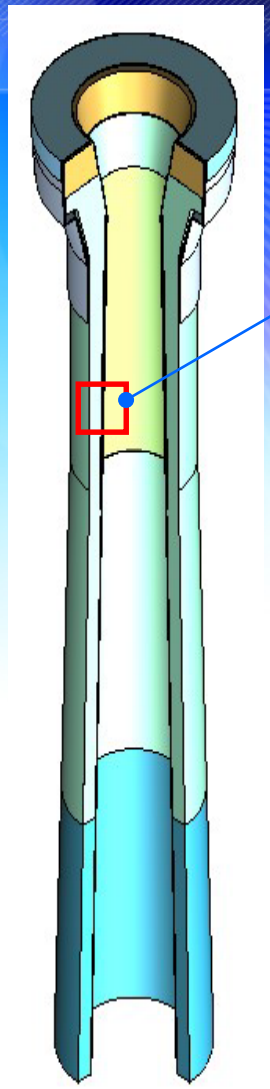
About air sealing at the ladle shroud,The right side chart shows how much you can reduce N2 pick up into steel.

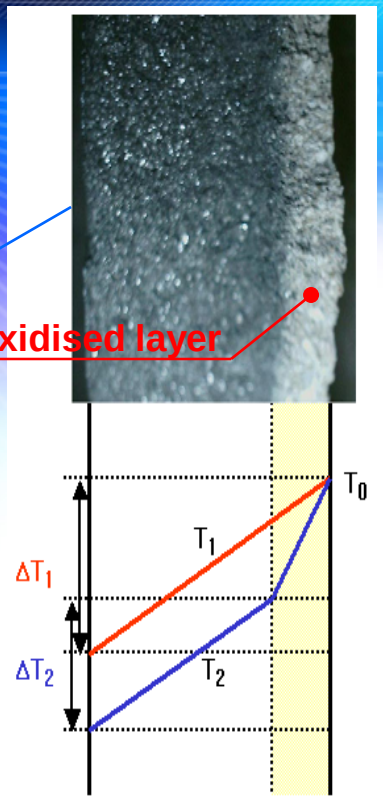
Chosun offers several kinds of ladle shroud as a countermeasure of air infiltration.



	Butt-type	Porous-type	Metal Slit-type
Profile			
Sealing method	- Non-Ar (or Extra Tool) - Required high device pressure	- Injection Ar gas through porous part	- Injection Ar gas through the gap between shroud and metal can

High thermal shock resistance ladle shroud



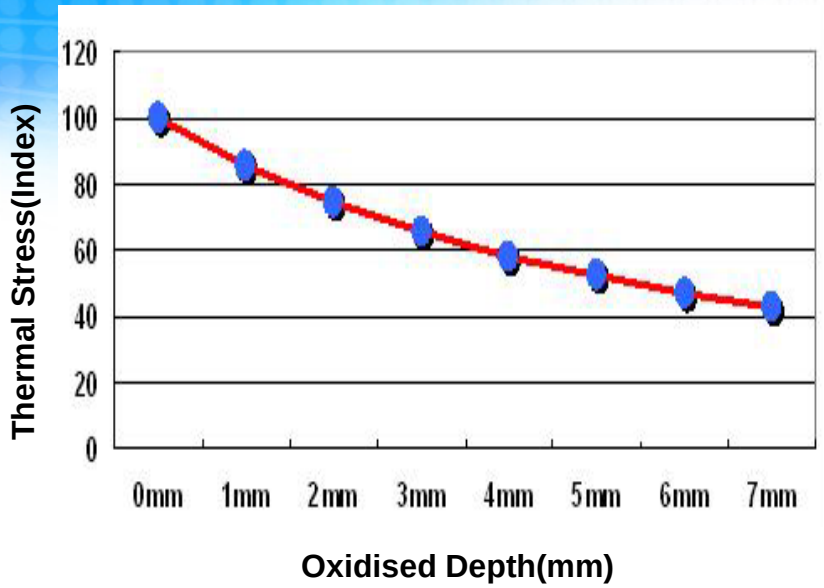


$\Delta T_1 \gg \Delta T_2$

ΔT_1 : Without oxidized layer

ΔT_2 : With oxidized layer

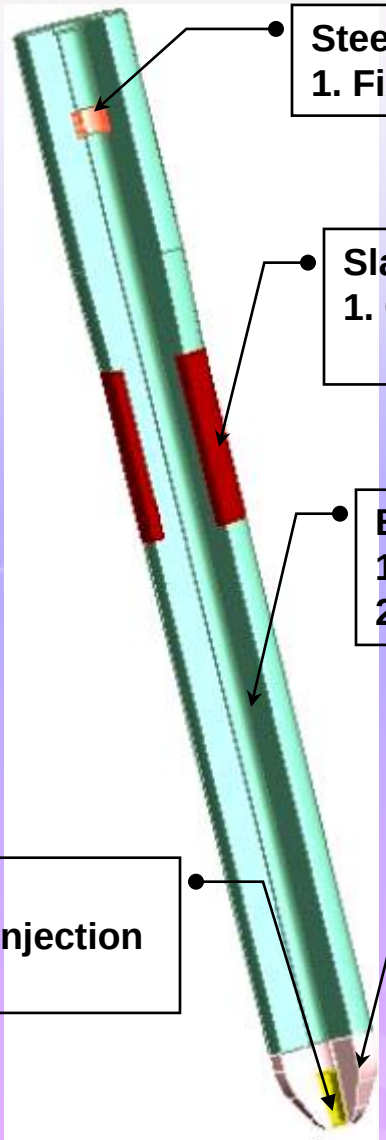
《Effect of oxidized layer in boreside 》



When the ladle shroud is used without preheating, High thermal shock resistance of ladle shroud is needed.

CHOSUN ladle shroud which has oxidized layer in bore side can reduce thermal stress up to 40% in starting of pouring steel stream

3 Mono Block Stopper



Steel nut :
1. Fixed with device tightly

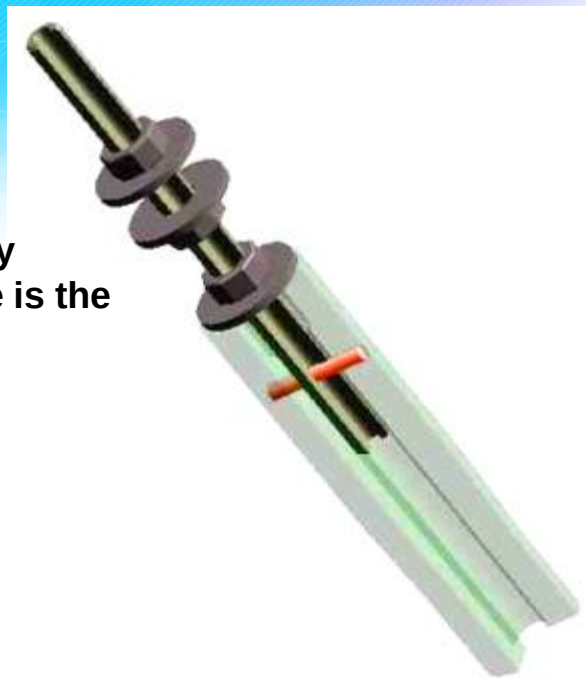
Slag Line
1. Corrosion resistance to tundish flux

Body :
1. High strength
2. Thermal shock resistance

Ar injection part:
1. Guarantee steady Ar injection rate

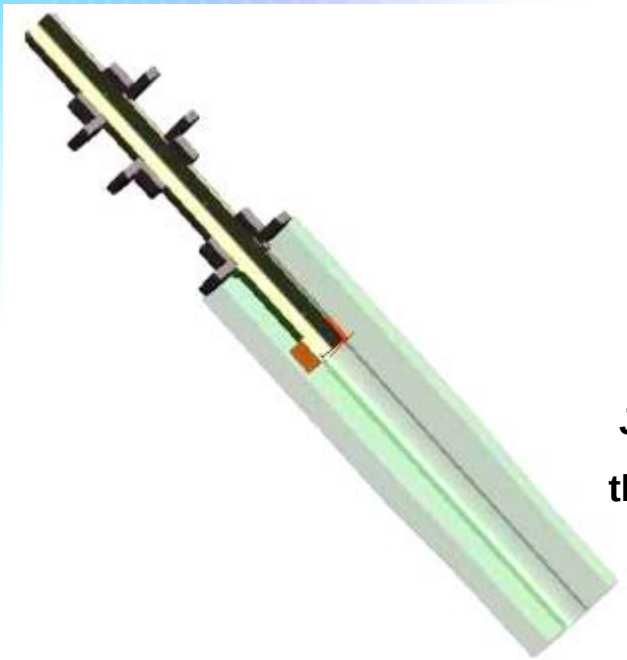
Nose
1. Abrasion and corrosion resistance to molten steel stream
2. Anti-clogging material
3. Special AlN containing material for free cutting steel

Join method between device and stopper



Join by pin :

the simple method with a pin placed transversely through both components, and secondary there is the screw-on method with a refractory thread.



Join by nut :

the screw-on method with a refractory thread.

4 Porous upper nozzle

To suppress nozzle clogging, by non-metallic inclusions, upper nozzle is equipped proper air-permeability by control of particle size distribution and pore size.

CHOSUN offers upper nozzle which is a high-purity composition with very fine uniform pores.

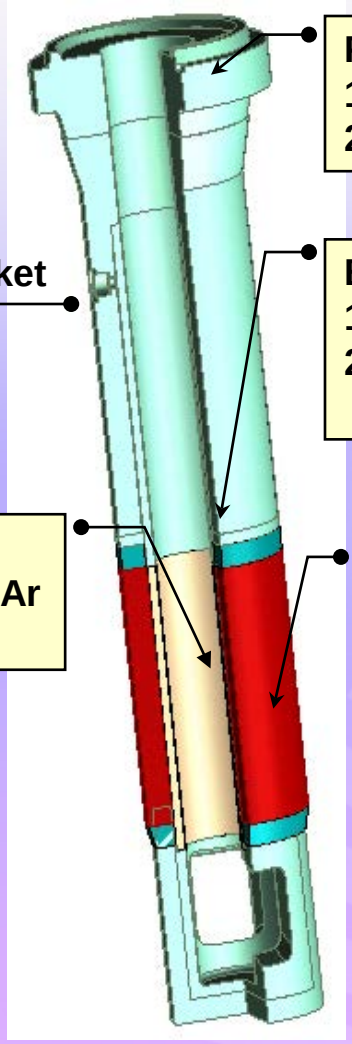
- Uniform permeability and porosity diameter
- Non-clogging and Non-gas leakage
- Better quality.

Concept

- **Materials**
  - -. Non-Clogging
    (Al2O3, Mullite, Al2O3-ZrO2 material)
  - -. Fine from large to porosity diameter
    (7~40㎛)
- **Structure**
  - -. Argon blowing Structure
    (Groove, Slit)
  - -. Non-gas leakage
    (Sealing and coating material)
  - -. Non-porous type (Channel)

Type

5 Submerged Entry Nozzle



Flange :
1. High strength
2. Resistance to oxydation

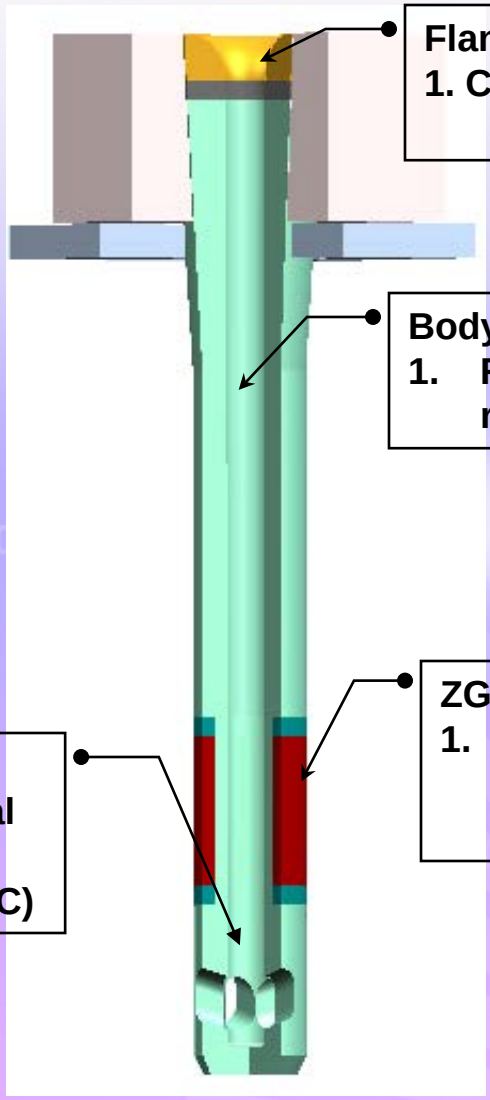
Ar Socket

Body :
1. Resistance to thermal shock
2. Abrasion resistance to moltel steel stream

Bore
1.Porous material is arrayed for Ar gas injection.

ZG Band :
1. Corrosion resistance to mold powder
   -.ZrO2 75% , 79% & 82% grade

5 Submerged Entry Nozzle



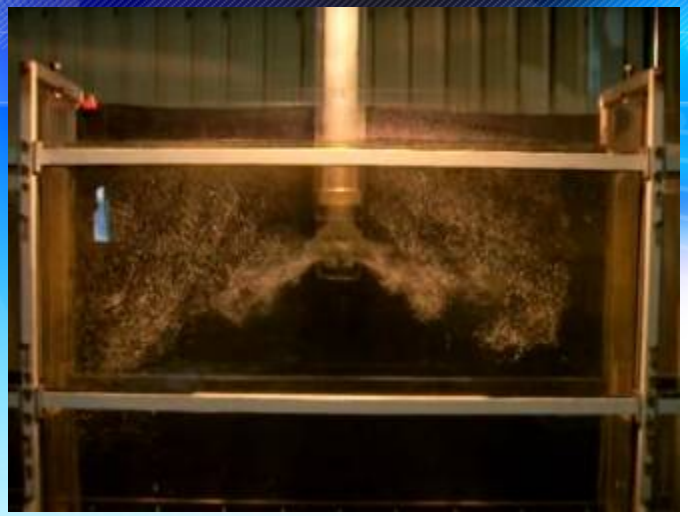
Flange :
1. Corrosion & abrasion resistnace to molten steel stream

Body :
1. Resistance to thermal shock resistance

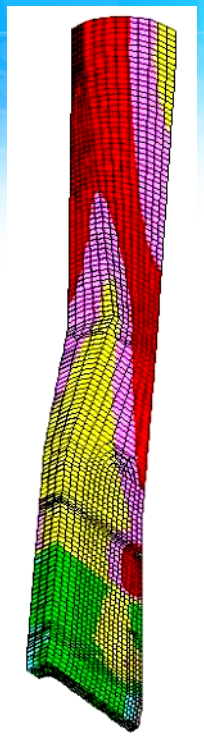
ZG Band :
1. Corrosion resistance to mold powder
   -.ZrO2 75% , 79% & 82% grade

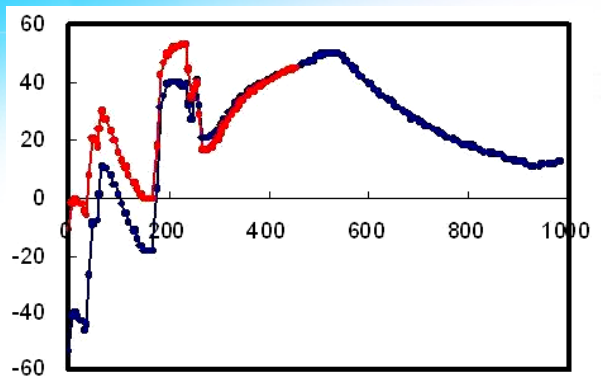
Bore & outlet part liner :
1. Array anti-clogging material
   -. Carbonless (Al2O3-MgO)
   -. Self cleaning (CaO-ZrO2-C)

Tools for robust design



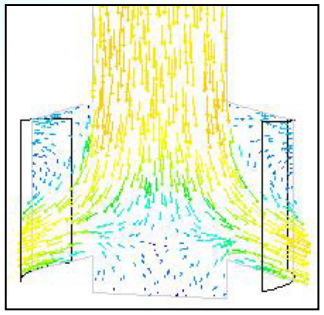
【Water model】

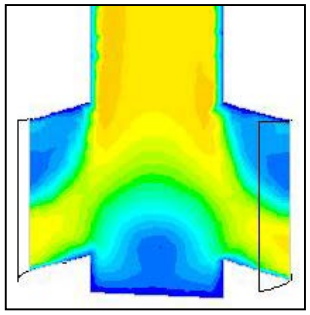




example of simulation result

【3-D FEM】



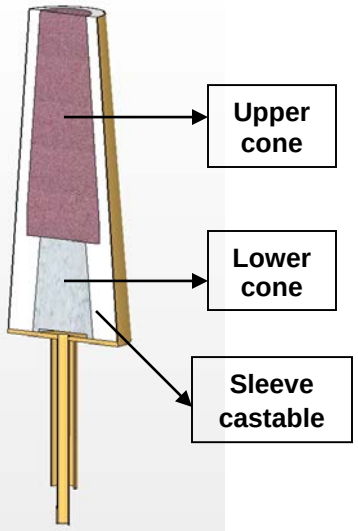


【3D-FLOW】

CHOSUN design expertise combined with finite elements methods ,water model and 3D-flow assure the security of operation

Purging Plug

Product characteristics

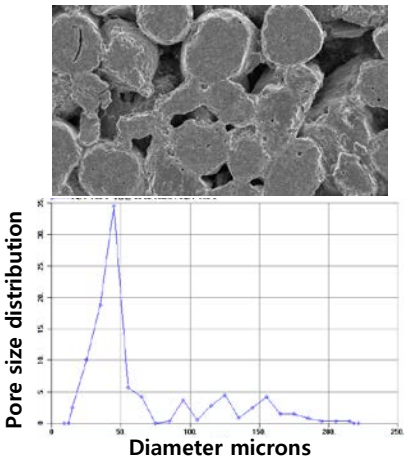


- High life time
- Good gas purging
- High infiltration resistance
- High wear resistance
- Safety design

Product test

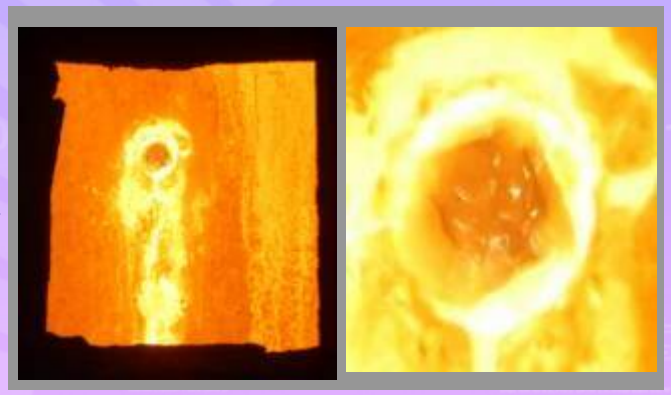
· Water model test

· Pore size distribution



Use of porous plug

L/D capacity	Life time (ch)	Height (mm)
150ton	40	430
120ton	40	430
100ton	30	370
80ton	20	265



LADLE SHROUD OPERATING CONDITION (2010)

No.	Customer-CCM		Ladle (ton)	Strand	Casting time (min/heat)	Life (heat)	Remarks
KOREA	POSCO	1	100	1	45~55	5.7	
		2	100	4	40~55	6.8	
		3	100	6	45~55	5.5	
		4	250	2	45~55	6.3	
		5	250	2*2	45~55	5.5	
		6	90	1	50~55	6.3	
		7	95	1	50	4.3	
		8	90	1	50~60	6.8	
		9	250	4*2	40~50	5	
		10	250	4*2	40~50	5	
	HYUNDAI	1	80	5	55~60	20	
		2	100	3	50~60	20	
		3	120	6	50~60	20	
	POSCO SS	1	30	1	50~60	3	
		2	100	6	50~60	6	
	SeAH	1	90	3	40~55	12	
		2	90	2	40~55	15	
INDONESIA	KRAKATAU STEEL						

SEN OPERATING CONDITION-1 (2010)

No.	Customer-CCM		Ladle (ton)	Strand	Casting time (min/heat)	Life (heat)	Remarks
KOREA	POSCO	1	100	1	45~55	5.6	
		2	100	4	45~55	6.8	
		3	100	6	45~55	5.5	
		4	250	2	45~55	8	
		5	250	2	45~55	5	
		6	250	2*2	45~55	5.7	
		7	90	1	50~55	6.3	
		8	95	1	50	4.3	
		9	90	1	50~60	6.8	
		10	290	2	40~50	5.5	
		11	290	2	40~50	5.5	
		12	290	2	33~36	5.5	
		13	290	2	33~36	5.8	
		14	290	2	33~36	5.7	
		15	290	2	40~50	5.7	
		16	290	2	40~50	5.7	
		17	290	2	40~50	5.7	
		18	100	1	30	20	

SEN OPERATING CONDITION-2 (2010)

No.	Customer-CCM		Ladle (ton)	Strand	Casting time (min/heat)	Life (heat)	Remarks
KOREA	HYUNDAI	1	80	5	55~60	20~25	
		2	100	3	50~60	20~25	
		3	120	6	60	20~25	
	POSCO SS	1	30	1	50~60	3	
		2	100	6	50~60	6	
	SeAH	1	90	3	40~55	12	
		2	90	2	40~55	15	
INDONESIA	KRAKATAU STEEL	1	120	1	50-60	6	

STOPPER OPERATING CONDITION (2010)

	Customer-CCM		Ladle (ton)	Strand	Casting time (min/heat)	Life (heat)	Remarks
KOREA	POSCO	1	100	1	45~55	5.6	
		2	100	4	45~55	6.8	
		3	90	1	50~55	6.3	
		4	250	2	45~55	8	
		5	250	2	45~55	5	
		6	250	2	40~50	5.5	
		7	140	1	40~50	15	
	HYUNDAI	1	100	3	50~60	20~25	
		2	120	6	60	20~25	
	POSCO SS	1	30	1	50~60	3~6	
		2	100	6	50~60	8~12	
	SeAH	1	90	3	40~55	8~13	
INDONESIA	KRAKATAU STEEL		120	1	50~60	7	
RUSSIA	NLMK		155	1	40~45	7	

Supply list of Slide gate

	Work		Ladle Capa.(Ton)	Stroke(mm)	Dia(mm)	Casting time (min)	Remark
KOREA	POSCO	1	100	200	60	50~55	
		2	300	230	90	45~55	
		3	100	200	55	50~55	
		4	100	200	55	50~55	
		5	100	200	55	50~55	
		6	120	200	60	40~55	
		7	250	230	85	40~55	
		8	250	230	85	40~55	
	HYUNDAI	1	75, 80	150	40	50~60	
		2	100	200	52	50~70	
		3	120	200	55	50~65	
		4	50, 60, 80, 90	150	35~40	35~55	
		5	120	200	55	45~55	
		6	150	175	55	45~55	
	YK Steel	1	30	120	29.5	50~65	
		2	70	180	40	50~55	
	POSCO SS	1	30	150	50	60~90	
		2	100	150	55	45~60	
	DONGKUK	1	100	160	50	45~55	
		2	140	200	55	45~55	
	KISCO	1	120	160	55	50~55	
	SeAH	1	60	125	55	45~55	

Supply list of Top & Collector Nozzle

	Work		Ladle Capa. (Ton)	Stroke(mm)	Dia(mm)	Casting time (min)	Remark
KOREA	POSCO	1	100	200	60	50~55	
		2	300	230	90	45~55	
		3	100	200	55	50~55	
		4	100	200	55	50~55	
		5	100	200	55	50~55	
		6	120	200	60	40~55	
		7	250	230	85	40~55	
		8	250	230	85	40~55	
	HYUNDAI	1	75, 80	150	40	50~60	
		2	100	200	52	50~70	
		3	120	200	55	50~65	
		4	50, 60, 80, 90	150	35~40	35~55	
		5	120	200	55	45~55	
		6	150	175	55	45~55	
	YK Steel	1	30	120	29.5	50~65	
		2	70	180	40	50~55	
	POSCO SS		30	150	50	60~90	
			100	150	55	45~60	
	DONGKUK		100	160	50	45~55	
			140	200	55	45~55	
	KISCO		120	160	55	50~55	
	SeAH		60	125	55	45~55	

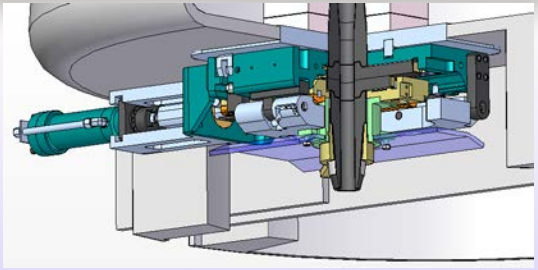
Contents

- Refractories for Steel Making Process
- **Flow control system for Steel Making Process**
- Countermeasure against Working Condition

1 Ladle slide gate (EG-200 Type)

EG Gate Characteristic

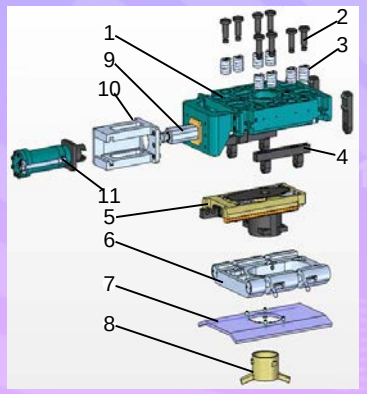
- Easy Operation System
  - ▪ Simple and easy assembly for refractories
  - -. Auto tensioning system
    - : No jig & tools required
  - ▪ One touch SN plate clamping
  - ▪ Stop position adjustment of top nozzle
- Simple Mechanism
  - ▪ Low maintenance cost
  - ▪ Foolproof installation & assembly
- Robust Structure Design
  - ▪ Increasing LSG life time
- Optimized Refractory
  - ▪ New shape plate designed to avoid crack



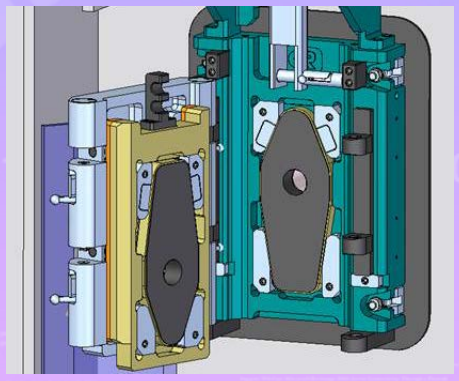
<Auto tensioning system>

Specification

- **Nozzle Dia. : Max. Ø80mm**
- **Sliding stroke : 200mm >**
- **Size : 995(L)x570(W)x310(H)**
- **Weight : approx. 650kg**
- **Face pressure : 7,500kg**



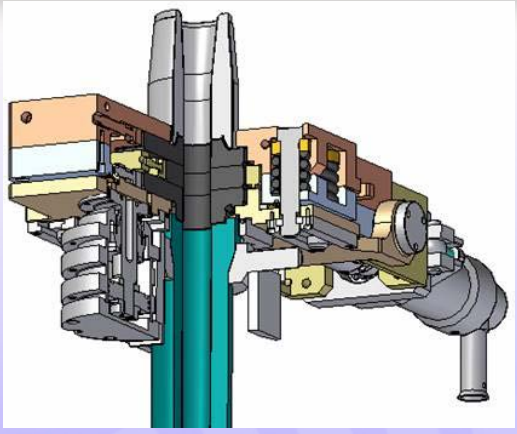
<Simple Mechanism>



<One touch SN clamping>

2 Tundish slide gate (Air Tight System)

The ATC Tundish slide gate system was designed for air tight mechanism to avoid air aspiration.

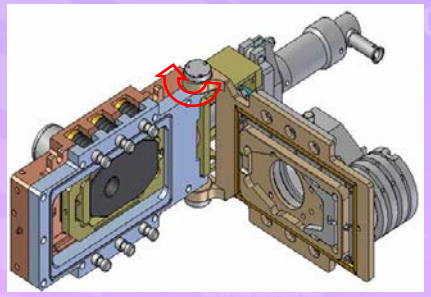


ATC System Characteristic

- Air Tight Mechanism : Increased slab quality
  - Air tight housing
  - Sealed driving rod
- SEN is directly connecting to the lower plate
- Simple mechanism : Reduced maintenance cost
- Auto tensioning system with hydraulic jack on the maintenance deck.
- Easy attachable & detachable hydraulic actuator with position transducer for flow control
- Backlash-free connection between cylinder and slider

Specification

- Bore diameter. : Max. Ø90 mm
- Throttling stroke : 120 mm
- Face pressure : 3,000 kgf
- Size : 580(W)x1139(L)x179(H)
- Weight : approx. 350kg1



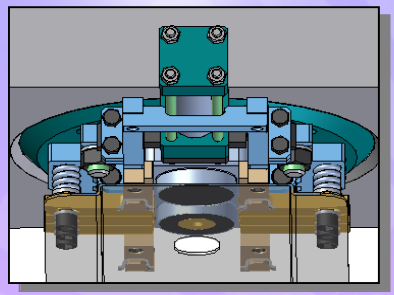
3 Tundish nozzle changer for BB/BT casting - ONQ

The ONQC system was developed to exchange tundish nozzle without interruption of casting.
The nozzle change is carried out within less than 0.5second and the steel flow can be maintained

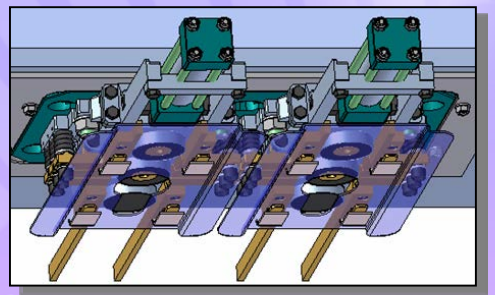
ONQC System Characteristic

- **High speed nozzle exchange** : < 0.5 sec
  - Casting stop & restarting individual strand.
  - The use of different nozzle bore diameter allows to adjust the casting speed.
  - Better flexibility to optimize any production condition.
- Safe & easy loading exchange nozzle
  - Constant high contact pressure centered around casting hole
  - Exchange loading system : 6 springs & clamps
    -. High temperature resistant springs.
- Easy and quick mounting of the ONQC to the tundish bottom by assembly cart
- The compact & simple design of the ONQC
  - Light weight & simple handling

- Increased sequence length & productivity
- Reduced number of tudish exchange
- Reduced amount of tundish skulls and cutting scrap.
- Reduced tundish refractory & heating cost
- Guaranteed optimum casting speeds of the strands.



<Billet & Bloom Casting>



<Beam Blank Casting>

Specification

- Bore diameter. : Max. Ø22 mm
- Weight : 23 kg
- Nozzle exchange time : <0.5 sec.
- Size : 120(H) x 250(W) x 450(L)

4 Purging plug closing system

Conventional pursing plug closer

Hinge+Bolting Type

Bayonet Type

Bolting Type

Cotter Type

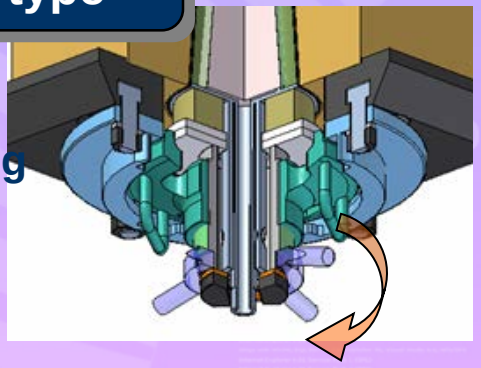
problems

- Cause of molten steel leak out from the purging plug.
- Different pursing plug assembly by operator.
- Hard replacement of purging plug

Solution ! ! !

CR PP Closing System : Centered Screw type

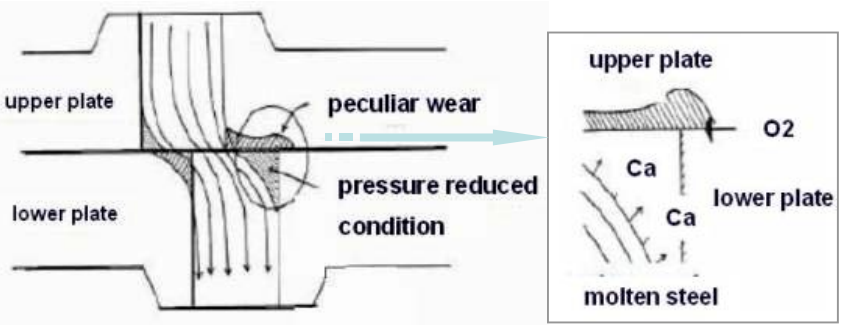
- Security optimized closing system
- Adjustable connection between pursing plug and seating block
- Simple handling of the CR closing system



Contents

Countermeasure [1] : Plate for ca-treated steel

Corrosion Mechanism



· Chemical corrosion from ca and cao oxide

Plate for ca-treated steel

· Excellent corrosion resistance to ca-treated steel
· Good safety and thermal shock resistance
· Hidh corrosion resistance by inserting of MgO-C and MgO-Spinel-C , ZrO2
· Improve thermal shock and corrosion resistance by one bodying of Al2O3-C

Choice of material for ca-treated steel

[Ca] < 25 ppm	SiO2 free Al2O3-ZrO2-C or Al2O3-C Plate
[Ca] < 25~30 ppm	MgO-Spinel-C ring insert composite plates
[Ca] > 30 ppm	MgO-C ring insert composite plates
	ZrO2-C ring insert composite plates

Countermeasure (2) : SEN Clogging

Cause of the clogging and the phenomena

- High Al content in steel
- Refractory supply oxygen to molten steel and it lead Al to Al2O3

$SiO_2(s)+C(s) \rightarrow SiO(g)+CO(g)$--(1)

$CO(ref.) \rightarrow O(Fe)+C(Fe)$--------(2)

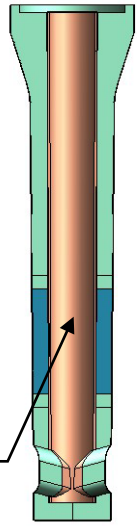
$2Al(Fe)+3O(Fe) \rightarrow Al_2O_3$--------(3)

Solutions

Carbonless material FS342

To remove the source of oxygen, carbon free and silicaless material is applied in the bore part as liner. It has proved good performance in stainless steel.

Carbonless liner

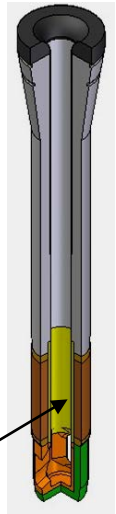


CaO Containing Self cleaning CSG613/CSG626

Self cleaning material is arrayed in bore & outlet part as liner.

It appeared to have very good anti – clogging effect in high Al containing steel.

Self cleaning material

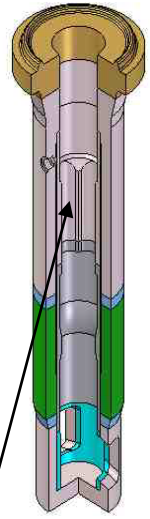


Petaloid

To prevent steel stream deflection,

The SEN's bore is designed like petaloid

Petaloid

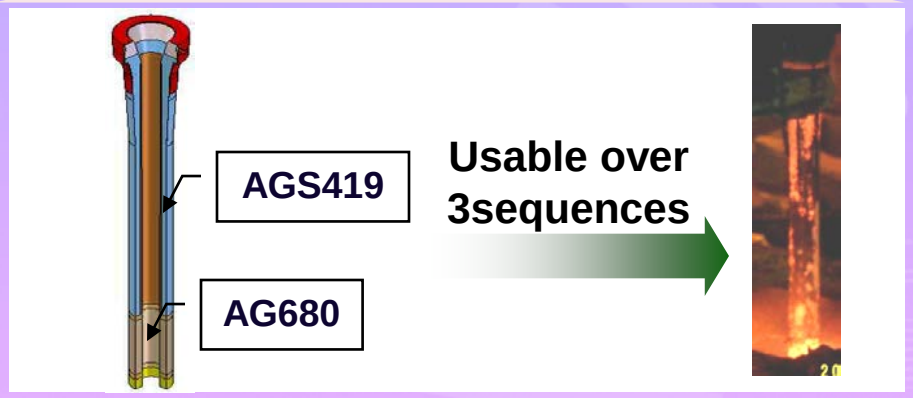


Countermeasure (3) : Reusable ladle shroud

The goals

- Reduced standard deviation induce good performance
- little quality change after used and it make ladle shroud reusable

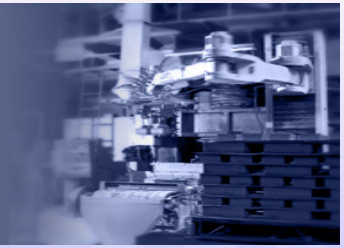
Process	ST.Dev of MOR	Method for Strength	Life Time (ch)	Life Time (Sequence)	Product
Conventional	25	Add Metal	6~18	1~2	AGL421
State-of-the-art	10	Raise mixing eficiency	20~50	3<	AGS419 AG680



Countermeasure (4) : Stopper & SEN for the special steel

Steel and the reason of refractories' damage

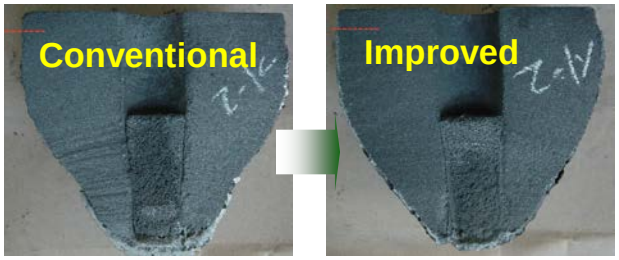
- API : Corrosion by Ca in steel
- Free cutting steel : Oxidation by free oxygen in steel
- Stainless steel : Carbon oxidation by Cr2O3 and steel infiltration



Solutions

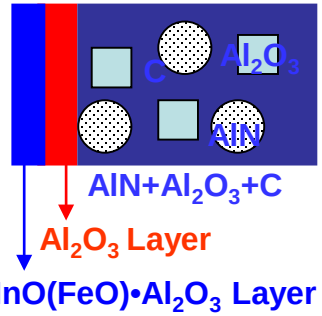
API

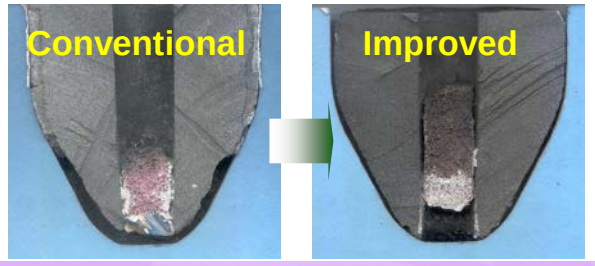
CHOSUN's stopper have much experience in API casting and have been leveled up continuously



Free cutting steel

AlN containing material have proved good performance





Stainless steel

-Special material prevent the infiltration of stainless steel In casting

-STS 304
-10h(=440min)
-Erosion speed
: 0.01mm/ch

Countermeasure (5) : Multi-function stopper

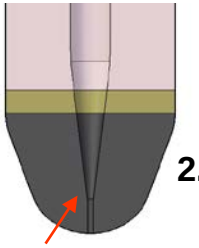
Developed and merit

Al-killed 4ch(=167min)

1. The clogging is disappeared in the nose part and the stopper open position is kept 25mm during casting
2. The back pressure was kept 1bar uniformly
3. The mold level becomes much more stable than before to the end of casting.

Conventional and problems awaiting solutions

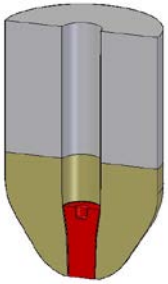
Φ5 hole piercing type



•Φ5 hole

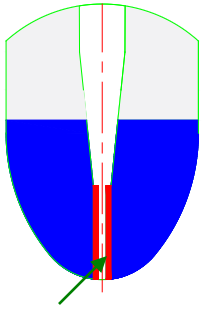
1. The mold level fluctuation.
2. Back pressure is almost 0bar. But occasionally, back pressure is abruptly hunted up to 3bar and down to zero 4 or 5 times in a casting.

Porous brick type



1.The back pressure is increased to 5.1 bar as the casting goes on.

Alumina tube insert type



•Alumin tube

The increase of back pressure is appeared in the middle of casting. This problem is caused by Al2O3 clogging in the alumina tube.

TTMS : Total Technical Management Service

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Installation

Supply
Refractories

TTMS

Saving Customer's Cost

Stabilizing Operation
Lengthening Span

Repair
Maintenance

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Design

Tapping Works
Support

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