SAINT-GOBAIN TODAY

TOP 100 GLOBAL INNOVATORS

1 product out of 4 sold by Saint-Gobain today didn’t exist 5 years ago

Nearly 400 patents filed in 2017

3700 Researchers

One of the top 100 industrial groups in the world

Present in 68 countries

2019 net sales €42.6 Billion

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.

We strive to deliver value through our global technical expertise in material science, manufacturing technology, design engineering and the long-term partnerships we form with our customers. Our employees are committed to delivering the best solutions and services to meet the unique material and engineering needs of our customers.

Our ability to deliver custom-made solutions for every application is further enhanced by our R&D centers, manufacturing plants, sales and application engineering specialists who are positioned strategically across the globe.

TOGETHER, WE MAKE THE MATERIAL DIFFERENCE.
BURNER SOLUTIONS TECHNOLOGIES

Our engineered ceramic products are custom designed, co-developed and manufactured for industrial heating applications. They deliver value in your toughest challenges related to efficiency, throughput, emissions and maintenance.

SINGLE ENDED RADIANT TUBE (SERT) SOLUTIONS

PERFORMANCE ENHANCING THERMAL DESIGNS FOR U- AND W-TUBES

KEY MARKETS & APPLICATIONS

NON FERROUS
ALUMINIUM, ZINC, COPPER

CHEMICAL
HIGH TEMPERATURE PROCESSING

AUTOMOTIVE
METAL HEAT TREATMENT

STEEL
CONTINUOUS ANNEALING
CONTINUOUS GALVANIZING

CERAMIC
DIRECT & INDIRECT HEATING
The foundation for our Burner Solutions is the silicon carbide radiant tube, that offers higher productivity at lower energy consumption. Our largest ceramic single ended radiant tube is 3.5 m long and withstands application temperatures up to 1,380°C / 2,500°F and can input up to twice as much energy as alloy radiant tubes into the furnaces. Available for straight and single-ended applications.

**CERAMIC RADIANT TUBE**

- Increased service-life
- Reduced maintenance costs
- Lower energy consumption
- Optimum efficiency
- Excellent creep resistance up to max. application of T = 1,380°C

**CERAMIC VS. METAL ALLOYS**

High temperature properties of Silit® SKD radiant tubes are superior in comparison to metal alloys. Strength of Silit® SKD is appr. 10 times higher and max. application temperature of 1,350°C compared to 1,100°C.

**MORE POWER**

- For both horizontally and vertically installed tubes, Silit® SKD can resist net heat outputs of appr. 50kW/m² (up to 1,050°C) whereas steel reach only 50% = 25kW/m².

**LOW MAINTENANCE AND WEAR**

- Strength of Silit® SKD is very good, no support for horizontal installation is necessary. Significantly higher resistance to bending rotation.
- No scaling on the ceramic tube. Therefore no wear and no cleaning of the tubes.
**RECUPERATORS**

Our recuperators that are integrated into burner systems for both direct and indirect-heating applications. Recuperator serves to recycle energy. Traditional ceramic recuperators allow for efficiencies of up to 75% in more sophisticated burner systems.

**FLAME TUBES / DIFFUSERS**

Flame tubes (diffusers) act as a guide for the flow of combustion and combustion gas in single-ended radiant tube applications.

**BURNER NOZZLES**

We provide a wide range of industrial, domestic oil or wood pellet boiler burners for direct heating. Amasic-3D® Additive Manufacturing, 3D printing capabilities enable us to offer burner nozzle designs of novel configurations and innovative designs to enhance performance.
Saint-Gobain also possesses a heat exchanger technology, enabled by its Amasic-3D® manufacturing platform that allows recuperators and burner systems to exceed 80% efficiencies. Known as HeatCor™, the unique twisted-channel design enables surface areas of up to 3x more than traditional recuperators that fit the same footprint.

**FEATURES**
- Thin-Wall Silicon Carbide
- Variable Twist / Channel Cross-Section
- 3D Printed End-Sets
- Novel Metal-Ceramic Interface

**CASE STUDY**
Continuous annealing line, U-type Radiant Tube w/metal recuperator

**Energy Savings:** 9% to 16%
**NOx Reduction:** 39%

<table>
<thead>
<tr>
<th>Metal recuperator</th>
<th>Efficiency</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70 - 72%</td>
<td>320 ppm</td>
</tr>
<tr>
<td>HeatCor™-140</td>
<td>After with HeatCor™-140</td>
<td>79% to 83%</td>
</tr>
<tr>
<td></td>
<td>NOx</td>
<td>195 ppm</td>
</tr>
</tbody>
</table>
SPYROCOR® RADIANT TUBE INSERTS

These inserts can be easily retrofitted into existing radiant tubes to improve efficiency and bolster the amount of heat that the radiant tube is re-radiating into the furnace chamber. By implementing these inserts, users can experience energy savings of up to 15% or throughput improvements of up to 5%. Available for simple installation in straight, U-type, W-type, and tri-type radiant tubes. Also applicable in P-type and double-P-type radiant tubes.

FEATURES

- Patented twist fin design
- Absorbs heat energy
- Re-radiates heat back into the furnace
- 2 - 6% throughput improvements

BENEFITS

- Reduction of exhaust temperature
- Improved energy efficiency
- Reduction of polluting emissions

CASE STUDY

Aluminum slab reheating furnace with W-type Radiant Tube & 567,000BTU/Hr burner

Energy saving: 9.7%
Additional capacity: +28 cycles / year
ROI*: 4 months

Natural gas consumed per furnace cycle

![Graph showing reduction in gas consumption]

More heat into the furnace allows operators to reach YOUR desired temperature faster and boost throughput.

*Energy savings represents an average at gas cost of $4.00/MMBZU.
NOXBUSTER® RADIANT TUBE INSERT

NOxBuster® patented design permits the recirculation of flue gasses within the radiant tube. With the NOxBuster® shape, you can significantly reduce flame temperature and lower NOx emissions by up to 50%!

BENEFITS

- Significant energy and maintenance savings via hot-spot elimination
- Combined with SpyroCor®, achieve temperature uniformity up to 150°F / 83°C

PYROCOR™ FLAME TUBE

An uniquely designed flame tube, modified and developed for use in U-tubes and W-tubes, that protects the radiant tubes by eliminating hot spots caused by direct flame impingement and increases the life of the radiant tube. The spiral shape can be custom engineered to promote excellent temperature uniformity.

Radiant Tube Temperature Profile
OUR SOLUTIONS

PERFORMANCE ENHANCING THERMAL DESIGNS

The combined benefits of Saint-Gobain’s Thermal Designs make them the best total sustainable solution for you. Apply them to your system to help achieve your performance objectives.

2% - 10% heat release with SpyroCor®

Improvements of uniformity with PyroCor™

Up to 50% NOx reduction with NOxBuster®

Advanced combustion with 3D Printed Burners

Up to 70% - 85% efficiency improvement with HeatCor™

SERT

U-TUBE

W-TUBE
**SILIT® SKD / AMASIC-3D®**

Silit® SKD and Amasic-3D® are a reaction-bonded, siliconinfiltrated silicon carbide (SiSiC).

**FEATURES & BENEFITS**
- Gastightness
- Very high thermal shock resistance
- Dimensional stability till maximum application temperature
- Very high thermal conductivity
- Low mass
- High efficiency
- High operational reliability and operating efficiency
- Amasic-3D®: 3D-printable SiSiC

**HEXOLOY® SA SiC**

Hexoloy® SA SiC is a pressureless, sintered form of alpha silicon carbide, with a density greater than 98% theoretical. It has a very fine grain structure (4 - 10 microns) for excellent wear resistance and contains no free silicon, which makes it highly chemically resistant in both oxidizing and reducing environments.

**FEATURES & BENEFITS**
- Near universal corrosion resistance
- Excellent resistance to wear
- Exceptional strength at high temperature
- High oxidation resistance, up to 1650°C in air
- Low thermal expansion
- High thermal conductivity
Saint-Gobain’s application engineers are available to assist you with your technical project in designing cost effective high performing products that will meet your need now and in the future.

<table>
<thead>
<tr>
<th>Test specification</th>
<th>Unit</th>
<th>Silit® SKD</th>
<th>Amasic-3D®</th>
<th>Hexoloy®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiC</td>
<td>%</td>
<td>85</td>
<td>60</td>
<td>&gt; 99</td>
</tr>
<tr>
<td>Si</td>
<td></td>
<td>15</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Maximum application temperature¹)</td>
<td>°F / °C</td>
<td>2510 / 1380</td>
<td>2460 / 1350</td>
<td>3450 / 1900</td>
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<tr>
<td>Bulk density</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN 993-1</td>
<td>g/cm³</td>
<td>3,0</td>
<td>2,8</td>
<td>3,1</td>
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<tr>
<td>Apparent porosity</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EN 993-1</td>
<td>Vol. %</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Young’s modulus RT²)</td>
<td>Gpa</td>
<td>340</td>
<td>155</td>
<td>430</td>
</tr>
<tr>
<td>Modulus of rupture RT²)</td>
<td>Mpa</td>
<td>260</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>Coefficient of thermal expansion α RT ... 1.300°C</td>
<td>EN 993-10</td>
<td>10⁻⁵/K</td>
<td>4,5</td>
<td>4,8</td>
</tr>
<tr>
<td>Thermal conductivity 1.000°C</td>
<td>EN 993-15</td>
<td>W/(m*K)</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

¹) Dependent on the corresponding operating conditions
²) Ambient temperature
SAINT-GOBAIN’S TOTAL BURNER SOLUTIONS

The combined benefits of Saint-Gobain’s Total Burner Solutions makes it the most sustainable solution for you. Apply them to your systems to help achieve up to

10% throughput  50% reduced emissions  30% energy savings  3x life

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