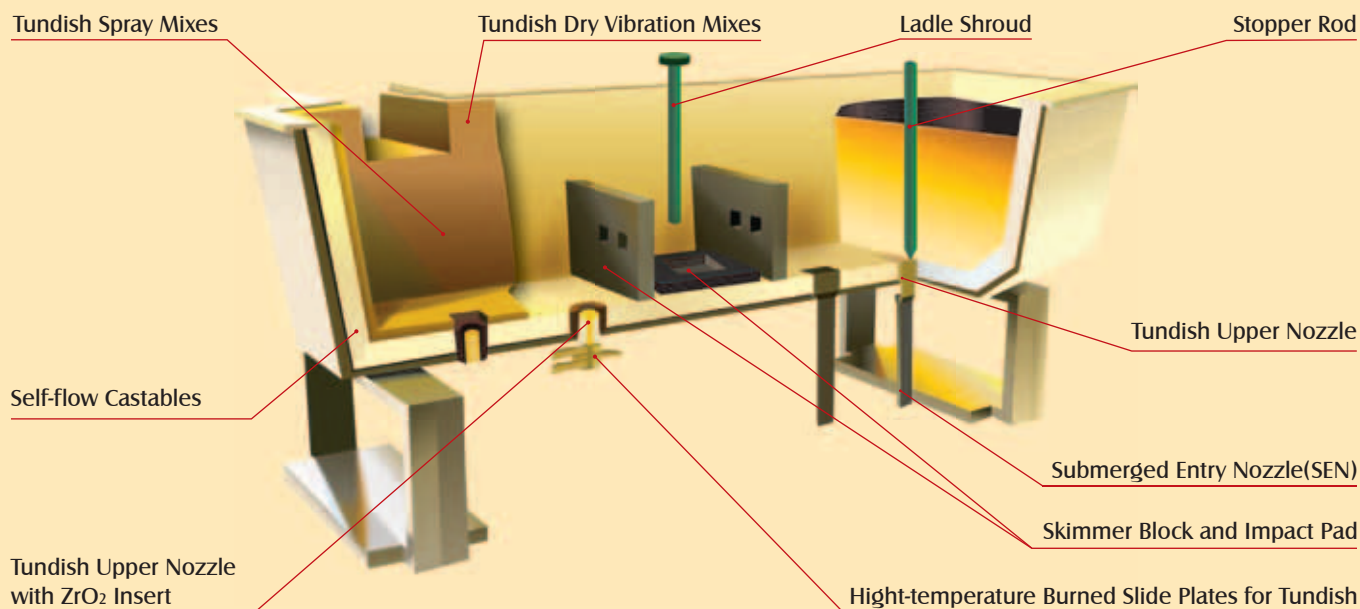


Refractory Products for Tundish



Tundish Porous Upper Nozzle

To solve clogging problem occurred on conventional tundish upper nozzle and submerged entry nozzle, Horton developed porous upper nozzle serial products including fast-change type and normal type.

The replacement of SEN may be done during casting when using Horton serial fast change porous upper nozzles, and longer tundish casting sequence is obtained. Horton has offered porous upper nozzles to a decade of steelworks, gaining high customer satisfaction.

Al ₂ O ₃ % Min.		80	80	80
C+SiC % Min.		10	10	
Bulk Density g/cm ³ Min.		3.15	3.10	3.15
Cold Crushing Strength MPa Min.		60	45	70
Modulus of Rupture MPa Min.	1100°C ×24h	12	10	15
Apparent Porosity % Max.		10	16	15
Permeability %		-	100	-



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Refractory Products for Tundish

Stopper Rods

The Horton series of mono block stoppers include alumina-carbon type and magnesia-carbon type to suit for individual casting conditions. A broad range of designs are available for stopper head or slag line, reliable and satisfactory performances have been achieved in decades of operations worldwide.

Material	Body		Head	
	ASR	ASH	ASM	YS
Chemical analysis				
Al ₂ O ₃ %	≥45.0	≥55.0		≥75.0
MgO %			≥60.0	
C+SiC %	≥25.0	≥20.0	≤20.0	≥10.0
Physical properties				
Bulk density g/cm ³	≥2.36	≥2.44	≥2.50	≥2.70
Apparent Porosity %	≤17.0	≤19.0	≤18.0	≤17.0
Cold Crushing Strength Mpa	≥16.0	≥20.0	≥15.0	≥20.0
Modulus of Rupture Mpa	≥5.0	≥5.0	≥4.0	≥6.0

Tundish Dry Vibration Mixes

Horton series dry vibration mixes are designed for tundish working lining. The products feature excellent adhesion, easy dry-out etc. Furthermore, it can efficiently prevent molten steel from refractory pollution. Without adding water during the installation, dry-out period is dramatically reduced. They are ideal alternative products to conventional insulating board and coating mixes.

MgO % Min.		60			
CaO % Min.		30			
SiO ₂ % Max.		3.0			
	150°C ×3h	2.0		150°C ×3h	5.0
Bulk Density g/cm ³ Min.	1100°C ×3h	1.8		1100°C ×3h	2.0
	1500°C ×3h	2.2		1500°C ×3h	8.0
	150°C ×3h	2.0		1500°C ×3h	-2.0
Modulus of Rupture MPa Min.	1100°C ×3h	1.5			
	1500°C ×3h	5.5			

Refractory Products for Tundish

Ladle Shroud

The Horton serial ladle shrouds are ISO-pressed Al₂O₃-C based products, featuring superior thermal resistance to erosion-corrosion, oxidation and thermal cycling, etc. They are easy to install and preheat is unnecessary. Horton has supplied ladle shrouds for decades of customers worldwide, proving reliable performances and long casting life.

Performance condition	Body		Slag line		
	Preheating	Non-Preheating	Acid	Basic	Neutral
Chemical analysis					
Al ₂ O ₃ %	≥40.0	≥45.0			≥55.0
ZrO ₂ %			≥55.0		
MgO %				≥55.0	
C+SiC %	≥30.0	≥20.0	≥18.0	≥15.0	≥15.0
Physical properties					
Bulk Density g/cm ³	≥2.15	≥2.10	≥3.40	≥2.50	≥2.40
Apparent Porosity %	≤19.0	≤19.0	≤18.0	≤18.0	≤18.0
Cold Crushing Strength Mpa	≥18.0	≥18.0	≥20.0	≥18.0	
Modulus of Rupture Mpa	≥6.0	≥6.0	≥6.0	≥4.0	≥6.0



Fused Silica Stopper

Chemical analysis	Physical properties		
SiO ₂ %	Bulk Density g/cm ³	Apparent Porosity %	Cold Crushing Strength Mpa
≥99	≥1.85	≤15	≥40

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Refractory Products for Tundish

Submerged Entry Nozzle (SEN)

The Horton series of SENs are ISO-pressed products with special reinforcement at slag line. Horton SENs enjoy good reputation for excellent slag resistance, clog-proof, long life and safety etc. Horton has supplied SENs with fast-changeable system and SENs for thin slab casting for many customers worldwide, demonstrating reliable performance and long service life.

Performance condition	Body		Al ₂ O ₃ Anti-clogging			Slag line		Bowl
	Preheating	Non-Preheating	Argon	Non-Argon	Non-carbon	Z45	ZSP	
Chemical analysis								
Al ₂ O ₃ %	≥40.0	≥45.0	≥43.0		≥65.0			Material is same as the cooperative stopper
ZrO ₂ %				≥35.0		≥75.0	≥65.0	
C+SiC %	≥25.0	≥20.0	≥20.0	≥15.0	≤8.0	≥11.0	≥15.0	
MgO %					≥18.0			
Physical properties								
Bulk Density g/cm ³	≥2.25	≥2.36	≥2.10	≥2.58	≥2.65	≥3.50	≥3.30	
Apparent Porosity %	≤19.0	≤19.0	≤25.0	≤21.0	≤20.0	≤22.5	≤20.0	
Cold Crushing Strength MPa	≥19.0	≥20.0	≥10.0	≥18.0	≥18.0	≥16.0	≥16.0	
Modulus of Rupture MPa	≥6.0	≥6.0				≥3.0	≥3.0	

Tundish Spray Mixes

Horton series spray mixes for tundish lining feature easy of coating, long life, high erosion/corrosion resistance, etc. They are ideal alternative product over previously used insulating board. It can be applied through spray machine.

MgO % Min.		65
CaO % Min.		10
Bulk Density g/cm ³ Min.	110°C ×16h	1.8
	1500°C ×3h	2.1
Cold Crushing Strength MPa Min.	110°C ×16h	5
	1500°C ×3h	6
Linear Change %	1500°C ×3h	-3.0±0.5
Water addition %		22±3

Refractory Products for Tundish

Tundish Upper Nozzle

Stopper system is normally used in tundish for con-casting of slab and bloom. Through adjusting the slot between the stopper and the upper nozzle, the steel flowing rate could be controlled. During the casting, there will be some erosion on the stopper and upper nozzle. So the quality of the upper nozzle is very important to tundish life.

The Horton series of upper nozzles with ZrO₂ Insert feature high refractoriness, superior resistance to thermal shock, erosion/corrosion etc. Fitting together with Horton serial of ladle shroud, stopper and SEN, tundish casting sequences will be remarkably improved. The products have been used in decades of steelworks worldwide, gain high customer satisfaction.

	Upper Nozzle-Insert				
ZrO ₂ % Min.	64	69	79	93	94
Bulk Density g/cm ³ Min.	3.6	3.7	3.9	4.3	4.3
Apparent Porosity % Max.	23	23	23	21	21
Cold Crushing Strength MPa Min.	80	80	80	100	100
Refractoriness °C Min.	1790	1790	1790	1790	1790

	Upper Nozzle-Body			
Al ₂ O ₃ % Min.	65	75	65	80
MgO % Min.			10	
C % Min.			3	3
Bulk Density g/cm ³ Min.	2.3	2.4	2.9	3.0
Apparent Porosity % Max.	25	25	10	10
Cold Crushing Strength MPa Min.	60	60	40	60



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Refractory Products for Tundish

Metering Nozzle

Horton series of metering nozzles adopt mosaic pattern - the zirconia's inner core and alumina sleeve including typical nozzle and fast-changeable nozzle. Both feature high refractoriness, low expansion superior resistance to erosion/corrosion and thermal cycling, etc.

Horton nozzles with fast-change system could be replaced easily to ensure consistent steel flow. They have been widely used in long-life tundish system in many I&S works at home and abroad, demonstrating excellent application results.

	Zirconia Inner Core					
ZrO ₂ % Min.	64	69	79	84	93	94
Bulk Density g/cm ³ Min.	3.6	3.7	3.9	4.0	4.3	4.3
Apparent Porosity % Max.	23	23	23	23	21	21
Cold Crushing Strength MPa Min.	80	80	80	80	100	100
Refractoriness °C Min.	1790	1790	1790	1790	1790	1790

	Alumina Sleeve Block					
Al ₂ O ₃ % Min.	50	65	75	80	80	80
C % Min.						3
Bulk Density g/cm ³ Min.	2.1	2.3	2.4	2.8	2.8	3.0
Apparent Porosity % Max.	25	25	25	25	25	10
Cold Crushing Strength MPa Min.	40	40	40	40	40	40

Refractory Products for Tundish

Self-flow castables

Self-flow castable is characterized by suitable setting time, good flowability, high strength, superior resistance to thermal shock, erosion/corrosion. Without vibration, the self-flow castable can level and get degassed by gravity, which leads to densification. It can also be installed by pump. The self-flow castable is recognized as the fourth generation castable, it is an ideal alternative product to previously used low cement or no cement castable. Horton mullite serial self-flow castables suit for ladle & tundish safety lining. So far they have been proven reliable performances in decades of operations worldwide.

Al ₂ O ₃ % Min.		50	60
Bulk Density g/cm ³ Min.	110 °C ×16h	2.25	2.30
	1350 °C ×3h	2.20	2.25
Cold Crushing Strength MPa Min.	110 °C ×16h	30	40
	1350 °C ×3h	50	60
Modulus of Rupture MPa Min.	110 °C ×16h	5	6
	1350 °C ×3h	7	9
Max. Service Temperature °C		1600	1600
Water addition %		7~9	7~9

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Refractory Products for Tundish

Skimmer Block and Impact Pad

Horton offers a wide range of precast shapes for tundish such as MgO-based or MgO-Al₂O₃-based skimmer blocks and impact pads. Individual design is available to meet needs of specific operation condition. Horton series products feature high fired strength, superior resistance to erosion/corrosion, long service life.

Al ₂ O ₃ % Min.		45	80	80	5	-
MgO % Min.		33	6	4	80	85
SiO ₂ % Max.		10	7	7	8	7
Bulk Density g/cm ³ Min.	110 °C ×24h	2.90	3.00	3.05	2.90	2.85
Modulus of Rupture MPa Min.	110 °C ×24h	10	3	5	7	10
Cold Crushing Strength MPa Min.	110 °C ×24h	60	20	35z	50	58
Linear Change %	110 °C ×24h	±0.1	±0.1	±0.1	±0.1	±0.1

Slide Plate for Tundish

Horton series of high-temperature burned slide plates have the features of high strength, high erosion/ corrosion resistance, excellent thermal shock resistance and long life etc.

They are used widely in large and medium-sized con-casting ladles and tundishes

Brand	Al ₂ O ₃ -ZrO ₂ -C Slide Plate		MgO-Spinel Slide Plate	High Performance Slide Plate
Al ₂ O ₃ % Min.	70	75	10	60
C % Min.	5	6		4
ZrO ₂ % Min.	5	5		5
MgO % Min.			80	
Apparent Porosity % Max.	6	6	10	11
Bulk Density g/cm ³ Min.	3.15	3.10	2.95	3.00
Cold Crushing Strength MPa Min.	100	100	70	95
Modulus of Rupture MPa (1400°C ×0.5h) Min.	18	13	7	10
Application	Large or medium-sized con-casting tundish.		Calcium steel, killed steel, open steel etc.	Tundish slide plate