SAINT-GOBAIN

OUR MISSION
Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the wellbeing of each of us and the future of all.

OUR PURPOSE
Making the world a better home.

WE ARE COMMITTED TO BEING CARBON FREE BY 2050.

PERFORMANCE CERAMICS & REFRACTORIES
Saint-Gobain Performance Ceramics & Refractories leads the industry in design, development and production of engineered ceramics and refractory products for extreme operating conditions and high temperature applications. Every product and material is designed to maximize performance and durability while minimizing environmental impact.

IRON MAKING & BLAST FURNACE
Saint-Gobain’s wide experience with refractory materials for iron making assure its customers the best performance available in the market, with tailor-made solutions. We supply high-quality materials for TROUGH & RUNNERS which are used to transport the molten metal drained from the blast-furnace to the torpedo cars. The molten slag is separated by using a skimmer, where it follows a secondary path through the slag runner. The separation takes place because of the density difference between the hot metal and slag.
## PRODUCTS

### PROVIDING END-TO-END SOLUTIONS

#### Working Lining
- Ultra low cement $\text{Al}_2\text{O}_3$-$\text{SiC}$-$\text{Carbon}$ castables
- Colloidal-silica bonded $\text{Al}_2\text{O}_3$-$\text{SiC}$-$\text{Carbon}$ castables
- Magnesium aluminate spinel containing castables
- Extremely high oxidation resistant castables

#### Repair Materials
- $\text{Al}_2\text{O}_3$-$\text{SiC}$-$\text{C}$ ready-to-use ramming mix
- High-performance gunning materials
- Shotcrete pumping materials

#### Back-up Lining
- Ultra low cement $\text{Al}_2\text{O}_3$-$\text{SiC}$-$\text{Carbon}$ castables
- 70% $\text{Al}_2\text{O}_3$-$\text{SiC}$-$\text{C}$ pre-shaped blocks
- Complete set of insulating castables, bricks and fibers

### BENEFITS
- Reduced maintenance costs
- Lower repair time
- Longer trough campaign
- Customized solutions

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>CHARACTERISTICS</th>
<th>APPLICATIONS &amp; BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra low cement castable</td>
<td>Oxidation, erosion and corrosion resistance</td>
<td>High performance materials customized for all regions of the casting floor and providing reduced maintenance cycles</td>
</tr>
<tr>
<td>Dry Mix Lining</td>
<td>Water free application</td>
<td>Extremely fast repairing materials designed for secondary runners</td>
</tr>
<tr>
<td>Shotcrete</td>
<td>High performance, low rebound, fast repair</td>
<td>Easy-to-pump and high corrosion resistance castables for cold and hot repairs for all regions of the main trough and secondary runners</td>
</tr>
<tr>
<td>Spinel containing castable</td>
<td>High resistance to FeO corrosion</td>
<td>Extended campaign of metal line and iron runners</td>
</tr>
<tr>
<td>Colloidal silica castables</td>
<td>High performance, quick drying</td>
<td>Zero-cement material designed for a reduced repair time of main trough and secondary runners</td>
</tr>
<tr>
<td>Pre-cast shapes</td>
<td>Controlled environment</td>
<td>Lower repair time and longer campaign for skimmers and secondary runners</td>
</tr>
<tr>
<td>High Performance Gunning mix</td>
<td>High adhesion</td>
<td>Versatility for all types of repairs in any region of the casting floor</td>
</tr>
<tr>
<td>Ramming mix</td>
<td>High workability</td>
<td>High performance and easy to apply mix for quick repairs at any regions of the casting floor</td>
</tr>
</tbody>
</table>
CASTABLES - BLAST FURNACE MAIN TROUGHS

Due to the constant thermal cycling and the direct exposure of the refractory lining to oxidizing environments during the main trough operation, the standard Al$_2$O$_3$-SiC-SiO$_2$-C castable can be easily damaged and the trough campaign consequently reduced. When events like this happen, emergency repairs must be executed, resulting in increased refractory unit consumption and an unplanned shutdown of unit operation.

AGGRESSIVE OXIDATION IN MAIN TROUGHS

Problem:
Aggressive oxidation leads to high porosity & low resistance. Root cause analysis of higher frequent repairs & lower yield.

New Material:
New material CASTFRAX® S25-NG shows improved performance - lower decomposition of refractory material.

OUR SOLUTION - CASTFRAX® S25-NG

Different from the standard material and owing to the innovative concepts used in its formulation design, our outstanding CASTFRAX® S25-NG presents extremely high performance when exposed to air even after 11 hours at 1,000°C, which is the most critical temperature for Al$_2$O$_3$-SiC-Carbon castables.

As a low oxidation rate leads to small variances on the castable porosity, those results indicate that the material’s corrosion resistance would clearly be increased during use.

<table>
<thead>
<tr>
<th>Oxidizer Layer (Relative Index)</th>
<th>S25-S</th>
<th>S25-NG</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours</td>
<td>100%</td>
<td>46%</td>
</tr>
<tr>
<td>11 hours</td>
<td>100%</td>
<td>39%</td>
</tr>
</tbody>
</table>

We developed an optimal material mix with very low oxidation rate.

Cross-sections of S25-S and S25-NG samples after oxidizing test at 1,000°C for 6 hours and 11 hours.
NEW MATERIAL CASTFRAX® S25-NG

Post-mortem samples of both materials (highlighting the regions where chemical analyses were performed) show that it is clear that the reason for trough campaign instability at blast furnaces with two holes was directly related to the poor oxidation resistance of S25-S.

<table>
<thead>
<tr>
<th>Region</th>
<th>$\text{Al}_2\text{O}_3$</th>
<th>SiC + C</th>
<th>$\text{SiO}_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASTFRAX® S25-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>62.2</td>
<td>11.7</td>
<td>22.4</td>
</tr>
<tr>
<td>2</td>
<td>65.4</td>
<td>11.9</td>
<td>17.6</td>
</tr>
<tr>
<td>3</td>
<td>59.6</td>
<td>13.7</td>
<td>16.2</td>
</tr>
<tr>
<td>CASTFRAX® S25-NG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>68.3</td>
<td>19.4</td>
<td>9.6</td>
</tr>
<tr>
<td>2</td>
<td>68.3</td>
<td>22.0</td>
<td>7.0</td>
</tr>
<tr>
<td>3</td>
<td>64.7</td>
<td>27.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Chemical analyses of different regions in the post-mortem samples of standard material and CASTFRAX® S25-NG (Results expressed in wt.%).

CASTFRAX® S25-S

CASTFRAX® S25-NG

Post-mortem samples of standard material CASTFRAX® S25-NG after 250 days of operation.

OUR SOLUTION HAS PROVIDED BETTER YIELD OF IRON PRODUCED FOR EVERY KG OF REFRACTORY USED

<table>
<thead>
<tr>
<th>FROM</th>
<th>47 days</th>
<th>25 days</th>
<th>25 days</th>
<th>97 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR</td>
<td>75.000 ton</td>
<td>40.000 ton</td>
<td>40.000 ton</td>
<td>155 Mton</td>
</tr>
<tr>
<td>PR1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO</td>
<td>71 days</td>
<td>62 days</td>
<td>62 days</td>
<td>257 days</td>
</tr>
<tr>
<td>PR</td>
<td>125.000 ton</td>
<td>100.000 ton</td>
<td>100.000 ton</td>
<td>425 Mton</td>
</tr>
<tr>
<td>RP1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PR</td>
<td></td>
<td></td>
<td></td>
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</table>

CAMPAIGN INCREASED BY - 3 TIMES

GR General Repair
PR Partial Repair

SPECIFIC CONSUMPTION

<table>
<thead>
<tr>
<th>kg/ton of steel</th>
<th>Previous</th>
<th>New material: CASTFRAX® S25-NG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.892 (2.0 lb/sh tn)</td>
<td>0.686 (1.5 lb/sh tn)</td>
</tr>
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</table>

VALUE PROPOSITION

- Higher yield between repairs
- Lower consumption of refractory material
- Longer trough campaigns
- Higher no. of campaigns
SHOTCRETE MATERIAL SHOTFRAX® CSB

Easy-to-pump and high corrosion resistance castables for cold and hot repairs for all regions of the main trough and secondary runners.

Characteristics

- State-of-the-art technology for T&R repair
- Quick installation rate
- Low rebound rate (< 5.0 %)
- Consolidated and long experience in the use of shotcrete for hot and cold repairs
- Association of fast pumping + robot application techniques, if necessary

Materials

- **SHOTFRAX® CSB 18**: High-performance Al₂O₃-SiC-C for main trough and metal runner
- **SHOTFRAX® CSB 30**: High-performance Al₂O₃-SiC-C for main trough and slag runner

Saint-Gobain Reference

<table>
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<th>DAILY PRODUCTION*</th>
<th>SAINT-GOBAIN SPECIFIC CONSUMPTION**</th>
<th>TOTAL NO. OF T&amp;R</th>
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<tbody>
<tr>
<td>1</td>
<td>1000 - 3000</td>
<td>0,60 - 0,70</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3000 - 7500</td>
<td>0,60 - 0,70</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>7000 - 8500</td>
<td>0,60 - 0,70</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>8500 - 11000</td>
<td>0,45 - 0,65</td>
<td>18</td>
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* Production in MT
** Specific consumption in kg/MT of Pig Iron

** Benefits**

- Extended lifetime
- Reduced refractory consumption
- Increased trough availability

Materials

- Extended lifetime
- Increased trough availability
- Reduced refractory consumption

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** Specific consumption in kg/MT of Pig Iron
SERVICES

SERVICE & APPLICATION

Continuous technical improvement in order to meet all the customer needs

- Technical assistance / continuous monitoring
- Equipment / procedures
- Reduction of repair time
- Campaign increase

VERY STRONG TECHNICAL ASSISTANCE DURING THE WHOLE LIFE CYCLE OF OUR PRODUCTS. FROM TECHNICAL INSTALLATION TO DEMOLITION.

SERVICE & EQUIPMENTS

A vast experience with contractors and partners for refractory installation and repairs

1. DEMOLITION
   We can support you with using the right equipment and technologies to ensure precise removal.

2. INSTALLATION SERVICE
   Various machines & processes for the service.

3. PLANNED SCHEDULING OF REPAIRS
   On the one hand, we monitor the original installation and subsequent repairs through frequent audits, and on the other hand, we help forecast repair needs well in advance.

4. RESIDUAL THICKNESS MAPPING
   During audits we provide such detailed analysis for better understanding the performance of refractory material enabling continuous improvement & lowering of operational costs.