EREDI SCABINI

EREDI SCABINI NEWS

Since 1945, the refractory specialist at your disposal.

An ongoing story of success…

Eredi Scabini has been on the refractories market for almost 75 years, during which time it has grown constantly, to become what it is today: a company Italian by birth but international by vocation, which has always believed in the importance of good business practice to offer products and services of quality, with ever-improving performances and more and more advanced technologies, with the aim of achieving growth not only for itself but above all for its customers.

To enable all this to come about, the company's organisation has also undergone major changes over time: as production has increased in terms of both quantities and number of types, the company has expanded its premises to accommodate the new equipment and the new staff required.

The latest expansion took place in the first half of this year, when the company purchased another 5,000 sqm of factory buildings next door to its headquarters.

Today, Eredi Scabini has a total operating area of about 30,000 sqm, on two separate sites. The plants are close together and are both strategically located in the Milan hinterland.

The complex includes 3 different monolithics and preformed production plants, also recently expanded with 2 new high-temperature furnaces of impressive capacity; several warehouses for raw materials and products in transit, and a brand new centre entirely dedicated to the experimentation and design phase, which precedes and accompanies the birth of the products and solutions offered to customers: the ATC - Advanced Technology Centre, opened at the end of 2018.

The new ATC houses professionals of vast experience, including engineers, chemists and designers, who cooperate and exchange ideas on a daily basis in a well organised process, to create products and services of excellence. It is equipped with state-of-the-art technological tools including Wavelength Dispersive X-Ray Fluorescence spectrometers, Electric Fusion Machine for preparation of beads (XRF analysis), compression and flexural strength test presses also for large-sized pre-forms, equipment for analysis of apparent density and porosity, pH, viscosity and much more.

Eredi Scabini is a sound, prosperous business, with a solid past and excellent future prospects, thanks to its innate ability to evolve and keep constantly up to date.

Eredi Scabini headquarters

Flextrong®: unity is strength!

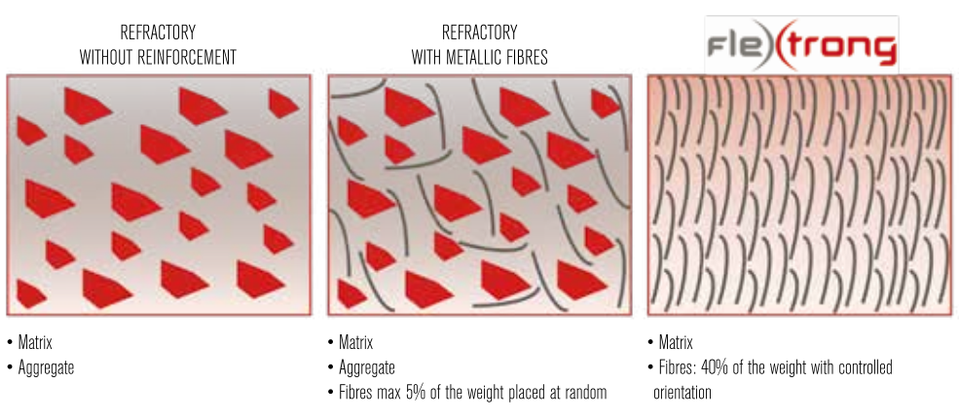
Flextrong is a line of Eredi Scabini products developed and launched relatively recently. However, thanks to its distinctive characteristics it has rapidly achieved success, becoming one of the product families most widely used in situations requiring high levels of performance and/or involving particularly tough conditions. Today Flextrong® is the exclusive Eredi Scabini product family with countless applications for steel, iron and steel, aluminium, copper and cement.

What makes Flextrong® so special?

First and foremost, we need to know that Flextrong® is not a ceramic product but is a composite. Composites are characterized by the combination of at least two different, physically separate substances, with different properties. The combination thus produced has new physical and chemical properties not provided by its individual constituent materials. One excellent example of a composite material is reinforced concrete, where concrete and steel maintain their individual identities but combine to generate a product with unique characteristics: the rebars mainly withstand the tensile loads, while the concrete is more resistant to the compressive loads.

The individual constituent parts of the composite are the MATRIX and the REINFORCEMENT. In Flextrong the matrix consists of a CERAMIC material, while the reinforcement is in METAL. Flextrong® is therefore a fibre-reinforced composite material. The matrix is initially in the viscous fluid state in order to fill all the spaces and bond perfectly with the fibres, then hardens to protect the fibres from physical and chemical attacks. The job of the fibres, on the other hand, is to give the composite strength and resistance to mechanical stresses.

Flextrong® has a ceramic matrix made from a special superfine, high fluidity, microionic set refractory material, which gives the product hardness and refractory properties, while the large quantities of special steel fibres, with controlled orientation, give it ductility.



The combination of these factors creates a product with outstanding thermal shock, impact, fracture and oxidation resistance, even in an oxidising atmosphere.

What's more, since the ceramic matrix acts like a shell, protecting the metal fibres from oxidation and high temperatures, Flextrong® is also widely used in situations in contact with direct flames and molten metals. Mechanical resistance of Flextrong compared to some competitor products. Another factor which has made Flextrong® a widely used product is the ease with which it can be installed, removed and replaced. Flextrong® is designed to simplify its installation, thanks to the use of screws, stud bolts, tie-bolts and eye bolts which are bolted to metal structures.

The case histories offered on the following pages explain how this product is able to guarantee performances immensely superior to those of standard solutions previously used by the same customers.

So enjoy the read but never forget that every situation is unique and unrepeatable, so please get in touch so we can design the ideal refractory solution for you, too.

Preformed are easier said than done!

Eredi Scabini was one of the first, if not the first (or one of the very first) refractory industry companies to believe and invest in the development of the technology for producing preformed shapes, as an alternative to bricks and castables. More than 35 years have now passed since those early days, and time has confirmed the wisdom of the choices made back then: while initially preformed were only used in steel production, for "accessory" components such as the tundish barriers or the burner blocks of heating furnaces, today their use is also widespread in foundries for iron and other metals, even for complete linings. Thanks to its countless benefits, the use of preforms has set new performance benchmarks which have now become essential for competitiveness. At present we have a portfolio of over 100 different preformed solutions, including complete reverberatory furnaces for aluminium, vertical furnaces for copper production, tundish covers, basins and inductors of channel-type induction furnaces, EAF delta section, crucibles for coreless induction furnaces and many more items, through to the complete realisation of the world's largest channel-type furnace, with capacity of 200 tons (some examples of preformed shapes are featured in this Newsletter). We are proud of having believed and invested so much in this project. Over the years, the work that has followed in both production and performance analysis, in the various types of application, has enabled the company to specialise and design new, increasingly sophisticated preformed, larger in size and more important in function. Naturally, none of this would have been possible without the foundation of in-depth knowledge of the raw materials and their behaviours in the most widely different conditions. Because, contrary to what one might think, taking any castable and giving it a shape is not enough to make a good preformed. The castables produced in our plants, in a controlled environment, specifically for preformed shape production, are developed "ad hoc" bearing in mind the geometrical forms and the stresses and temperatures the future preformed will have to withstand as well as the performance levels desired by customers. There is no denying that it has not always been easy, and even today for every new challenge we need to bring into play all the skills and know-how acquired, focusing very closely on every phase of the production process; however, we do not know any other method able to guarantee better results, or any competitors who have achieved results which come even remotely near to our standards. Today, Eredi Scabini is really the only company able to design and produce preformed weighing up to 15 tons, and with amazing performances. The market knows this, and more and more often it is recognising our supremacy by offering us major new challenges.

Cover Tundish

Crucibles CPS®

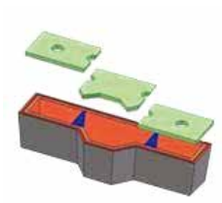
Inductor IPS

Realization of a complete furnace

Highlights

Engineering & Flextrong®: a winning combination for a long-lasting solution for tundish cover.

Flextrong® is a preformed ceramic matrix composite reinforced with heat resistant steel. The product has excellent resistance to thermal shock, impact, fracture and oxidation as well as to contact with molten metals. The product is used to replace both refractory linings or metal castings.



The customer is an European electric steel mill which produces about 900.000 tons per year of carbon steel using a 100 tons E.A.F., a L.F. and two continuous casting (CC) machines, with a capacity of 15 and 25 tons respectively.
The customer had serious problems on tundish cover consisting of 2 cast-iron sections. Most critical areas were the joint between sections (photo 1) and pre-heating burner holes where high temperature, thermal shocks and oxidation deformed the cover forcing the customer in replacing both sections after just 20 heating cycles. Eredi Scabini designed and produced a new tundish cover, consisting of 3 parts: the middle section in Flextrong® HT (Photo 2) and the two side sections in cast iron. The test performed with the new design gave very encouraging results: 130 heating cycles (Photo 3) compared to the 20 achieved previously.
On the basis of these results, the customer decided first and foremost to use the Flextrong® HT solution for the entire CC2 tundish cover and then to do the same for the CC1.
The new lids in Eredi Scabini Flextrong® HT are still in use, in both continuous casting machines.

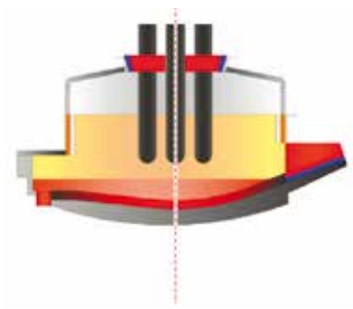
REF. N.16

Photo 1 - Cast iron cover sections

Photo 2 - Middle cover section in Flextrong® HT

Photo 3 - Middle cover section in Flextrong® HT after 100 cycles

Alfablock®: once again, a graduation with honours.



Alfablock® is the Eredi Scabini nanoplastic preformed shape with amorphous Silico-Aluminate binder which features an exceptional resistance to corrosion and thermal shocks.

The customer is an electric steelworks that produces about 3,000,000 ton of coils per year. The steelworks has two EAF (Electric Arc Furnace) of 130 and 260 ton. The main issue experienced by the customer was related to the lifetime of the 130 ton EAF delta section, which on average never lasted more than one week. The customer usually lined the EAF delta section with chrome alumina and bricks, which however would wear very quickly, forcing the customer to change the lining frequently - after just 180 heats. Eredi Scabini's solution to the problem was a new preformed delta section, produced using its exclusive Alfablock®, a nanostructure large-aggregate product (Photo 1).
The results were highly positive: the delta section's lifetime went from 1 to 4 weeks of operation, from 180 to more than 750 heats (Photo 4). During the Alfablock® test, the customer wanted to remove the delta section at the end of the second and third weeks to evaluate its wear and monitor its overall performance. So, at the end of the second week of operation (photo 2), the delta section showed a residual thickness of almost 70% and after three weeks more than 50% (photo 3).
At the end of the fourth week of operation, the delta section had a final residual thickness of 40%. Furthermore, the Eredi Scabini preformed shape surface remained cleaner and the wear - in addition to being less - was more uniform over the entire delta section. Thanks to its main characteristics of high thermal shock and chemical resistance, the Alfablock® solution proved to be absolutely the right choice. The Eredi Scabini's new preformed shape passed yet another test, and even in this case graduated with all honours!

REF. N.30

Photo 1 - Alfablock® eaf delta section preformed shape

Photo 2 - Alfablock® eaf delta section after 2 weeks

Photo 3 - Alfablock® eaf delta section after 3 weeks

Photo 4 - Alfablock® eaf delta section after 4 weeks operation and more than 750 heats

Dristone®: The best monolithic safety lining solution.

Dristone® is a line of dense dry ramming mixes made with neutral or basic raw materials for installation by dry vibratory compaction. The products in this line can be used as either safety or working linings and with either melt-in or removable forms.
For the steel industry, Dristone® is specifically designed to be installed behind the brick working lining, creating a joint-free, monolithic back up. At the operating temperature, the product develops a high strength and low- porosity hot face but maintains a loose back-up to stop metal infiltrations.

The customer is a major European steel group which produces about 3,000,000 tons/year of coils. The steelworks has one 130 ton and one 260 ton electric arc furnace with the relevant ladles. The customer has already been using Dristone® for the safety lining of the 130 ton ladle as an alternative to the conventional alumina bricks for a considerable period of time. In view of the constant very satisfactory results achieved, the customer recently decided to use the same solution for the 260 ton ladle.
While the 130 ton ladle is cylindrical in shape, the 260 ton ladle is conical.
The use of our dry ramming product meant that the safety lining was able to hug the metal structure precisely, providing the perfect supporting surface for the brick working lining, with none of the steps typically found with brick safety linings. Moreover, the use of our Dristone® dry ramming mix for the safety lining was combined with the use of ISOLINE® Micropor as insulating lining on the metal structure. The combination of insulating and safety linings applied as described above provided the customer with energy savings and a joint-free solution, which was therefore able to withstand any metal infiltrations.

REF. N.50

Microporous insulating lining in ISOLINE® Micropor

Dristone® safety lining after 7 campaigns

Dristone® safety lining after 7 campaigns

Flextrong® makes another goal.

Flextrong® is a preformed ceramic matrix composite reinforced with heat resistant steel. The product has excellent resistance to thermal shock, impact, fracture and oxidation as well as to contact with molten metals. Flextrong® HT, offering a new combination of ceramic matrix and metal reinforcement, is intended for applications that require greater resistance to mechanical stresses at high temperatures, even in oxidizing atmosphere.

The customer is the largest Italian electric steel mill for the production of carbon steel laminates, with two 150 and 260 ton furnaces and an annual production of over 3,000 tons.
The customer used to line the ladle protection screen drawers with conventional castable, which lasted around 30/40 castings at the most and required frequent maintenance.

After evaluating the customer's needs as a whole, Eredi Scabini proposed the design and production of the screen drawers using Flextrong® HT, a pre-formed ceramic matrix composite with a refractory steel reinforcement that -due to its excellent resistance to thermal shock- has all problems solved brilliantly.

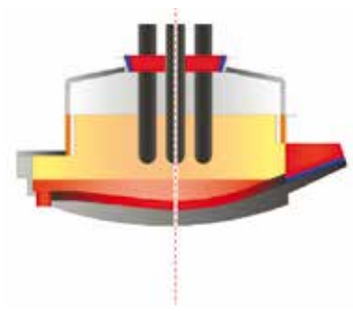
Thanks to this new solution, in fact, the customer has considerably increased the number of castings, going from 30/40 to 250, and has cleared all kinds of maintenance.

REF. N.57

Screen drawers in Flextrong® HT

Screen drawers in Flextrong® HT

Longer lasting EBT lining with Flustone® SP.



Flustone® is a line of microionic dense castables with excellent flow ability allowing application by self-distribution. They are used mainly for working linings requiring high resistance to abrasion and/or saturation by metals and/or slags. They are self-bonding, allowing linings to be repaired by applying the same product to the worn surface without changing the whole lining.

The client is a steelworks belonging to one of the European market's top producers of concrete rebars, wire rod and electrowelded mesh. The steelworks uses an electric arc furnace for treatment of the molten steel in the ladle followed by a continuous casting plant for the production of billets, which also supply the nearby rolling mill. During steel production, the electric arc furnace periodically requires hot lining repair of the EBT.
The steelworks needed to find a lining castable suitable for this operation, more durable than the one used in the past. It needed greater resistance to thermal shock, wear from the molten steel, and chemical attack from the sucked-in slag, especially when emptying the furnace. Considering the customer's requirements, Eredi Scabini offered Flustone® SP, a microionic setting dense castable with excellent fluidity which allows self-distribution. It contains extra-pure Synthetic Spinel with excellent corrosion resistance, high mechanical strength and good thermal shock resistance. This high quality product, specifically developed for steelworks maintains its essential fluidity during lining of the red-hot EBT partly due to its self-distributing properties, facilitating the operators' work during installation and speeding up the repair job on the furnace. What is more, the product's hot bonding to the existing worn nozzles is also maintained during the furnace's duty cycle with no peeling.
After the first repair, this customer immediately noticed and appreciated the strength of the liner's bond to the substrate and the reduction in the number of repairs necessary, which proved to be one every 55 – 60 taps, using just 150 kg of material. Furthermore, the customer found that Flustone® SP maintains the uniformity and diameter of the EBT hole much better over time, minimising the entrainment of primary slag into the ladle. (This slag is very rich in oxygen, causing a lower ferralloy yield, the need to add more of these materials during correction of the steel outside the furnace and, last but not least, more aggression towards and wear of the refractory lining on the ladle slag trap.)

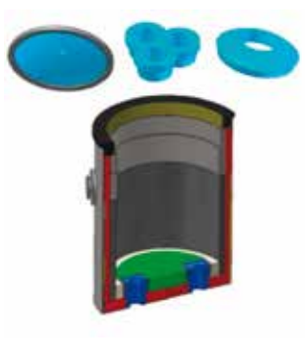
REF. N.58

EBT awaiting repair

EBT after 10 heats. After repair with FLUSTONE® SP

EBT relined with FLUSTONE® SP at end of cycle

Eredi Scabini delivers record-breaking ladle lid lifetime: 5 years (+500%).



CAST-LITE™ is a line of micro-porous insulating and super-insulating castables for installation by rodding or self-distribution. Developed for applications up to 1,700°C on both hot face and second face, they are an excellent alternative to insulating bricks and ceramic fibres. Compared to ceramic fibres, in addition to their greater mechanical strength and lower thermal conductivity, there are also no restrictions on their use arising from environmental and occupational health and safety considerations. Specific products have been developed for use in direct contact with molten metals.

The customer is an electric steelworks with output of about 900,000 tons per year of steel, which is processed in-house to serve the petrochemical, energy and automotive markets. The plant is equipped with a 100 ton electric arc furnace, two vacuum degassing systems and two ladle furnaces, using 100 ton ladles. The customer used to line the ladle preheating lids with ceramic fibres, aware of the relative environmental problems, the countless limitations on use at high temperatures and the risk of tearing due to the run-off burrs on the lip rings of the ladles themselves (photo 1). The customer was forced to repair the torn fibre parts quite frequently, replacing the entire lining after just 12 months service. Moreover, during operation the metal structures were stressed and deformed because the fibre no longer provided the necessary insulation due to the continual compression and tearing.
Eredi Scabini designed and produced a specific solution that lined the lid with environment-friendly CAST-LITE™ insulating castable, with density of 1 kg/dm3 and a maximum temperature of use of 1,600 °C combined with excellent mechanical strength (photo 2). The rim, on the other hand, was constructed using a Flustone® product, a refractory castable with high mechanical strength and thermal shock resistance, to increase the resistance to run-off bur formation on the ladle lip rings and thus avoid the deformation of the metal structures. With the Eredi Scabini solution, the customer managed to eliminate all repairs and to extend the lid's lifetime to over 5 years in service (+500%).
Today all the lid linings in the steelworks are still in good condition.

REF. N.59

Photo 1 - Ceramic fiber lid after 6 months of use

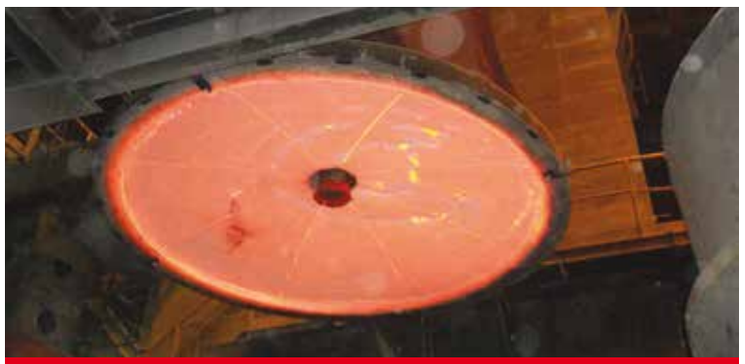
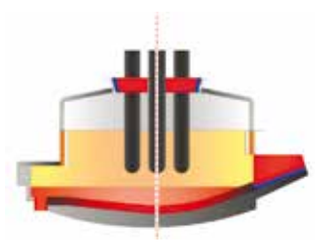


Photo 2 - Eredi Scabini Solution: lid after 12 months

With RESISTONE™ the slag pit of electric arc furnace lasts at least 3 times as long.



As well as its large range of refractory castables and preformed shapes, the company has a line of products specifically developed for industrial floorings subjected to extreme mechanical and chemical stresses combined with heat: RESISTONE™. RESISTONE™ products are installed by procedures similar to those used for construction concretes, but develop extremely high mechanical strength within just a few hours and can be used up to 1,400°C, even in contact with metal and slag splashes. Its rapid installation and ease of use also make RESISTONE™ excellent for maintenance purposes.

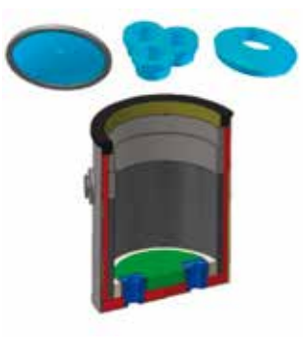
The customer is a European electric steelworks specialising in the production of special alloy ingots. The 250,000 tons produced annually are forged within the group for the railway and energy market. The steelworks contains a 70-ton electric arc furnace, a V.O.D. station and two ladle furnaces. The customer used to line the walls of the slag pit with construction concrete and metal plates. The lining's lifetime was very short, to the point where the entire surface had to be completely replaced every 6 months (photo 1), during all scheduled production stoppages. At the same time, the structures of the metal plates were modified by the heat, and they lost their fixing power. The customer complained of numerous problems and was also aware of the difficult conditions endured by the workers assigned to clean out the slag pit. Eredi Scabini came up with a solution using specific products for the different parts of the slag pit, to ensure the best possible performance in relation to each area's specific problems. The bottom of the wall, subjected to thermal shock due to contact with the slag and mechanical stress from the machine used to remove it, was lined with RESISTONE™ HT MF, a castable with excellent mechanical strength and thermal shock and abrasion resistance. The upper section of the wall, subject to high temperatures from the slag, was lined with RESISTONE™ ST, a castable with good mechanical and thermal shock resistance (photo 2).
Thanks to the Eredi Scabini solution, the customer has no longer had to completely reconstruct the linings every six months; since then, maintenance work has been limited to a few partial repairs at two-year intervals. For the customer, this has meant considerable reductions in maintenance costs and the major benefit of a slag pit operational at all times.

REF. N.62

Photo 1 - Conventional Solution: construction concrete wall after 6 months

Photo 2 - Eredi Scabini Solution: new installation and wall after 12 months in operation

800 castings with Flextrong® HT lip ring.



Flextrong® is a preformed ceramic matrix composite reinforced with heat resistant steel.The product has excellent resistance to thermal shock, impact, fracture and oxidation as well as to contact with molten metals. Flextrong® HT, offering a new combination of ceramic matrix and metal reinforcement, is intended for applications that require greater resistance to mechanical stresses at high temperatures, even in oxidizing atmospheres.

Founded through the strategic alliance of two major players in the world steel industry, the customer is now Europe and North Africa's top producer of beams and long rolled steel products. The company has four production units. The steelworks is equipped with an electric arc furnace, an out-of-furnace metallurgy station, and two continuous casting lines, for an annual liquid steel production capacity of 800,000 tons/year.
The steel, poured into the ladles from the EAF, followed by the downstream corrective treatments, combined with tapping and wall cleaning performed using a "ripper hook/carousel" system every 5–10 castings, put heavy demands on the previous steel lip ring. After just a few campaigns, these rings became misshapen and burnt, forcing the customer to make continual replacements at huge expense for carpentery maintenance.
The customer asked Eredi Scabini to come up with an alternative which would be more resistant to attack by the steel and its slag and more durable, to limit the deformation, costs and servicing times. After considering the needs stated by the customer overall, Eredi Scabini S.r.l. suggested construction of the lip ring sectors in Flextrong® HT. With design in six sectors bolted to the ladle structure, this innovation provide much simpler installation. The customer was immediately impressed by the very low adhesion level and easy cleaning and removal of run-off and slag from the composite material. The lip ring maintained its characteristics in use, with minimal wear and deformation of the sectors.
The customer has now completed its 10th campaign, of 80 castings each, and it has only been necessary to replace one of the six sectors: the pouring sector. This operation was very simple, and was performed by steelworks staff themselves.
The customer subsequently installed the Flextrong® HT lip rings on all its ladles, helping the steelworks to achieve an increase in production and down-time avoidance.

REF. N.67

Eredi Scabini solution: Flextrong® HT lip ring at the preheating station during the first campaign

Conventional solution:
steel lip ring, 50 mm thick, without sectors

Eredi Scabini solution: ladle with Flextrong® HT lip ring at the end of the 10th campaign

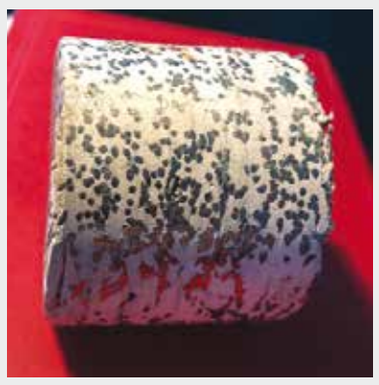
Papers

Refractory concrete: knowing and limiting the explosion hazard.

Regardless of the installation technique used, all monolithics, except dry ramming mixes, may explode if the appropriate procedures are not followed. In terms of the product, a large number of factors may contribute to causing an explosion: density and porosity after installation; type of porosity and monolithics; presence of fibres; and the ex post addition of setting accelerators or retardants. There are also multiple potential factors relating to installation and the first heat-up, which may contribute to an explosion: type of installation; type and percentage of liquids present after installation; the temperature of the product's components and of the liquids used, as well as ambient temperature; finishing; presence of scoring; the type of curing, precast v/s cast insitu installation; the maximum thickness present; the first heat-up curve; the type of furnace and the certainty that the curve can be complied with uniformly and monitored; and the presence of monitoring thermocouples with the relevant recording and read-out instrument. Separately or in association, to a greater or lesser extent, all these factors help to increase or decrease explosion risks. An explosion is a sudden, violent release of thermal and mechanical energy generated by a pressure build-up, accompanied by the production and expansion of gases, normally at high temperature. In the case of refractory castables, in 95% of cases explosion problems are generated by the presence of water. All castables (except dry ramming mixes) contain smaller or larger amounts of water.

Why does a material explode?

Because the pressure and expansion of the gases inside it exceed the mechanical strength with which it is able to retain them. The violence and destructive power of the explosion depend on the density and porosity of the material. High density and low porosity (especially when the pores are closed) lead to violent explosions with destructive effects on the surroundings, while the explosion of low density, open pore items will take the form of more or less significant crumbling and cracking. It should be noted that given the same apparent density of the castables used, plastic ramming mixes are generally more porous and less likely to explode; conventional castables are more porous than the low moisture type but they contain more chemical water since they have more cement; cement-free castables are more impermeable than the conventional and low moisture types even if their total porosity is the same; open pore insulating castables are the most porous of all castables, but it is important to take care with "bubble alumina or special alumina" types with closed or semi-closed pores, where the total porosity is high but the number of open pores is low; "nanoplast" castables have an apparent porosity with pores that are always open, with pore diameter more or less constant regardless of their density. 95% of Eredi Scabini castables contain anti-explosion fibres which help to prevent explosions but which are UNABLE TO GUARANTEE THAT THEY CANNOT OCCUR; however, it is important to know that castables containing metal fibres are less likely to explode than those without them.



Flextrong® 304 coring

Installation by ramming is less likely to lead to explosion than when casting or vibration is used; installation by spraying or shotcrete (pre-humidified concrete, pumped at low pressure, with setting accelerator added at the delivery pipe outlet) will be less at risk than installation by vibration; a pumped material will be less risky than one installed by conventional delivery systems.

Shotcrete

Castables with chemical-setting binders, including Nanoplast® castables, cause fewer problems than those which use only water; naturally, the more water is present, the greater the risks.
All chemical reactions are affected by the ambient temperature and the temperature of the product's components and the water used, which may cause possible abnormal transformations leading to the risk of explosions during the initial heating process.
Smooth pieces without scoring are more likely to explode and crumble; curing at high temperature (37-45°C) with low ambient relative humidity increases the green strength, an important factor in order to counteract the pressure and expansion of steam at temperatures up to 150°C. Covering with plastic film which does not adhere to the surface during the initial curing phases keeps the surface damp to prevent it from "scorching" and ensures that its humidity is the same as that of the layers beneath.

It should also be borne in mind that a cast insitu part is more at risk than a pre-casted shape of the same density, porosity, maximum thickness and geometrical form; the thicker the piece, the more accurately the initial heating curve must be designed, considering any insulation present. Eredi Scabini initial heating curves are the outcome of theoretical simulations and the company's practical experience built up over the last 40 years, but CANNOT BE CONSIDERED ABSOLUTELY SAFE unless every detail of the project has been weighed up.

Moreover, unsuitable heat treatment equipment (furnaces, burners, thermocouples, temperature recorders, fans, etc.) can put a carefully executed project at risk, causing an explosion which destroys the equipment where the refractory is installed and also causes serious safety risks for the people concerned.

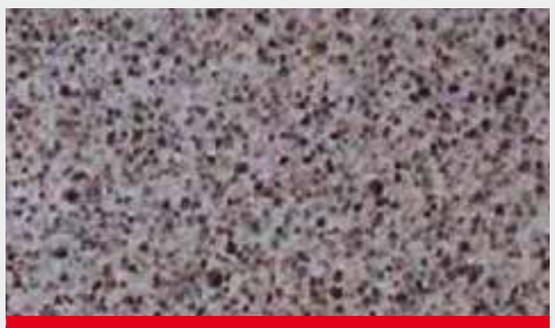
The role of water

In general, water performs various functions in refractory castables: it saturates the open pores; it serves as a lubricant between particles after the open pores have been saturated; it interacts chemically with other elements in the dry mix to create new chemical compounds (chemical or chemically bonded water) which generate flocculation or deflocculation, setting (solidification) of the product, and so on; it provides temperature balancing where required (the temperature in the piece does not rise too quickly in the areas which contain large amounts of water); and it provides surface protection during initial heating to prevent "scorching" of the visible surface of the piece. Basically, pure water evaporates with temperature, whatever this may be, but it takes a considerable amount of time to eliminate it, so it is heated to +100°C to transform it into steam, thus increasing ambient relative humidity. The density of the steam is 1/1800 compared to the density of water. From 110°C to 150°C, as steam increases in temperature, it becomes superheated and expands, generating the first significant build-up of pressure inside the piece, which will withstand it to a greater or lesser extent depending on the mechanical strength it has acquired during curing. It is in this phase that tiny cracks, sometimes invisible to the human eye but with undesirable results in the heating process which follows, are normally formed.
From 110°C to 150°C the water/cement and other bonds start to break, and so the piece's mechanical resistance starts to decrease, unlike the pressure and expansion of the water vapour, which increase considerably. As already explained, steam dispersal depends on the piece's degree of porosity (permeability), the presence of anti-explosion fibres, which disappear at 90°C -150°C to leave tiny pathways, its maximum thickness and the time for which the piece is allowed to remain at this temperature. Uneven distribution of anti-explosion fibres may lead to tiny cracks and/or explosion. Clumping of anti-explosion fibres is normally due to the use of unsuitable mixers, generally of standard construction type, or suitable ones but with the wrong type of blades or rotation speed. The fibres are electrostatic so high speeds and abrasion with aggregates tend to agglomerate. The presence of excess fibres increases apparent porosity but at the same time it reduces the mechanical strength of the piece overall and generates more transmigration of the super-fine particles in the mix, which may clump to create more impermeable zones or layers; this situation is therefore very hazardous and does not bring any benefits in terms of steam dispersal. Depending on fibre type and length, the optimal value is between 0.06%w and 0.1%w; below this size sufficient steam is not dispersed, but above it mechanical strength is reduced and the amount of steam dispersed does not significantly increase.
Normally, the use of setting accelerators or retardants - with the same curing time - reduces the mechanical strength, both unfired and at the critical intermediate temperatures, which is undesirable for the prevention of explosions.
The temperature should not be increased over 150°C until the water trapped in the material's open pores has been eliminated.
The chemical water is the water which has been used to form other compounds, and it therefore accounts for only a small proportion of the total water (from 1%w to 15%w depending on family). It is eliminated within the temperature range from 150°C to 890°C depending on the compounds contained in the various families of castables. In Eredi Scabini castables, the most significant loss, by weight, takes place between 220°C and 300°C.

Loss of free water + combination water for traditional and low moisture castables (Cast-Lite™ - Castone™ - Flusto-ne® - Dystone® - Vibro-steel™ - Gunstone™ - Patchstone® - Resistone®): modern technology means that explosions do not occur up to temperatures of 150°C; however, the risk of micro-cracks persists. Obviously, if more time were available the heating gradients would be so gradual that, given our products' open porosity, explosions would definitely be avoided. It has also been proven that the highest pressure occurs in traditional and low moisture castables between 150°C and 470°, after which the pressure and expansion of the remaining steam decrease, and mechanical strength increases in proportion with the temperature. This means that explosion is avoided if the body temperature has been uniform up to this point and the heating curve has been followed correctly, at least up to the dwell time at 430°C (minimum safety temperature). Attention has to be focused on the 110°C - 430°C range: if there is uncertainty concerning the reliability of the heating equipment, the quality of the product and the complexity of the geometrical forms, and the thickness is over 50mm, up to a maximum of 700mm, the heating gradient up to 110°C must not exceed 50°C/h and the dwell time at 110°C must be 1h for every 40mm of the maximum thickness. The heat is then increased to 430°C without ever exceeding 5°C/h, and dwell times at 430°C must be calculated with a ratio of 1 hour for every 50 mm of maximum thickness.

Loss of free + combination water for cement-free castables (Histone®): the binding system in this family is based on a cement-free sol-gel solution ("sol-gel" is a technology which uses colloidal solutions of metal oxide particles in a suitable solvent -"sol"- to create continuous reticulations of metal oxides -"gel"- which generate gelling and solidification), which provides final setting after suitable curing, although mechanical strength is low and decreases even more after 110°C. Moreover, in the 150°C-250°C range, this sol-gel becomes denser, decreasing the permeability of the piece, which thus becomes more vulnerable to explosions if the thicknesses concerned exceed 100 mm and the heat treatment equipment is not reliable. The transformations generate products with excellent corrosion resistance. With these materials, users are advised to request the best initial heating curve from our Technical Department on a case-by-case basis.

Texture of Histone® TAB similar to Carrara marble



Open nano porosity

Loss of free water + combination water for Nanoplast® castables (Alfaplast®, Sigmaplast®, Zetaplast®): the bonding system of these materials allow the achievement of extremely uniform porosity, also open on the surface, and also does not generate chemical compounds which transform pure into combined water.
The water saturates the pores, lubricates the components and is dispersed by evaporation (Zetaplast®) or through the formation of wet steam (Alfaplast®; Sigmaplast®). In practice, about 95%w of it is eliminated by evaporating it, with low levels of pressure and expansion, at the temperature of 150°C. The only constraint is the thickness of the piece and thus the time needed to achieve this result.

Initial heating curves for castables and preformed shapes. There is a difference between these two operations. For castables, the heat energy travels to the cold external part and is more or less blocked by other layers of materials, including the insulators. With preformed shapes, the heat strikes the whole surface and attempts to reach their core as the water present is gradually eliminated. While for shapes the variable factor, for the same quality, is thickness, for castables many are the variables and they must all be considered, but the absolute difference in terms of time is not so great: the numbers are virtually the same.

We simulated a comparison between a preformed shape and an in situ casting with the same material and thickness.
For the in situ casting we added the following alternative scenarios concerning insulation and/or safety lining:
"A" = 7mm of Micropor SF1100 boards on a contatto carpenteria ferrosa da 10mm
"B" = 5mm of Micropor SF1100 boards + 120mm of Patch-lite 94 castable (pre dried)
"C" = 5mm of Micropor SF1100 boards + 114mm of K23 insulating bricks + 114mm of 44% Al2O3 dense bricks.

The final result of the two heating curves at 800°C and related cooling indicates 40.82 hours for the preformed shape against an average of the three scenarios of 40.72 hours.

Written by Daniele Scabini