

SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES

WASTE TO ENERGY

PERFORMANCE REFRACTORY SOLUTIONS FOR WASTE THERMAL TREATMENT

SAINT-GOBAIN

Derwent Top 100
Global Innovator
2020

Clarivate Analytics

SAINT-GOBAIN TODAY

TOP100 GLOBAL INNOVATOR

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

3700
Researchers

Present in
70
countries

Nearly
400
patents filed each year

One of the top
100
industrial groups in the world

2020 turnover
€ 38.1
Billion

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.

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 accross the globe.

TOGETHER, WE MAKE A MATERIAL DIFFERENCE.



Excellent refractory materials, products and systems are our strengths and if you are looking for solutions for waste-to-energy facilities, then we are the specialists. Our products comply withthe highest economic and environmental requirements and are known to provide a high level of performance under the most demanding conditions. All well-known installation companies in this field are ranked among our partners.

It is our know-how and experience resulting from over 100 years development and production of refractory products that makes the difference. Silicon carbide with its excellent properties is an important base material that was discovered in our laboratories. As the world's largest manufacturer, no other company knows this material better than Saint-Gobain.



INDIVIDUAL SOLUTIONS FOR REFRACTORY

TAKING A STEP FORWARD WITH R&D

Worldwide, we support three R&D centers which work on the development of new and continuous improvement of existing ceramic products. As a result, we develop innovative bonded and monolithic refractory products with outstanding oxidation resistance and excellent thermal and mechanical properties, tailored to meet their respective application requirements.



OUR PRODUCTION - QUALITY BY EXPERIENCE

We can fulfill the highest quality standards for our products. Here, concern for worker safety and the environment play an important role in product development and manufacturing. Our manufacturing operations rely on decades of experience with refractory forming techniques and high temperature firing processes. Sophisticated manufacturing make it possible to produce complex components and systems. Due to high production capacity through our worldwide network of, we are able to accommodate demand schedules for large projects.



INDIVIDUAL SOLUTIONS FOR REFRACTORY

OUR CONSULTING - NOTHING IS LEFT TO CHANCE

The starting point of each venture is an individual consultation with our customer. Their needs and expectations as well as the existing technical and economic resources are carefully examined. Our experienced engineers and technicians find answers, analyse the operating conditions and give advice on the selection from the different qualities. Our worldwide sales team works closely together to offer a fast, personal service.



OUR EXPERIENCE - OUR EXPERTISE

Excellent refractory materials and system concepts support the efficient operation of waste to energy facilities. Due to our extensive worldwide experience, we have the expertise to find the best technical and design solutions for various types of waste conversion systems. We can provide thermal and mechanical design and modeling to fit system requirements. We work worldwide with leading installation companies that stock and install our products, while providing technical installation support, where needed.

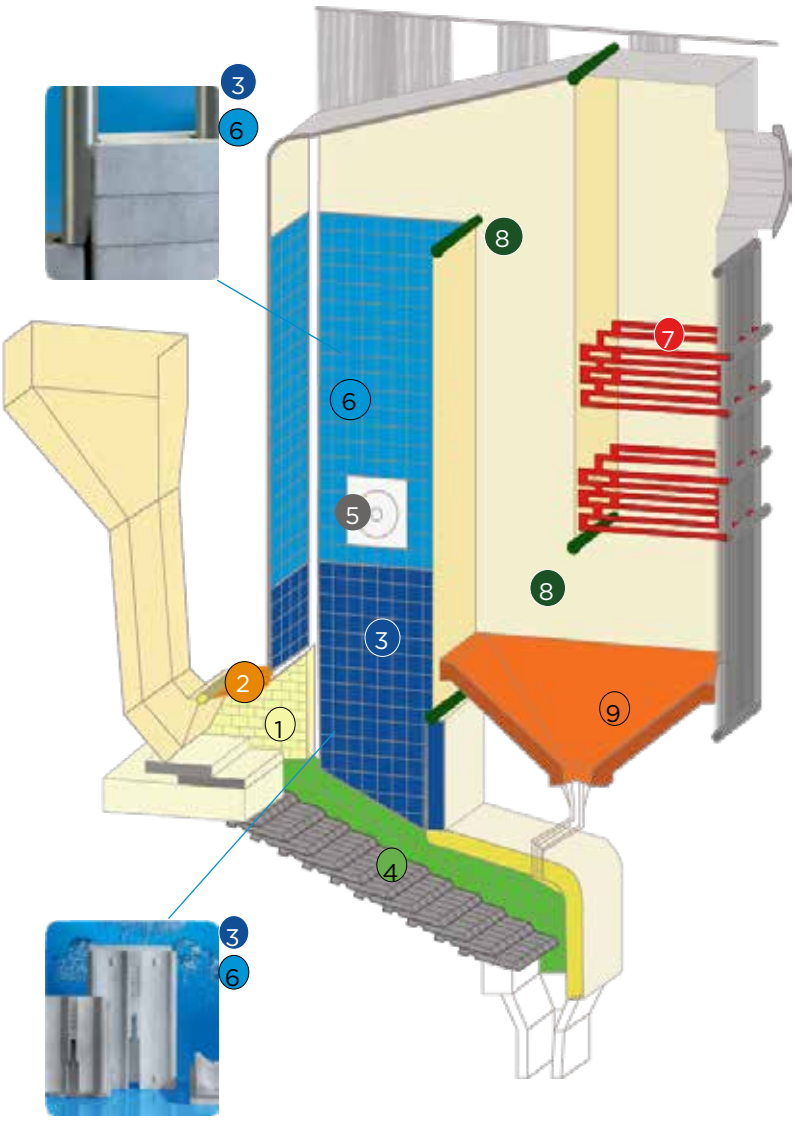


UNIQUE TUBE PROTECTION SYSTEMS

TAKING A STEP FORWARD WITH R&D

Saint-Gobain protection systems are extremely tough and highly efficient. They are optimized for each application from technical and economic points of view. The requirements are diverse: maximum protection for the tube walls against corrosion and erosion, optimal thermal conductivity, long lifetime, together with a safe and simple installation, keeping downtime and repairs to a minimum.

APPLICATION & PRODUCTS



1 Charge Zone
Alumina brick / Refrax® 20 Brick

2 Inlet Roof
Refrax® ProGun 80 / ProGun 70
Refrax® ProPlast 80 : ProGun 70
T-Clip PRO tile System

3 Combustion Area
T-Clip PRO tile system in
Refrax® PLUS Or
Refrax® TOP

4 Grate Lining
Special bricks in Refrax® PLUS Or Refrax® TOP

5 Burner Outlet
Alumina ramming- Alfrax AFR 700
SiC ramming – Refrax® ProRam 80 / Pro-Ram 70

6 1st Pass
T-Clip PRO tile system in
Refrax® PLUS Or
Refrax® TOP

7 Superheater
Special tubes shields in super cast Refrax® and super Refrax® 20
using Carbofrax® 3445AT mortar

8 Header/Collector
Refrax® ProGun 80 Or
Refrax® ProPlast 60 / ProPlast 70

9 Ash Hopper
Alfrax CK abrasion resistant trowel mix
Or Refrax® ProCast 70

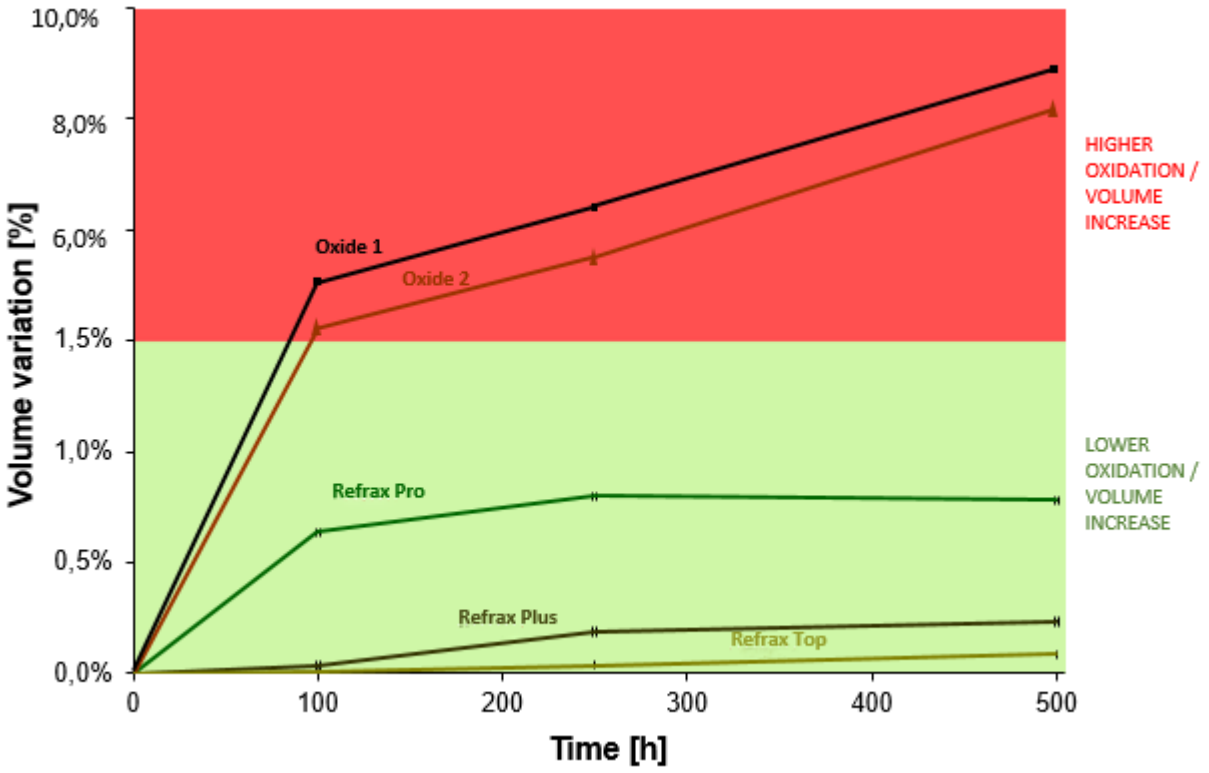
Repairs / Patching in tube areas 3,4,6,8
Refrax® ProGun 80 / ProGun 70 - suitable for troweling & casting
as Refrax® ProPlast 60 / ProPlast 70 – Plastic / Ram mix

REFRAX® PERFORMANCE OVERVIEW

MATERIAL OXIDATION

As the major enemy of silicon carbide within the WTE market, ASTM oxidation test is necessary for all typical SiC products of Saint-Gobain, especially in the case of Refrax® TOP (as shown in the graph below). Oxide or silicate bonded SiC will have a much higher level of oxidation and expansion of tiles (see typical oxide 1 & oxide 2 levels). We have the lowest level of oxidation and the longest life in the demanding conditions of WTE plants.

Test: ASTM C 683 – steam at 1000°C for 500 h

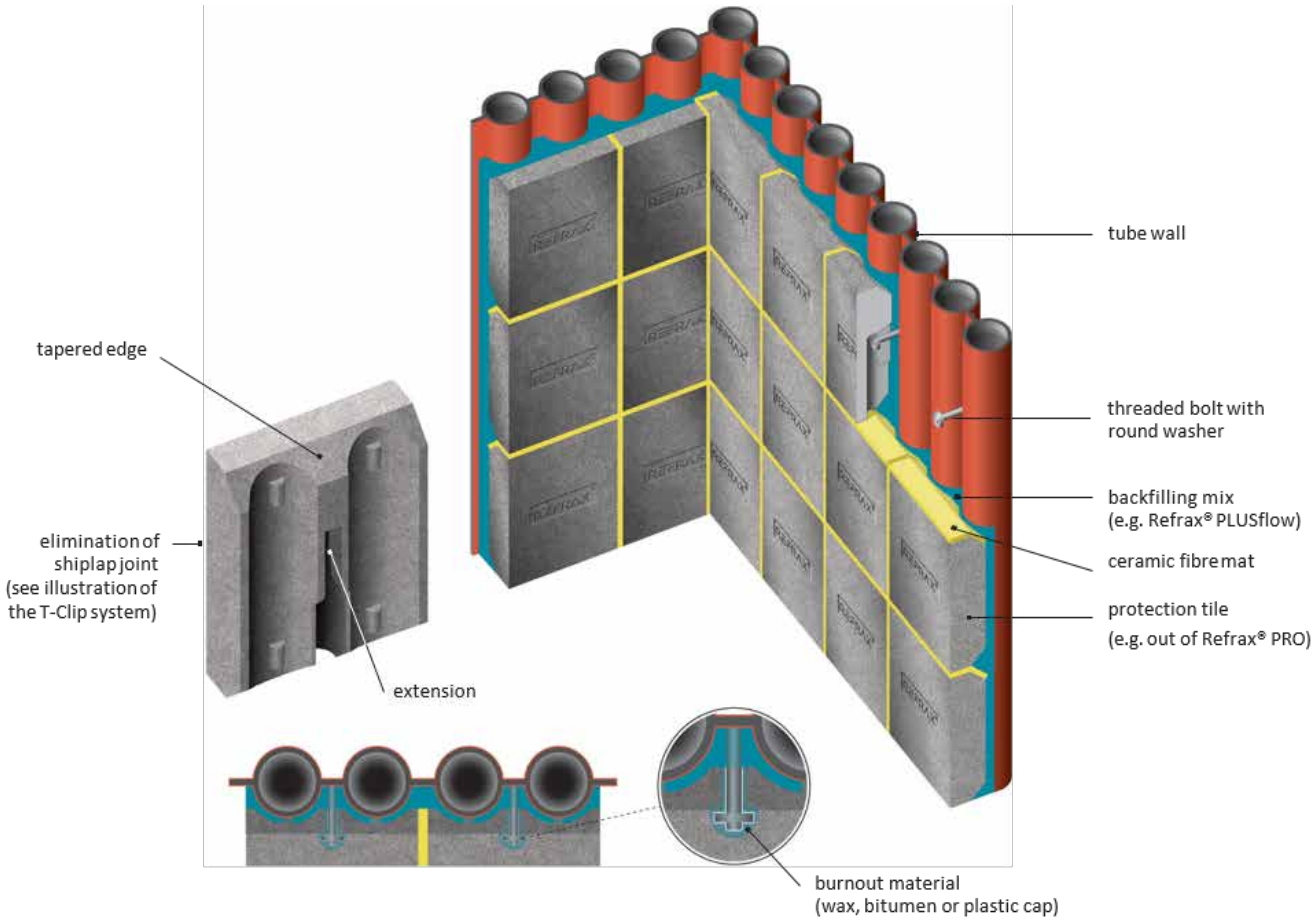


CONTENT OF THE FOLLOWING PAGES

- T-Clip PRO System
- T-Clip System
- 45° System
- CFB System
- Belly Brick System

THE T-CLIP PRO SYSTEMS

An optimized backfilled tile design offering optimum protection



BENEFITS

- Quick and precisely defind instllation
- Increased tile flexibility
- Reduced tension
- Oxidation & corrosion & high mechanical load resistance
- Excellent thermal conductivity
- Best price - performance ratio on the market
- Available for all tube diameters and spacings

APPLICATION

Can be used in all installation systems, for vertical boiler tube walls, e.g. the side walls, back and front walls, as well as the slanted tube walls on the ceiling, like inlet ceiling, burn out and boiler ceilings.

SYSTEMS FITTINGS

Anchorage to the tube wall: Threaded bolts with round washers made from heat-resistant steel with bitumen or wax coating (alternative with plastic caps).
Backfilling mix: Offers added protection against flue gases and reduces the anchor corrosion. Refrax® PLUSflow with higher thermal conductivity. The self-flowing and selfcompacting SiC concrete is formulated to fill a defined gap between the tile and the tube wall.
This ensures optimal contact to the wall and offers added protection against flue gases.
Note:
The tube walls in the ceiling area can be backfilled if the angles are not smaller than 15° otherwise the self-flowing SiC concrete would not fill the hollow spaces. If the angle is smaller than 15°, the tiles have to be laid using SiC mortar, Refrax® PROmor.
Ceramic fibre mats or fibre paper to compensate for potential expansion.

ASSOCIATE THIS UNIQUE SYSTEM TO THE BEST PERFORMING MATERIALS

Refrax® PLUS: Highly perfoming patented material to address harsher conditions with enhanced resistance to steam and chemical attack, thanks to significant improvements in material formulation.

Refrax® TOP: Outstanding material that provides superior performance to improve the life-time for special applications or in areas where ash or slag adhesion is a problem.

We can also supply our Refrax® PRO: Reliable, proven and quality material in standard condition areas.

STEADY STATE HEAT TRANSFER CALCULATIONS THROUGH PLANE WALL

T-CLIP PRO - DIFFERENT MATERIAL COMBINATIONS

MATERIAL COMBINATIONS		CALCULATIONS		
		SURFACE TEMPERATURE		HEAT LOSS PER m^2
TILE	BACKFILLING MIX	Inside °C	Outside °C	W/m^w
1 Refrax® PRO	Refrax® PLUSflow	419.0	266.1	61006
with ash build-up		775.1	262.4	23612
2 Refrax® PLUS	Refrax® PLUSflow	432.0	266.0	59645
with ash build-up		777.4	262.3	23372
3 Refrax® TOP	Refrax® PLUSflow	404.9	266.2	62487
with ash build-up		772.7	262.4	23868

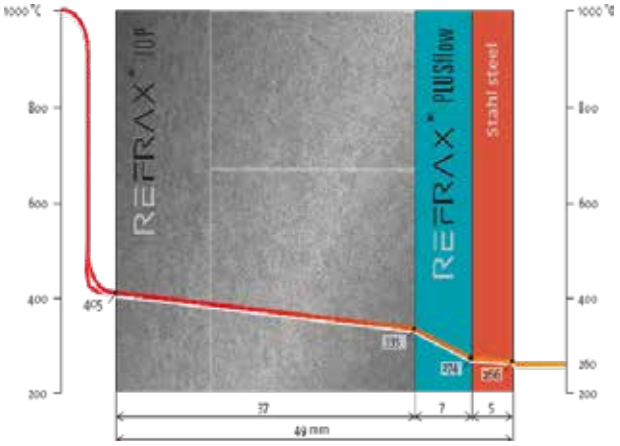
Following specifications apply to all calculations:
Ambient temperature inside 1000 °C, outside 260°C.
Heat transfer coefficient inside 105 W/m2K , outside 10000 W/m2K.
Material thickness for steel, tile, mix and build-up see tables and diagrams on the following pages. Calculation point: Soffit.



DETAILS FOR THE MATERIAL COMBINATION 3

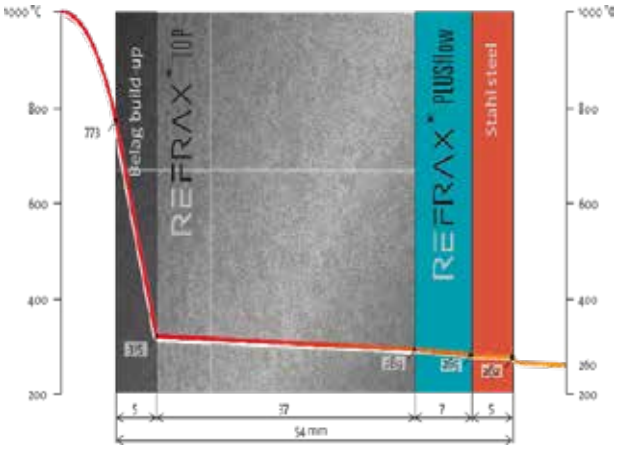
WALL LAYERS FROM INSIDE TO OUTSIDE - WITHOUT BUILD-UP

MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Refrax® TOP	37.0	33.00	370	404.9
Refrax® PLUSflow	7.0	7.200	304	334.8
Steel	5.0	40.00	270	274.1
	49.0			266.2



WALL LAYERS FROM INSIDE TO OUTSIDE - WITH BUILD-UP

MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Ash build-up	5.0	0.279	529	772.7
Refrax® TOP	37.0	33.00	302	315.3
Refrax® PLUSflow	7.0	7.200	277	288.6
Steel	5.0	40.00	264	265.4
	54.0			262.4

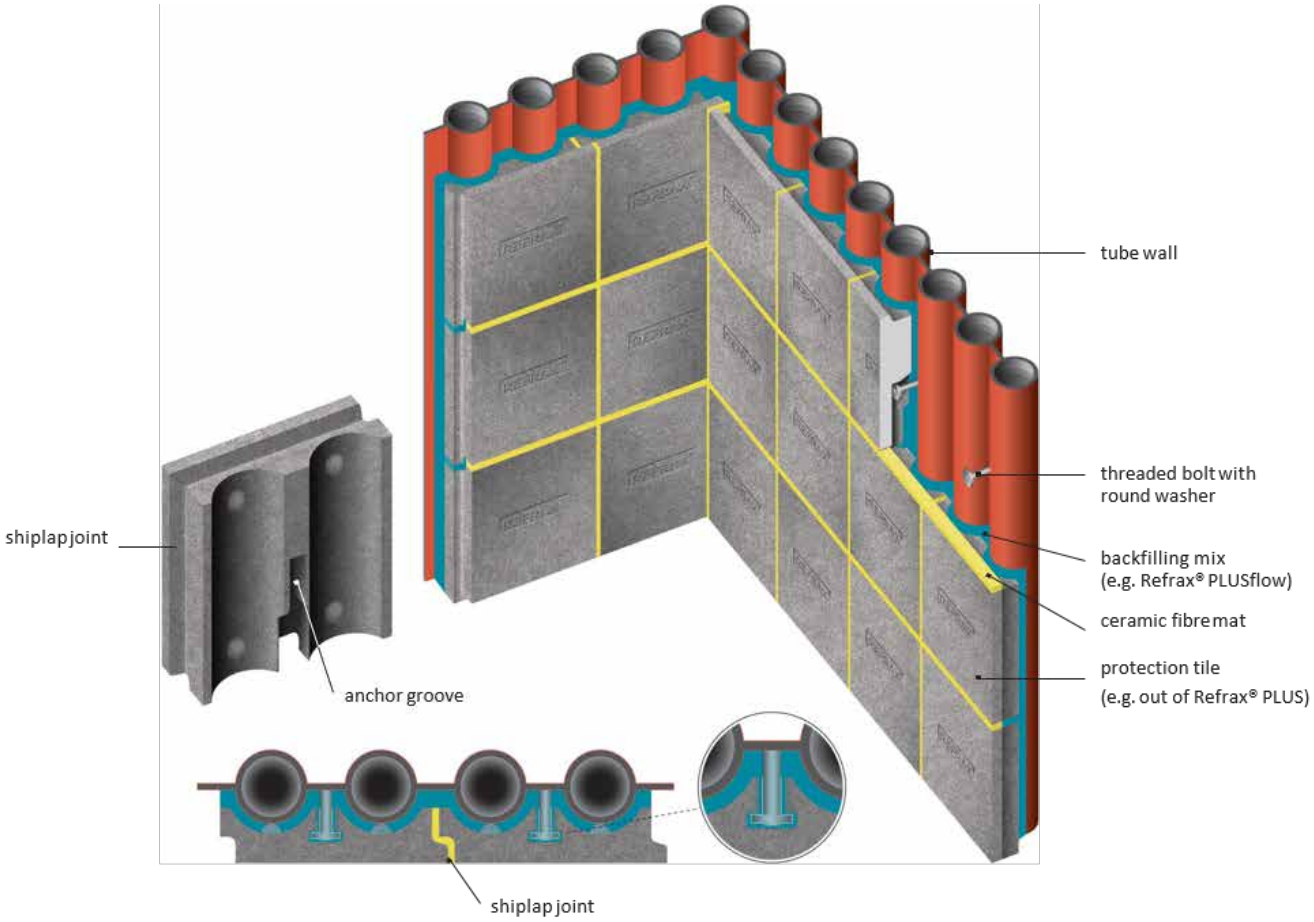


Heat Transfer Calculations

The thermal conductivity values used in these calculations are average values, recognizing that thermal conductivity can have a range of values according to testing procedure and material and manufacturing variations. Therefore, the calculations represent an approximation of heat transfer characteristics and should be used accordingly, without a guarantee of results. Also, metallic anchors (hangers), joints between tiles and unusual buildup of ash deposits or any other factors which would change the tubewall design assumptions in the heat transfer models are not included in the calculations.

THE T-CLIP SYSTEM

Patented backfilling design for reliable protection



BENEFITS

- Quick and clean instllation
- Universally applicable
- Excellent heat conductivity
- Protection (oxidation & corrosion & high mechanical stress resistance)
- Very good price - performance ratio on the market

APPLICATION

Can be used in all installation systems, for vertical boiler tube walls, e.g. the side walls, back and front walls, as well as the slanted tube walls on the ceiling, like inlet ceiling, burn out and boiler ceilings.

SYSTEMS FITTINGS

Anchorage to the tube wall: Threaded bolts with round washers made from heat-resistant steel with bitumen or wax coating (alternative with plastic caps).
Backfilling mix: Offers added protection against flue gases and reduces the anchor corrosion. Refrax® PLUSflow with higher thermal conductivity. The self-flowing and selfcompacting SiC concrete is formulated to fill a defined gap between the tile and the tube wall.
This ensures optimal contact to the wall and offers added protection against flue gases.
Note:
The tube walls in the ceiling area can be backfilled if the angles are not smaller than 15° otherwise the self-flowing SiC concrete would not fill the hollow spaces. If the angle is smaller than 15°, the tiles have to be laid using SiC mortar, Refrax® PROmor.
Ceramic fibre mats or fibre paper to compensate for potential expansion.

ASSOCIATE THIS UNIQUE SYSTEM TO THE BEST PERFORMING MATERIALS

Refrax® PLUS: Highly perfoming patented material to address harsher conditions with enhanced resistance to steam and chemical attack, thanks to significant improvements in material formulation.

Refrax® TOP: Outstanding material that provides superior performance to improve the life-time for special applications or in areas where ash or slag adhesion is a problem.

We can also supply our Refrax® PRO: Reliable, proven and quality material in standard condition areas.

STEADY STATE HEAT TRANSFER CALCULATIONS THROUGH PLANE WALL

T-CLIP - DIFFERENT MATERIAL COMBINATIONS

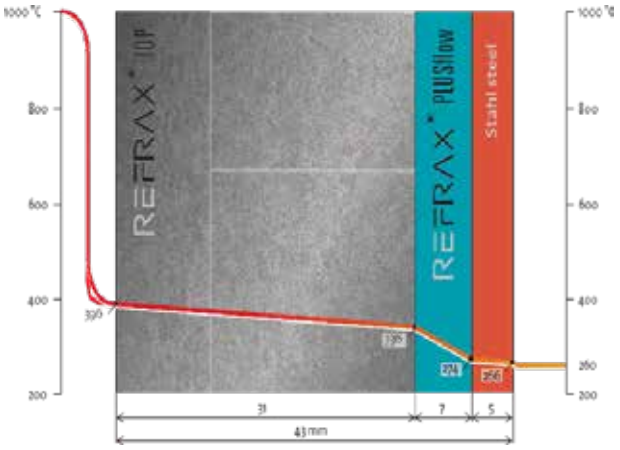
MATERIAL COMBINATIONS		CALCULATIONS		
		SURFACE TEMPERATURE		HEAT LOSS PER m²
TILE	BACKFILLING MIX	Inside °C	Outside °C	W/m²
1 Refrax® PRO	Refrax® PLUSflow	407.8	266.2	62184
with ash build-up		773.2	262.4	23813
2 Refrax® PLUS	Refrax® PLUSflow	419.1	266.1	60998
with ash build-up		775.2	262.4	23607
2 Refrax® TOP	Refrax® PLUSflow	395.6	266.3	63463
with ash build-up		771.1	262.4	24031

Following specifications apply to all calculations:
Ambient temperature inside 1000 °C, outside 260°C.
Heat transfer coefficient inside 105 W/m2K , outside 10000 W/m2K.
Material thickness for steel, tile, mix and build-up see tables and diagrams on the following pages. Calculation point: Soffit.

DETAILS FOR THE MATERIAL COMBINATION 3

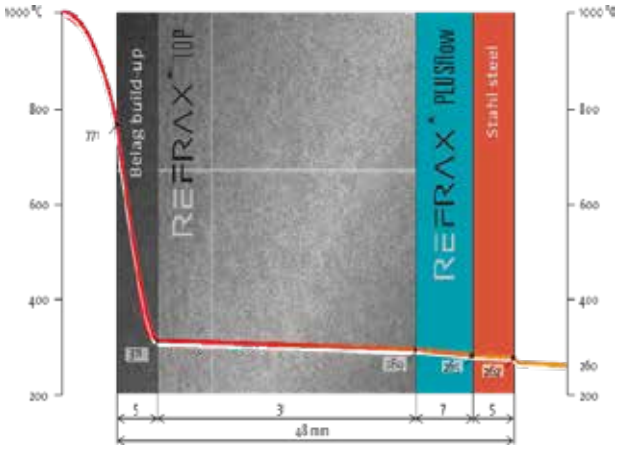
WALL LAYERS FROM INSIDE TO OUTSIDE - WITHOUT BUILD-UP

MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Refrax® TOP	31.0	33.00	366	395.6
Refrax® PLUSflow	7.0	7.200	305	336.0
Steel	5.0	40.00	270	274.3
	43.0			266.3



WALL LAYERS FROM INSIDE TO OUTSIDE - WITH BUILD-UP

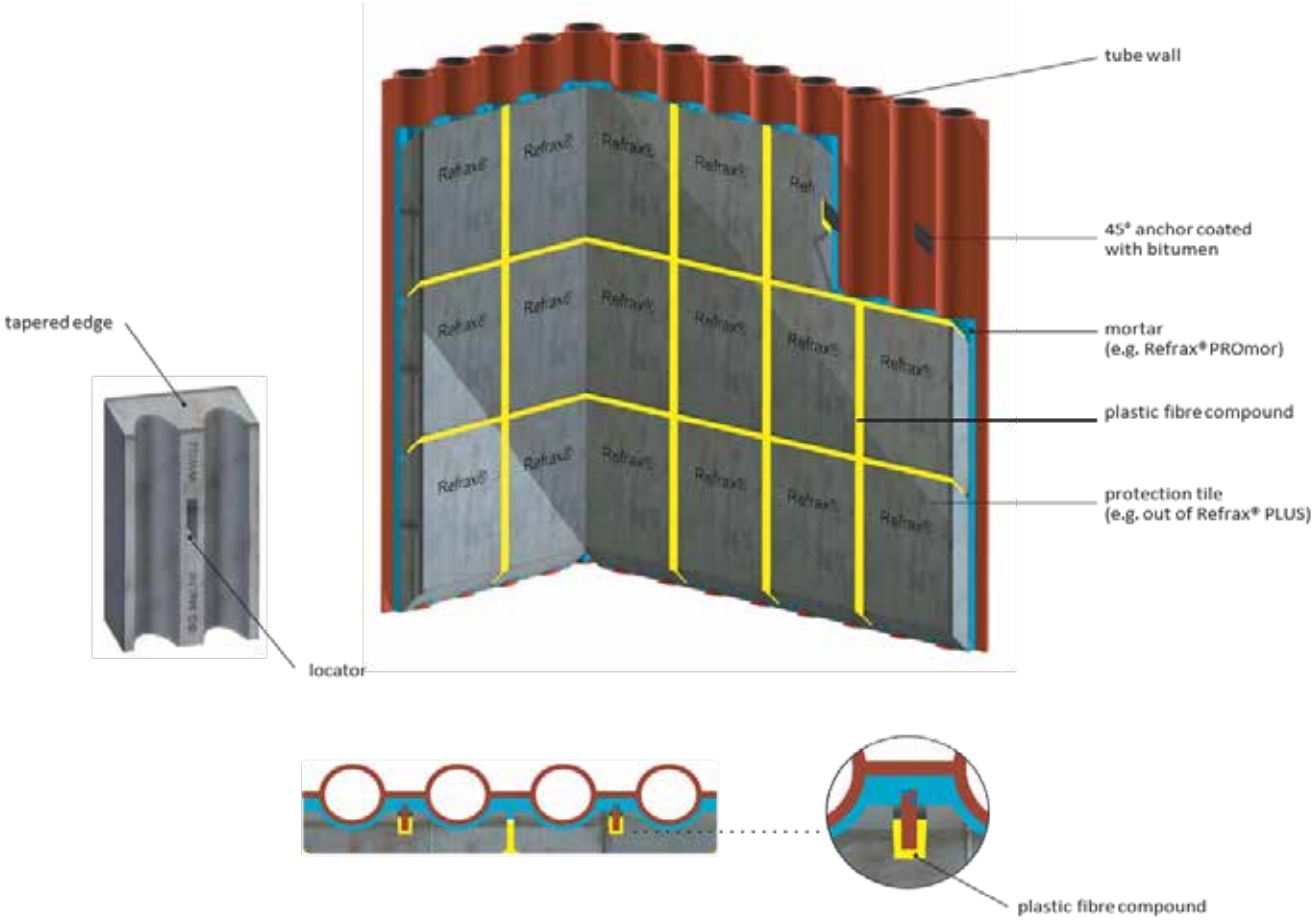
MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Ash build-up	5.0	0.280	527	771.1
Refrax® TOP	31.0	33.00	300	311.3
Refrax® PLUSflow	7.0	7.200	277	288.8
Steel	5.0	40.00	264	265.4
	48.0			262.4



Heat Transfer Calculations
The thermal conductivity values used in these calculations are average values, recognizing that thermal conductivity can have a range of values according to testing procedure and material and manufacturing variations. Therefore, the calculations represent an approximation of heat transfer characteristics and should be used accordingly, without a guarantee of results. Also, metallic anchors (hangers), joints between tiles and unusual buildup of ash deposits or any other factors which would change the tubewall design assumptions in the heat transfer models are not included in the calculations.

THE 45° SYSTEM (OPTIMIZED)

Mortared system



BENEFITS

- Good thermal conductivity and quicker cooling effect
- Simple and quick replacement
- High durability

APPLICATION

Can be used in all installation systems, for vertical boiler tube walls, e.g. the side walls, back and front walls, as well as the slanted tube walls on the ceiling, like inlet ceiling, burn out and boiler ceilings.

SYSTEMS FITTINGS

Anchorage to the tube wall: 45° anchors made from heat-resistant steel covered with bitumen or wax coating.
Mortar: Refrax® PROmor, a chemical-ceramic bonded, thick refractory mortar with the best possible cohesion. This ensures optimal contact to the wall and offers added protection against flue gases.
Plastic fibre compound (alternatively ceramic fibre mat) to fill in the anchorage and assure flexibility of the tiles and to file the joint and compensate for potential expansion.

ASSOCIATE THIS UNIQUE SYSTEM TO THE BEST PERFORMING MATERIALS

Refrax® PLUS: Highly perfoming patented material to address harsher conditions with enhanced resistance to steam and chemical attack, thanks to significant improvements in material formulation.

Refrax® TOP: Outstanding material that provides superior performance to improve the life-time for special applications or in areas where ash or slag adhesion is a problem.

We can also supply our Refrax® PRO: Reliable, proven and quality material in standard condition areas.

STEADY STATE HEAT TRANSFER CALCULATIONS THROUGH PLANE WALL

45° - DIFFERENT MATERIAL COMBINATIONS

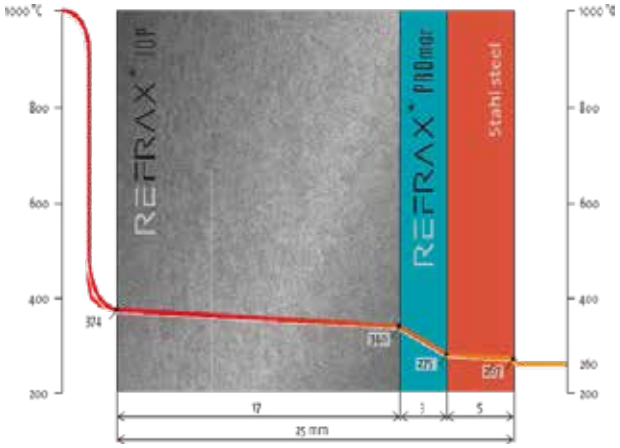
MATERIAL COMBINATIONS		CALCULATIONS		
		SURFACE TEMPERATURE		HEAT LOSS PER m²
TILE	BACKFILLING MIX	Inside °C	Outside °C	W/m²
1 Refrax® PRO	Refrax® PLUSflow	381.5	266.5	64940
with ash build-up		768.8	262.4	24275
2 Refrax® PLUS	Refrax® PLUSflow	388.3	266.4	64228
with ash build-up		769.9	262.4	24158
2 Refrax® TOP	Refrax® PLUSflow	374.3	266.6	65696
with ash build-up		767.7	262.4	24397
2 Carbofrax® BASIC	Refrax® PROmor	399.0	266.3	63109
with ash build-up		771.1	262.4	23973

Following specifications apply to all calculations:
Ambient temperature inside 1000 °C, outside 260°C.
Heat transfer coefficient inside 105 W/m2K , outside 10000 W/m2K.
Material thickness for steel, tile, mix and build-up see tables and diagrams on the following pages. Calculation point: Soffit.

DETAILS FOR THE MATERIAL COMBINATION 3

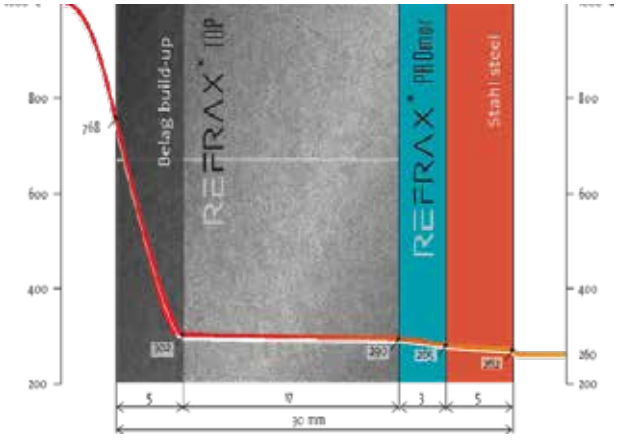
WALL LAYERS FROM INSIDE TO OUTSIDE - WITHOUT BUILD-UP

MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Refrax® TOP	17.0	33.00	357	374.3
Refrax® PROmor	3.0	3.000	308	340.5
Steel	5.0	40.00	271	274.8
	25.0			266.6



WALL LAYERS FROM INSIDE TO OUTSIDE - WITH BUILD-UP

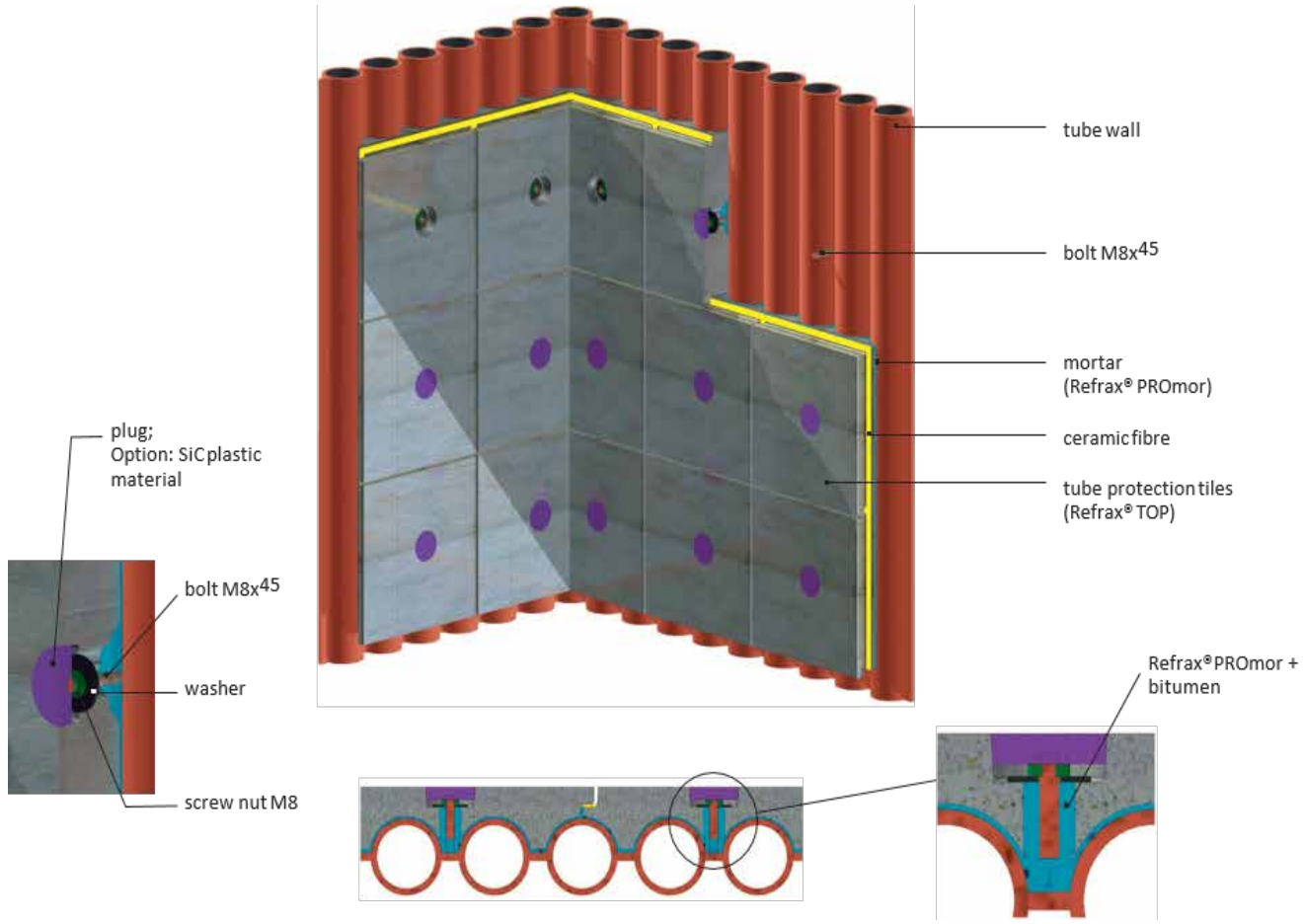
MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Ash build-up	5.0	0.282	520	767.7
Refrax® TOP	17.0	33.00	296	302.5
Refrax® PROmor	3.0	3.000	278	289.9
Steel	5.0	40.00	264	265.5
	30.0			262.4



Heat Transfer Calculations
The thermal conductivity values used in these calculations are average values, recognizing that thermal conductivity can have a range of values according to testing procedure and material and manufacturing variations. Therefore, the calculations represent an approximation of heat transfer characteristics and should be used accordingly, without a guarantee of results. Also, metallic anchors (hangers), joints between tiles and unusual buildup of ash deposits or any other factors which would change the tubewall design assumptions in the heat transfer models are not included in the calculations.

THE CFB SYSTEM

Tile protection system for CFB (circulated fludized bed) plants



BENEFITS

- High abrasion resistance of tile and joint
- Good thermal conductivity
- Protection of the anchor system (abrasion & corrosion resistance)
- No plastic fibre compound for the joint of the tiles is necessary

APPLICATION

Suitable for CFB plants with tube walls in the combustion celling / freeboard area, especially for intensive abrasion, corrosive load and heat transfer areas.

SYSTEMS FITTINGS

Anchorage to the tube wall: Pin, disc and screw nut made of heat-resistance steel covered with bitumen for fastening to the tube wall and closure plug in SiC or equivalent.
Mortar: Refrax® PROmor, a specially developed ceramic-bonded SiC refractory mortar with excellent adhesion
behavior and high thermal conductivity.
Ceramic fiber stripe to minimize the stress between the tiles.

ASSOCIATE THIS UNIQUE SYSTEM TO THE BEST PERFORMING MATERIALS

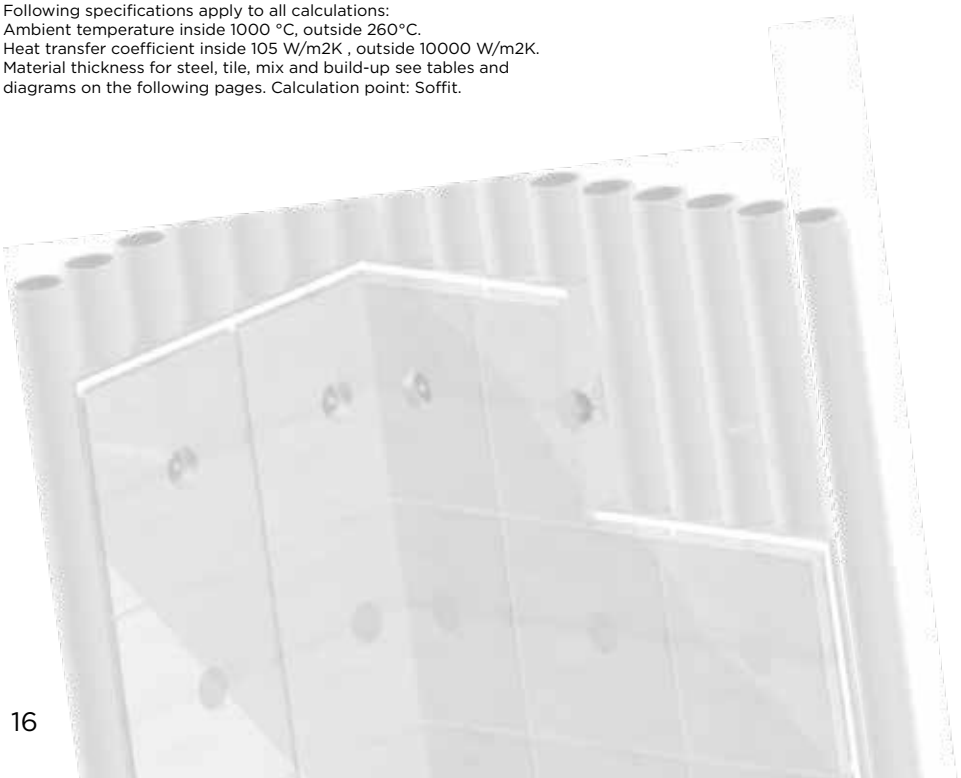
Refrax® TOP: Outstanding material that provides superior performance to improve the life-time for special applications or in areas where ash or slag adhesion is a problem.

STEADY STATE HEAT TRANSFER CALCULATIONS THROUGH PLANE WALL

CFB - DIFFERENT MATERIAL COMBINATIONS

MATERIAL COMBINATIONS		CALCULATIONS		
		SURFACE TEMPERATURE		HEAT LOSS PER m²
TILE	BACKFILLING MIX	Inside °C	Outside °C	W/m²
1 Refrax® TOP	Refrax® PROmor	391.1	265.9	58682
with ash build-up		724.6	262.4	23670

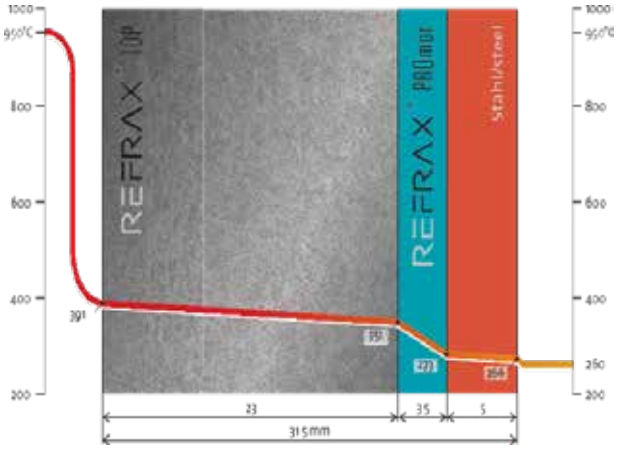
Following specifications apply to all calculations:
Ambient temperature inside 1000 °C, outside 260°C.
Heat transfer coefficient inside 105 W/m2K , outside 10000 W/m2K.
Material thickness for steel, tile, mix and build-up see tables and diagrams on the following pages. Calculation point: Soffit.



DETAILS FOR THE MATERIAL COMBINATION 3

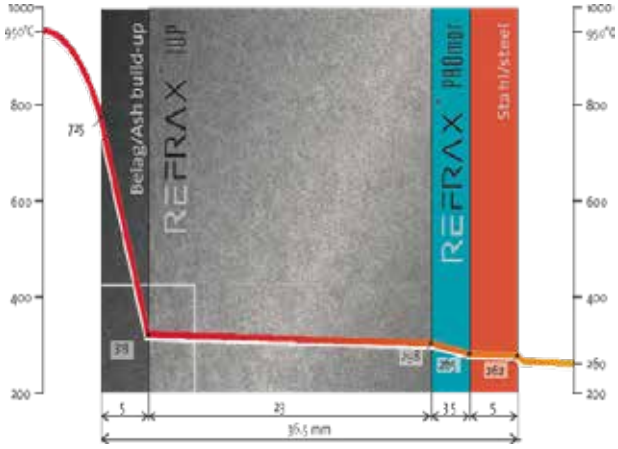
WALL LAYERS FROM INSIDE TO OUTSIDE - WITHOUT BUILD-UP

MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Refrax® TOP	23	33.75	371	391.1
Refrax® PROmor	3.5	3.000	313	351.1
Steel	5.0	40.00	270	273.2
	31.5			265.9



WALL LAYERS FROM INSIDE TO OUTSIDE - WITH BUILD-UP

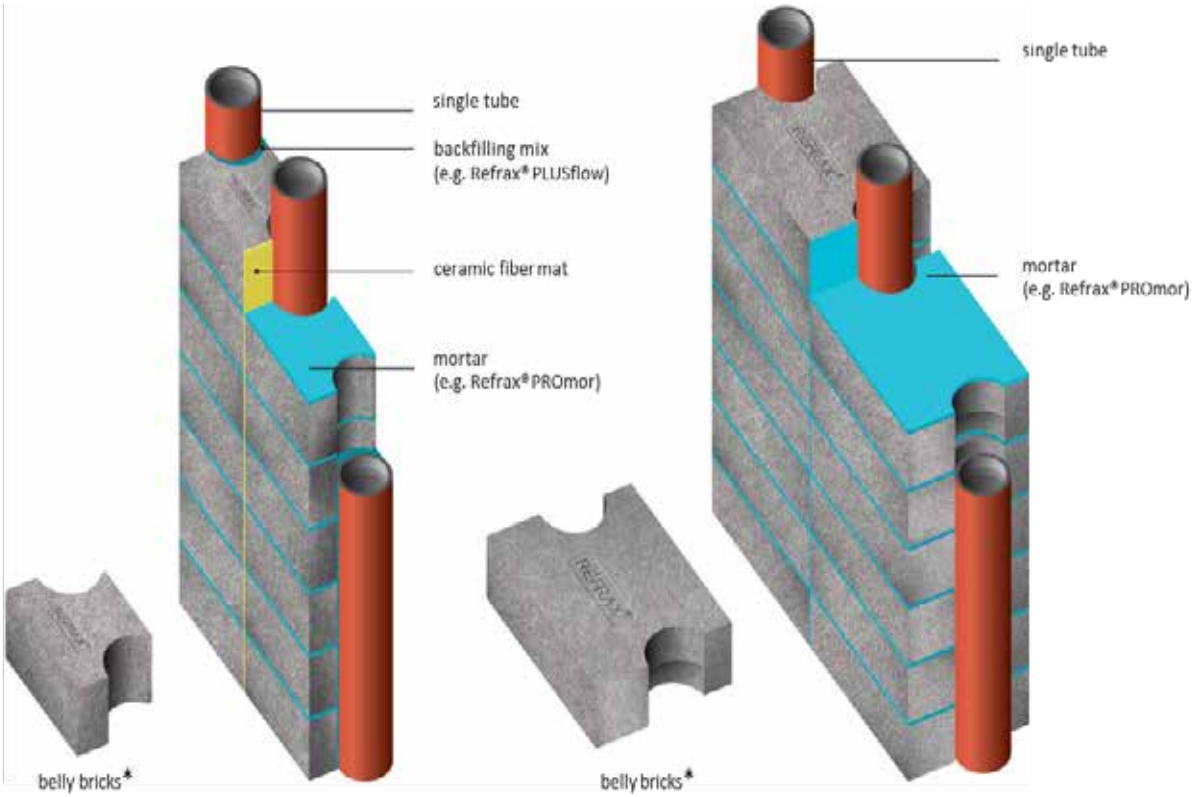
MATERIAL			TEMPERATURE °C	
	mm	W/mK	Mean temperature	Interface temperature
Ash build-up	5.0	0.2909	498	724.6
Refrax® TOP	23	33.75	306	313.3
Refrax® PROmor	3.5	3.000	282	298
Steel	5.0	40.00	264	265.3
	36.5			262.4



Heat Transfer Calculations
The thermal conductivity values used in these calculations are average values, recognizing that thermal conductivity can have a range of values according to testing procedure and material and manufacturing variations. Therefore, the calculations represent an approximation of heat transfer characteristics and should be used accordingly, without a guarantee of results. Also, metallic anchors (hangers), joints between tiles and unusual buildup of ash deposits or any other factors which would change the tubewall design assumptions in the heat transfer models are not included in the calculations.

THE BELLY BRICK SYSTEM

Simple and safe protection for single tube walls



The choice of the belly brick design depends on the boiler type in which it will be installed.

BENEFITS

- Simple and safe assembly
- High corrosion resistance
- High mechanical durability at high T°C
- Excellent thermal conductivity
- Available for all tube diameters and spacings

APPLICATION

Protection of single tube walls in high temperature areas and in the main combustion zone.

MATERIAL

Bricks: Refrax® PRO, Refrax® PLUS and Refrax® TOP
Installation: without metallic fittings
Mortar: Refrax® PROmor, a chemical-ceramic bonded, thick refractory mortar with best cohesion to the tiles
Backfilling mix: Refrax® PLUSflow
Ceramic fibre mat or paper to compensate for any expansion


REFRAX
REFRAX® PLUSflow
REFRAX® PLUS
REFRAX® PRO
AX® TOP
Refrax Promor
Carbal 130

EXTREMELY RESISTANT MATERIALS

It is the material that makes the refractory products from Saint-Gobain so exceptional. In order to meet the different thermal and chemical requirements in the boiler of steam generators in the best possible way, Saint-Gobain has developed various silicon carbide (SiC) based materials.

Contents of the following pages:

General Material Properties

The Material REFRAX®:
- Production, properties, types and details regarding the material Refrax® PLUS

The Material CARBAL® 130:
- Properties and types

The Material CARBOFRAX®:
- Properties and types



MATERIALS WITH OUTSTANDING PROPERTIES

In addition to the most important SiC properties, such as:
Excellent mechanical properties, even in high-temperature areas:

- Extreme hardness and high wear-resistance
- High thermal shock resistance
- Low thermal expansion

Very good heat conductivity
Corrosion resistance up to highest temperatures

Saint-Gobain materials have an additional decisive advantage:
Excellent oxidation resistance.

Due to the moisture from the wet waste and the operating conditions with high oxygen content, the wall linings made from silicon carbide are detrimentally affected by oxygen, steam or carbon dioxide. Normally this leads to an increase in volume, stress and crack formations in the tube wall protection tiles.

Saint-Gobain qualities Refrax® and Carbofrax® are produced using engineered bond phases that reduce oxidation and the resulting effects to a minimum.

BENEFITS

- Increased durability of the wall lingins
- Reduced maintenance costs
- Minimized unplanned down-time
- Quick pay-back time
- High energy efficiency

THE REFRAX® PRODUCT FAMILY

Under the name Refrax®, Saint-Gobain offers various qualities of nitride bonded SiC (NSiC).

Production
A moulded body of SiC granulate and metallic silicon powder is fired in an atmosphere of nitrogen at approximately 1400°C. Thereby the initial metallic silicon changes to the very stable silicon nitride (Si_3N_4). In case of our Refrax® TOP quality, the material is subsequently exposed to an oxidizing atmosphere above 1200°C. During this process a thin oxidation protection layer in the form of a very hard glass layer is formed on the surface of the moulded body.

BENEFITS

- Excellent oxidation resistance thanks to its small pore size
- Excellent thermal conducivity
- Low thermal expansion
- High mechanical strength

THE REFRAX® TYPES

In order to fulfill all the technical and economical requirements, Saint-Gobain has developed and newly arranged its material portfolio.

Shaped Products:

Material name	Description
Refrax® PRO	Tried and tested material with narrow tolerances. Application areas: Standard product for the first pass and the combustion area.
Refrax® PLUS	Endowed patented premium product for the toughest requirements. Application areas: For all areas; particularly suited for areas exposed to high wear and high stresses and for repairs.
Refrax® TOP	Doped patented, doubled fired material with glazed surface. Application areas: For all areas; particularly suited for areas exposed to aggressive slags.

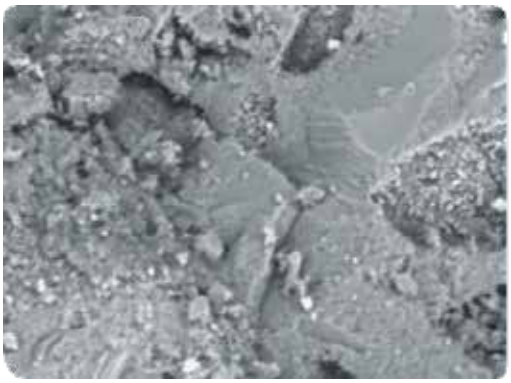
Castable / Mortar:

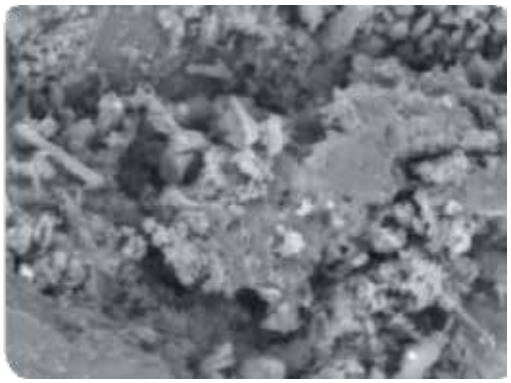
Material name	Description
Refrax® Plusflow	Backfilling mix with maximised thermal conductivity for T-Clip systems.
Refrax® PROmor	Mortar for 45° systems, CFB systems and belly bricks.

Sales and R&D departments work hand in hand to offer constantly improved materials.

DIFFERENT BONDING MORPHOLOGIES

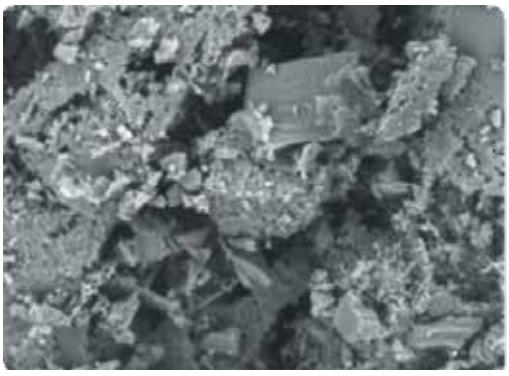
The Refrax® PRO bonding morphology

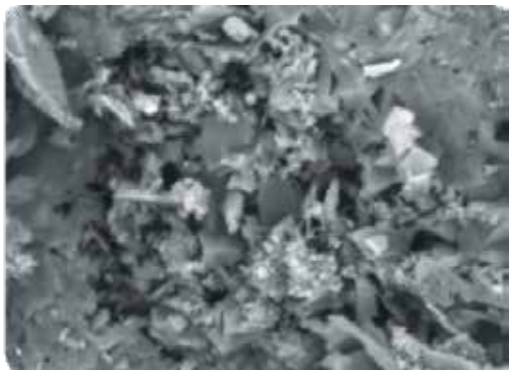




The bonding phase is more amourphous, with corresponding large surface structure.

The Refrax® PLUS bonding morphology



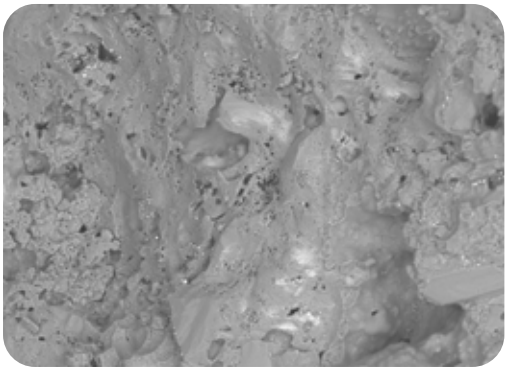


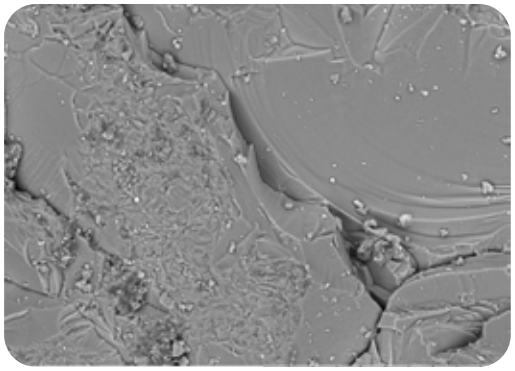
The crystalline build up in the bonding phase can be clearly seen. The surface is minimized by this well-regulated build up. Reactions to other materials, e.g. O_2, are thus hindered. In addition to this, the crystalline build up offers a high mechanical stability due to the structure.

Refrax® PRO and Refrax® PLUS bonding morphology after the corrosions test (1000°C / 500h).
Investigations of the Refrax® PRO and Refrax® PLUS materials after the steam corrosion test have led to the following findings:
In comparison to the usual nitride bonded SiC materials, Refrax® PLUS shows after the corrosion test:

- New microstructure with bigger crystals which improves resistance to corrosion and oxidation (due to the reduced surface)
- Low volume expansion, due to the low oxidation. This is very important for the application, since the adjusted expansion joints remain intact and the material can be used for a longer period of time
- Very low increase of volume. The mechanical strength remains constant in contrast to oxide bonded SiC, where the mechanical strength decreases with increasing temperature

The Refrax® TOP bonding morphology





As far as Refrax® TOP concerned, thanks to its special material composition and a second firing process, a glazed phase is generated at the surface, which clogs the material porosity and acts as durable physical barrier to corrosive media. This material is preferred in areas where ash or slag adhesion is a problem.

CARBAL® 130

The Saint-Gobain product Carbal® 130 consists of Al_2O_3 (40%) and high-quality SiC (50%).

This material represents an additional alternative to the nitride-bound qualities for controlling the heat balance in a boiler.
In addition, Carbal® 130 is characterized by its significantly lower porosity and the increased cold crushing strength (CCS) compared to SiC - refractory monolithic mixes.

BENEFITS

- Excellent oxidation resistance
- Good stress and form stability due to its better surface resistance
- Lower thermal conductivity
- High abrasion resistance due to addition of alumina oxide

Material name	Description
Carbal® 130	Tried and tested SiC (50%) material with addition of alumina (40%). Very good price-performance ratio. Application areas: Special bricks and tiles.



CARBOFRAX®

The silicate bonded SiC from Saint-Gobain.

Although Saint-Gobain Refrax® Materials have, to a large extent, replaced this material, Carbofrax® is still successfully used for certain applications, for example in plants with low heating values. It is characterized by its high SiC content (85%), and, in contrast to alternative materials, high thermal conductivity.

BENEFITS

- Excellent resistance to corrosion from gases at low T°C, thanks to the glaze on the materials, which acts as protection
- Good fracture toughness at middle T°C. This is thanks to the silicate bonding which makes the material less brittle

Material name	Description
Carbofrax® BASIC	Tried and tested silica bonded material with narrow tolerances. Very good cost-performance ratio according to Saint-Gobain quality standards. Application areas: Special bricks, and spandrel bricks.



Saint-Gobain

More Expertise, More Safety - A Reliable Partnership

Energy efficiency and environmental protection

30% of the turnover and 40% of the operating profit of the Saint-Gobain group are achieved through solutions, which help save energy, produce clean energy and protect the environment.
The innovation capacity of the company plays a major role here, 20% of all Saint-Gobain products are less than 5 years old.
Together with our subsidiaries, who specialize in high performance ceramics, as well as R&D centres in France and the U.S.A., we have established a leading team of ceramic experts. From the resources, the know-how and the technology within this worldwide network, synergies are created which guarantee expertise and safety even in complex projects.

Focus: Our employees, quality and environmental protection

Our employees and their dedication ensure the success of our products. Their highest priority is always to ensure stringent quality standards while adhering to safety standards of the highest level which are a must within our company. We also feel a responsibility towards the challenges facing the environment. Not only our products, but also our production processes play an active part in protecting the environment. Saint-Gobain has been a member of the United Nations Global Compact since 2003 and has also signed their declaration of management support for human rights.

We have the following certificates:

Quality:	DIN EN ISO 9001
Environment:	DIN EN ISO 14001
Occupational Safety:	OHSAS 18001
Energy:	ISO 500001

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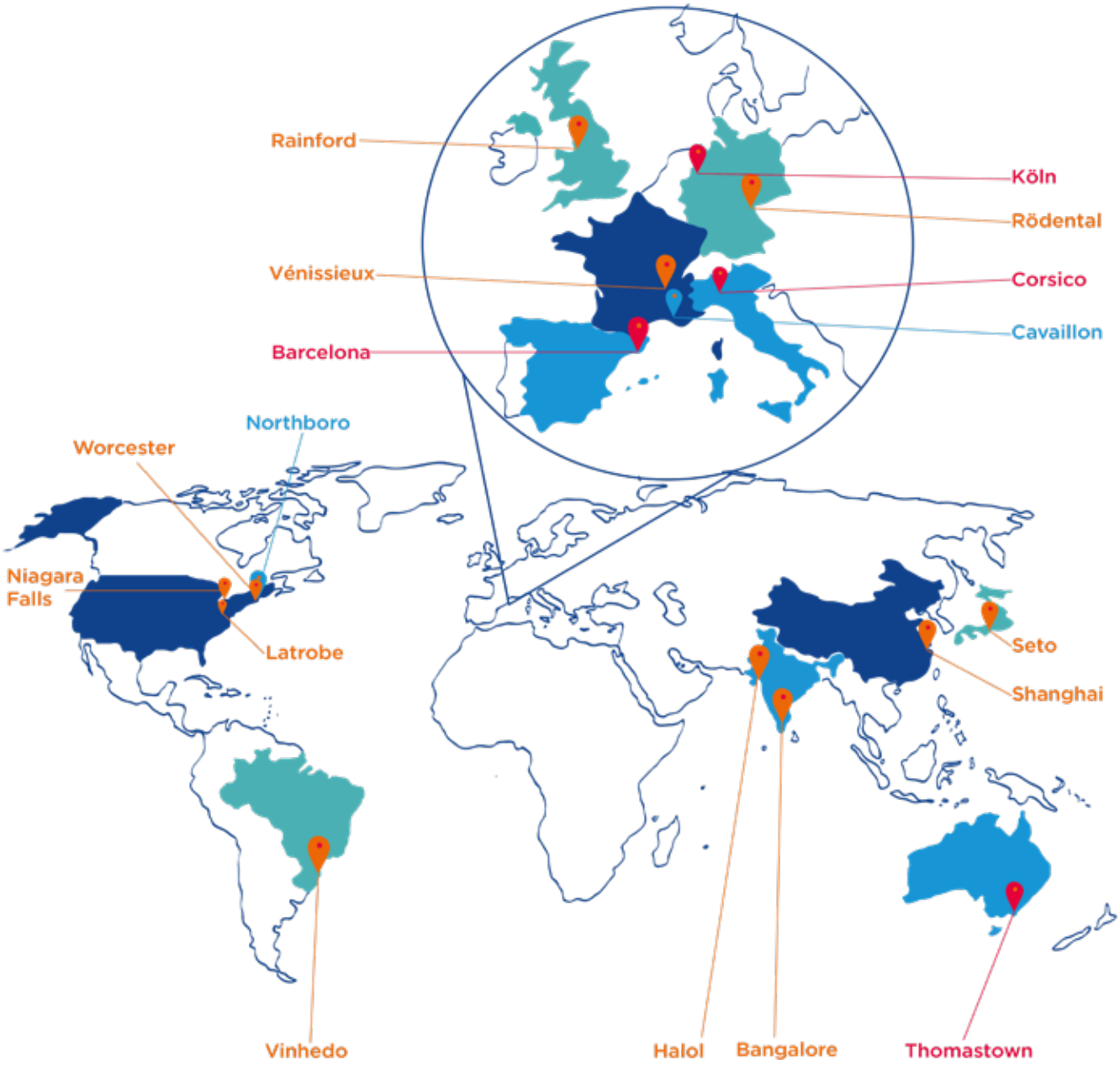
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