### STEEL

# Beyond Refractories Discover our Flow Control Solutions





# There for you, wherever you need us

### \*

The more closely we work with our customers, the greater the difference we can make for them. So having a global network of offices, research centers and production sites is important to us, and to them. We'll go on extending our global reach, to be nearer to even more customers.

Being closer to customers doesn't just mean we can be more responsive to their needs. It also helps us to listen better — to understand their concerns, cultures and ways of working. And to be alert to new thinking and ideas that enable us to deliver ever better advice. service and solutions.

Our exceptional resources and expertise extend far beyond making and selling products. We also provide solutions to customers worldwide for cover projects, materials specification, thermal studies, numerical simulations, follow-up and technical support in application of minerals, and maintenance and electromechanical services for refractory equipment.



28 Main production sites



+100 **Countries shipped** to worldwide



12 **Raw material** sites



5 R&D hubs and centers





### Smart solutions, meeting your challenges

Our holistic approach in Flow Control reaches from ladle to mold, comprising all relevant aspects of your Flow Control process, from systems, to refractories, to metallurgy.

We focus on process optimization including continuous product improvements.

Go beyond refractories and discover our full package portfolio for your key challenges in Flow Control:



**Clean Steel** — produce steel of the highest possible quality

Safety — achieve maximum safety in a challenging working environment



Productivity - driving your process efficiency



**Green Steel** — reduce your carbon footprint

If you have further questions, please contact us directly via flowcontrol@rhimagnesita.com





Nozzle Changer and Refractories for Open Casting Refractories for Closed Casting Tundish Gates and Refractories Monotube Changer and Refractories



### Well Filler Sand

Strand Lubricants

Thin Slab Refractories

## Purge Plug, Gas Management and Safety Closing System

### **Purging Ceramics**

- Purging plugs with customized shapes in different designs
- Customized blocks and sleeves
- Prefabricated sets with easy exchange technology

### Equipment

- Safety closing systems for ladle purging plugs
- Gas control systems
- Check valves
- Testing facility for purging plug functionality tests

### Technology – Service

- Customized fact-finding
- CFD analysis for optimization of plug positioning and recommended gas volume
- Commissioning of purging system
- After sales service





Operation and control box

Gas control unit

• Furnace control room Control over the entire gas purging process and technology from refractory to valve control and purging strategy.

**Operation and control box** User-friendly visualization allowing setting of gas flow, gas type, operational mode and easy monitoring of system condition.

E





### **3** Gas control box

Compact box with modular components including the mass flow controllers. Rapid reaction of mass flow controllers (90% set flow within 2s) and high precision of mass flow (+/- 1.5%). Gas supply and control of up to 4 purging plugs and for ladles with tap weights of up to 350t.

### 4 Purging plugs

Efficient steel melt mixing, leading to higher process control, increase in productivity and improved metallurgical results.

## **Purging Plugs**

Optimum product for

Suitable for application

"No maintenance plug"

Initial opening rate

Туре

Structure

Porosity

Controllability



Hybrid Plug

High-grade steel

Multi piece

Pressed & fired inserts, cast

Continuous &

discontinuous

000

Yes

Random & direct

000





High-grade steel

Multi piece

Pressed & fired inserts, cast

Continuous &

discontinuous

000

Yes

Random & direct

00





Continuous & discontinuous

000 Yes Random

000

Flow rate 00 00 000 Range Optimized desig Optimum soft Special product for Perfect all-rounder Comment special application bubbling behavior gas outlet ANKERPERM & DIPERMAL ANKERPERM URSTAR Main brand DIPERMAL Main raw material  $Al_2O_3$  $Al_2O_3$  $Al_2O_3$ MgO



Star Plug





#### **Slot Plug**

Low-alloyed steel	Low-alloyed steel		
Single piece	Single piece		
Cast	Cast		
Continuous	Continuous		
00	0		
No	No		
Direct	Direct		
0	0		
000	000		
Optimized design of gas outlet	Up to 60 slots		
URSTAR	URBLOCK		
Al <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>		

## Standard Closing and Safety Closing Systems

Closing systems contribute significantly to the safe operation of ladle purging. Depending on the requirements, we supply various systems, from a simple wedge system to the widely used bayonet system and the optimized safety closing system.

	Features	Wedge Gate	Bayonet Hinged         Cover	Image: Constraint of the second sec	SOC System	SIG		
	Operational safety	••	••	••				
	User-friendliness				••			
	Safety against self opening	٠	••	••	•••	I		
	Safety against steel breakout	٠	٠	٠				
	Multiple overlapping safety features	٠	••	••	•••	I		
	Full system solution (modular system for setting and extraction)	٠	٠	٠		I		
	Suitable for all purging plug shapes	yes	yes	yes	yes			
	Suitable various designs of purging plugs safety devices	no	no	no	yes			
Appropriate Excellent								





## SOC-H

### Safety Optimized Closing System — Hinged

SOC-H is the latest evolution of ladle closing systems by RHI Magnesita and is a further development of the well-established SOC-system.

### **Advantages**

- All-in-one system solution
- 100% reliable and safe
- Compact design
- No loose parts (screws, etc.)
- Easy handling
- No heavy parts (closing plate) have to be lifted
- Easy upgrade from SOC to SOC-H

The SOC-H system can be used with every RHI Magnesita purging plug type. As entire system solution it includes:

- SOC-H purging ceramics
- SOC-H closing system
- SOC-H setting device
- SOC-H extraction device
- SOC-H tools & accessories





SOC-H extraction device





## **Slide Gate Systems for Steel Casting Ladles**

More than 600 customers from the steel and foundry industries in over 70 countries worldwide rely on RHI Magnesita as a trustful partner for INTERSTOP<sup>®</sup> flow control systems. The latest generation of the INTERSTOP<sup>®</sup> S gate series offers extra features in terms of safety, ease of operation and low operational costs. As a system and solution provider we support our customers with expertise and experience in the fields of application technology, R&D, simulations, quality management and production.

### Ladle Gate Systems

- Size selection according to specific customer requirement 2-plate or 3-plate systems available
- User-friendly design for safe, fast and simple operation
- Minimal maintenance work required
- Support of clean steel production and automation

### Ladle Gates Refractories

- Clamping and self-centering of plates
- Positive effect to plate wear zone
- Controlled crack pattern of plates
- Wide refractory portfolio

### Technology – Service

- Customized fact-finding
- Proactive optimization of engineering solution
- Commissioning support and application training on site
- INTERSTOP® after sales service





## Ladle Gate INTERSTOP® SX

### **Overview**

- User-friendly design for fast, safe and simple operation
- Automatic system tensioning
- Easy handling at preparation area
- Support for clean steel production and ready for automation
- Size selection according to specific customer requirement

### **System Characteristics**

- Two main components only, housing and slider
- Easy integration of gas shielding and EMLI slag detection systems
- Easy and comfortable handling
- Designed for low operational costs

### **Refractory Parts**

- Wide refractory portfolio
- Clamping and self-centering of plates
- Controlled crack pattern of plates
- Positive effect on plate wear zone







- Long lifetime of parts
- Long inspection intervals, short inspection time
- INTERSTOP<sup>®</sup> after sales service
- Minimal maintenance work required

## **INTERSTOP®** Robotic Solutions — Ladle Preparation Area

### **Overview**

- Robotic solution for fully automated Ladle Preparation Area (LPA)
- Cylinder handling
- Oxygen lancing
- Inner nozzle surface cleaning
- Ready-to-use mortar joints •
- Inner nozzle repair
- Handling of slide gate refractory parts

### **User Benefits & Advantages**

- Safety get operators away from liquid steel, heat dust and time pressure
- Process stability high reliability of tasks performed
- Extension of refractory life (e.g. no more change of inner nozzle)
- Data acquisition for predictive maintenance and lifetime prediction models





## INTERSTOP<sup>®</sup> Robotic Solutions for Cylinder Handling at CCM

#### **Overview**

- The robotic solution for fully automatic handling of Flow Control system parts.
- Installs slide gate hydraulic cylinder for INTERSTOP® systems
- Couples media like argon, cooling air and electrics for slag detection
- Removes cylinder and media from empty ladle

### **User Benefits & Advantages**

- No-man needed on ladle charging area Robot fulfills all operator s tasks
- Enhanced health and safety standard
- Increase of efficiency and process control through
  robotic solutions





### Ladle Gate Refractories





### High-end Refractory Solutions Customized for:

Check out our INTERSTOP®

## JUSTAL / Complex Assemblies

#### Collector Nozzle for Ladle Gate



shock resistance







## Argon Supply for Slide Gate Refractories





#### Porous Ring

 $Al_2O_3$  porous ring for exact argon supply to prevent clogging

### **DELTEK®** Ladle Shrouds



### **Shielded Shrouded Connection by INTERSTOP®**



Interstop's high-end argon flow-control solution guarantees improved sealing of the steel stream minimizing oxidation and maintaining the steel's cleanliness.



#### Gaskets

For tight sealing of the casting channel

#### Ladle Shroud Canning

Reinforced LS head and adaptation to the gimbal ring

## **Mixes Overview**





## **Tundish Linings**

### **Requirements for Refractories in the Tundish**

- High thermal shock resistance
- High abrasion resistance to the turbulent flow of molten steel
- Simple handling and installation
- Fast lining and low-energy drying
- Service life in line with the requested sequence duration

Insulation • High chemical resistance to molten steel & cover agents Insulating Bricks Insulating Gunning Mixes Insulating Boards Anchors , m Cold Setting Mix Dry Setting Mix Slurry Gunning Mix



#### Permanent Lining

Low-cement Mixes Self-leveling Mixes Sol-bonded Mixes

#### Wear Linings Slurry Gunning Mix Dry Setting Mix Cold Setting Mix

## **Cold Setting System**

In addition to slurry gunning mixes and dry setting mixes that require thermal treatment before service, the Cold Setting System is the latest generation of tundish wear lining materials.

The term "Cold Setting System" stands for the tailored combination of three essential components:

- The ANKERTUN SH mix
- The ANKERTUN CS machine
- The adjustable tundish template

The right combination of these three components allows to obtain the best performance results of this innovative lining material.

Ready-to-use wear lining in only 60 min







## **Tundish Furniture**

Pre-fabricated basic and non-basic pieces specially designed and placed to modify the flow pattern in the tundish reducing turbulence, dead volumes and increasing residence times. These provide better steel cleanliness, homogenization and overall improvement of the operating conditions at the continuous caster.











Simulation Tools for Optimization of the Tundish Configuration

#### RHI Magnesita tundish furniture offer

- Impact plates & impact pots
- Dams and weirs
- Argon purging beams





TUNFLOW<sup>™</sup> Chevron



Purging Beam



#### **Furniture Benefits**

- Increased residence time for the
  - flotation of inclusions
- Improved steel bath homogenization
- Minimized dead volumes in the tundish
- Minimizing mixed volume when
- changing grades

## **TUNFLOW<sup>™</sup> Impact Pots**

RHI Magnesita provides our customers with a line of tundish steel flow modifiers, especially developed for each individual tundish geometry to achieve optimized steel flow by means of simulation methods, namely CFD and water modeling.

Shape design features have been developed to guarantee safety and support efficiency of the casting process.

Each TUNFLOW<sup>®</sup> design is a specific customer project adapted to process requirements, from anti-splashing to reduced dead volumes, turbulences and downgrading at grade change.



TUNFLOW<sup>™</sup> steel flow optimization through CFD/water model

TUNFLOW<sup>™</sup> Push



#### TUNFLOW<sup>™</sup> Meander

TUNFLOW<sup>™</sup> Hybrid

TUNFLOW™

## Tundish Gate & Submerged Nozzle Changer INTERSTOP<sup>®</sup> STG 33

#### **Overview**

- Sealed tundish gate (STG) for slabs with integrated monotube changer
- Play-free drive
- Process control technology for automatic casting
- Off-line assembly
- Support of clean steel production and automation

### **System Characteristics**

- Sealed system concept
- Inert gas application on housing, tundish nozzle and refractory joints
- Blank plate for emergency shut-off
- Compact design
- Minimized number of components

### **Integrated System Solution**

- Process visualization
- Automatic start-up
- Automatic mold level control
- Automatic emergency functions
- Precise steel flow regulation









- Minimal maintenance work required
- Long lifetime of parts
- Long inspection intervals, short inspection time
- INTERSTOP<sup>®</sup> after sales service

# Sealed Tundish Gate INTERSTOP® STG 13

### **Overview**

- Sealed Tundish Gate (STG) for Billet, Bloom and Beam Blank Casters
- 3-plate sealed tundish gate for high steel quality
- Process control technology for automatic casting
- Fully compatible with open and closed casting system INTERSTOP<sup>®</sup> MNC, 13QC and EG115

### **Main Parts**

### **System Characteristics**

- Closed box design ensures fully inert gas enclosure of the refractory plates
- Exact drive cylinder with integrated stroke measuring system and play compensation
- Compact and modular design offering tailor-made refractory set-ups, including option for Mono Tube Change
- User-friendly design for safe, fast and simple operation

### Integrated System Solution

- Precise mould level control over long
   production sequences
- Fully automatic start, mould level control and safety functions
- Process visualization
- Wide range of refractory concepts and qualities tailored to the needs







- System concept offering minimal and safe maintenance steps
- Long lifetime of parts results in reduced inspection intervals
- INTERSTOP<sup>®</sup> after sales service and on-site training

## Mono Tube Changer INTERSTOP® MTC-ESP

#### **Overview**

- Elevated Safety Plate (ESP)
- No handling of blind plate
- Minimal operator exposure time at mold
- Same fixation as emergency gate
- Nozzle design for improved handling and optimized flow geometry
- Support of clean steel production and automation

### **System Characteristics**

- Safety plate is an integrated part of the system always in stand-by position
- No cylinder manipulation necessary
- Minimal time required for mono tube exchange
- Open front and side view into the mold
- Hydraulic cylinder out of direct heat impact

#### Clean Steel Technology

- Tight joint between monotube and nozzle
- INTERSTOP<sup>®</sup> push-edge design
- Reliable argon couplings at the nozzle
- Rapid mono tube exchange





### 1



- Minimal maintenance work required
- Long lifetime of parts
- Long inspection intervals, short inspection time
- INTERSTOP <sup>®</sup> after sales service

## **INTERSTOP®** Robotic Solutions — Automatic Monotube Change

### **Overview**

- Fully automatic solution for monotube change and powder feeding
- Monotube handling
- Monotube preheating and drop-off
- Mould powder feeding

### **User Benefits & Advantages**

- Integrated automatic solution
- Maximizing safety in casting area
- Continuous powder feeding
- Free access for operators to the mould
- Increase of efficiency and process control through robotic solutions







## Metering Nozzle Changer INTERSTOP® MNC-AS

#### **Overview**

- For reliable and safe long sequence casting
- Swivelling drive arrangement
- Same plate fixation as tundish and emergency gate
- Optional submerged nozzle application

### **System Characteristics**

- Mechanical fixation of upper nozzle
- Clear view to the nozzle & mold
- Springs well protected for long service life
- Compact dimensions
- Optional submerged nozzle application

#### **Refractory Parts**

- Pressed and fired upper nozzle designed for long sequences
- Mechanical fixation of the upper nozzle
- Wide refractory portfolio







- Minimal maintenance work required
- Long lifetime of parts
- Long inspection intervals, short inspection time
- INTERSTOP<sup>®</sup> after sales service

## **Nozzles for Open Casting**

From mechanics and nozzles for safe and controlled casting to fixed metering nozzles, RHI Magnesita offers the complete tundish nozzle portfolio for the continuous casting of steel, with nozzles available in a broad range of properties. Encompassing diverse raw materials and production methods, RHI Magnesita's tundish nozzle portfolio serves all casting demands.

Tundish nozzles adapted to all systems and customer requirements.









### **DELTEK® Nozzles for Shrouded Casting**

RHI Magnesita offers a complete range of isostatically-pressed refractories for tundish-to-mold shrouding, comprising tundish nozzles and submerged entry shrouds, submerged entry nozzles, mononozzle and monotube designs for tubechanger systems and high-technology submerged entry nozzles for thin slab casters. These are available in a wide range of material and design options with product enhancements customized to the application. For slab & thin slab casters





## SHP Argon Purging Stoppers

RHI Magnesita's SHP stoppers for Ar purging are designed with a ring-shaped slot to improve gas bubble distribution in the casting channel to the mold. This results in reduced clogging, fewer flow pertubations and less mold slag entrapment.



Hole-in-nose



#### Argon bubble distribution. Standard vs SHP

SHP nose

## **GYRONOZZLE®**

The unique design of the GYRONOZZLE® provides a significant improvement of the steel flow in the mold for billets and blooms compared to traditional single-port designs.

By creating a downwards-directed swirling flow in the mold, the heat transfer and meniscus behavior are optimized leading to improvements in the solidification of the strand shell as well as in the internal solidified structure of the cast product.

#### Steel jet comparison







**GYRONOZZLE®** 







## Thin Slab Submerged Nozzles

Nozzles for thin slab casting are designed to maintain a stable flow with high throughput over long sequence casting.

The narrow funnel-shaped molds require a flat section of the immersed part of the nozzle. Modern simulation methods such as water modeling in combination with computational flow simulations are used to design the refractory to achieve the required flow performance.



### **Our Services**

- Standard OEM concepts
- Tailor-designed solutions
- Computer fluid dynamics (CFD)
- Finite elements stress analysis
- Water dye-injection modeling
- High-end refractory concept
- Long-life product offer

Long life slag-band material

S-PORT nozzle design





## **Strand Lubricants**

### DELTEK<sup>®</sup> IF — Mold Fluxes Made-to-Measure

Thanks to the partnership with PROSIMET, specific knowledge is available in both managing raw material properties and understanding end user needs. DELTEK® IF is the perfect solution for your casting process:

- Gives chemical protection of liquid steel from oxidation
- Provides thermal insulation avoiding solidification of steel surface
- Lubricates the strand-mold system by ensuring a uniform heat transfer at the interface
- Non-metallic inclusion (NMI) absorption potential, without losing material properties

### **PROIL** — The Revolution

PROIL is the next innovation in the open continuous casting environment. This new product is a solid-liquid dispersion, now offering the possibility to use the advantages of mold fluxes in billet casting, while at the same time avoiding the existing drawbacks of oil as mold flux.

#### Selective Adjustment of:

- Flux basicity
- Flux viscosity
- Melting rate
- Melting behavior
- Crystalizing behavior

The Holistic Approach CFD / Fluid Flow









### **EMLI-LadleSlag Electromagnetic Slag Detection for Ladles**

The EMLI-LadleSlag system continuously monitors the steel flow during ladle teeming when casting and provides immediate and accurate alarm outputs when slag is detected.

The use of a well-functioning slag detection system increases yield significantly due to consistent and objective gate closure, every time.

Special sensors engineered to be used in a high-temperature environment and compatible with vacuum degassing process routes.

### User Benefits & Advantages

- Control slag carryover precisely with a fast response time.
- Increase yield by leaving minimal amounts of steel in the ladle.
- Can handle any steel grades. No additional calibration necessary.





# **EMLI-TundishLevel**

### **Continuous Tundish Steel Level Measurement**

The EMLI-TundishLevel system continuously monitors the true steel levels in the tundish and provides outputs to control the flow from the ladle to maintain desired operating levels without being affected by the presence of slag or protection powder.

This allows a precise steel level control ensuring a constant pressure head, minimized intermix areas and accurate draining procedures.

### **User Benefits & Advantages**

- Continuous true steel level measurement
- Optimize yield at every drain
- Avoid slag in mold & breakouts
- Minimized intermixed area
- More constant casting speeds





### **EMLI-MouldLevel**

### **Electromagnetic Mold Level Measurement**

The EMLI-MouldLevel systems continuously monitors the steel levels in bloom and slab molds during casting.

The electromagnetic technology ensures that true steel meniscus levels are measured irrespectively of the amount of mold powder.

We offer both suspended and edge-mounted sensors.

The suspended sensor sensor system is compatible with the use of EMS, EMBr and Ni-coated molds.

The edge-mounted sensors ensure minimum interference with casting operations.

### **User Benefits & Advantages**

- True steel meniscus level independently of powder thickness
- Fast true response time
- Automatic and fast calibration
- Can be used with EMS, EMBr and mold coatings







#### EMLI-MouldLevel edge-mounted

# Machinery

### **ANKERTUN**

### **Application**:

For tundish slurry gunning

### **Advantages:**

- Robust frame design
- Open mix pumping system
- Quick pump changing system
- Easy-to-use automatic and manual operation
- Transportable by crane and forklift



### **MIXOMAT**

# **Application**:

### Advantages:

- Useable in a variety of aggregates
- Precise water addition
- High mixing quality
- Transportable by crane and forklift

### E402L

### Application:

Continuous mixer for monolithic refractory linings

### Advantages:

- Useable in a variety of aggregates
- Easy to use and install
- Continuous lining







Mixing and pumping unit for monolithic refractory linings

## Get in touch!

You have further questions? Our Flow Control experts are ready to discuss your individual challenges in detail and tailor a solution package meeting your needs.

Please contact us directly via flowcontrol@rhimagnesita.com

The Journal of Refractory Innovations

Subscriptions Service and Contributions



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