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

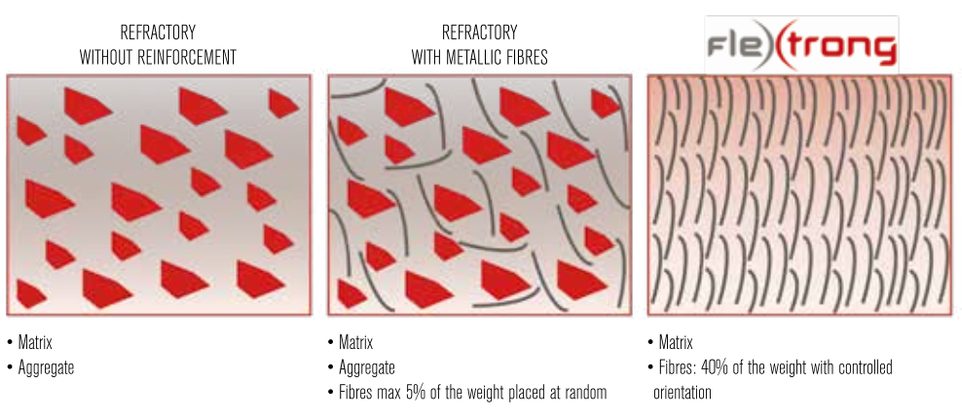
Flextrong®: unity is strength!

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

Photo 1 - Installing big blocks

Photo 2 – Furnace overview

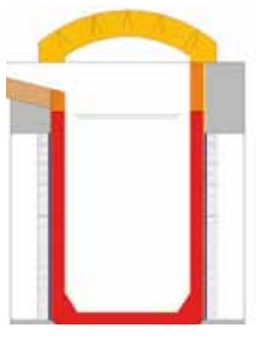
With Eredi Scabini's modular preformed and prefired solutions ABT you can forget about your furnace lining!

Eredi Scabini has always believed in the development of preformed shapes and its capability for producing preformed shapes up to 15 tonnes in weight places Eredi Scabini amongst the undisputed world leaders in this market sector. Eredi Scabini's ABT - Advanced Block Technology- solutions are preformed and customized kits for furnace linings. The kit developed for this customer included several products, among which Ultrablock®, dense pre-formed shapes featuring excellent "non-wetting" properties. The low porosity, the controlled pore size and the unique bonding system result in a winning combination against abrasion and chemical attach.

The customer is Europe's largest producer of brass rods, with a melting capacity of 700,000 tonnes/year. The melting centre comprises 3 foundries. The largest is equipped with two coreless induction melting furnaces of 75 and 32 tonnes, two channel induction melting furnaces of 120 tonnes and a 200 tonne channel induction holding furnace, all supplying a vertical continuous casting plant. In 2006, after successfully building the two channel melting furnaces using its ABT -Advance Block Technology- system, Eredi Scabini designed and installed the lining of the holding furnace using the same system, replacing the old brick lining.
The results obtained were undoubtedly amazing, starting from the installation itself, which with our solution took just 5 days compared to the 30 required for the previous lining. But that is not all. While in service, the brickwork lining underwent maintenance on many occasions, until it was eventually completely replaced after just 6 years; the Eredi Scabini ABT -Advanced Block Technology solution is still in operation, 8 years after its installation!

REF. N.5

Dristone® the dry ramming mix that really makes the difference!



Eredi Scabini has offered and subsequently conducted the in-house development of top quality monolithic refractories since its foundation. The range now comprises hundreds of different formulae, which can be used for the realisation of refractory and insulating linings by a wide variety of methods. DRISTONE® is a line of dense dry ramming mixes made with neutral or basic raw materials for installation by dry vibratory compaction. These products can be used as either safety or wear linings and with either disposable or reusable formworks.

The customer is a cast iron foundry with output of about 21,000 tons/year of grey (30%) and ductile (70%) cast iron. A few years ago, it also began to produce steel for the automotive industry. The cast iron foundry contains 28 ton coreless induction furnaces and 4 ton pressurised coreless induction furnaces; the steel foundry is also equipped with coreless induction furnaces from 1 to 7 tons. The first linings the customer used for its steel furnaces encountered duration and infiltration problems, and furnace lifetimes varied from 1 to 3 weeks at the most (photos 1-2). Eredi Scabini offered a "turnkey" solution including both supply and installation of the complete furnace lining. The lining ran from the coil grouting to the working lining, for which the choice was dry-rammed DRISTONE® , compacted with our innovative VIBROSYSTEM 4000 vibrator. This solution doubled the crucible lifetimes while maintaining a high safety level, demonstrated by the fact that the rammed DRISTONE® was found to be partially sintered on demolition. (Photos 3 – 4 – 5 - 6). At present, all coreless induction furnaces in this foundry are constructed using the Eredi Scabini solution.

REF. N.41

Photo 1 - Competitor solution

Photo 2 - Competitor solution with deep sintering

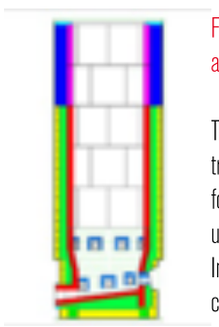
Photo 3 - Eredi Scabini Solution for coil grouting

Photo 4 - Eredi Scabini Solution for slip plane

Photo 5 - Eredi Scabini Solution for Vibration

Photo 6 - Eredi Scabini Solution after 5 weeks

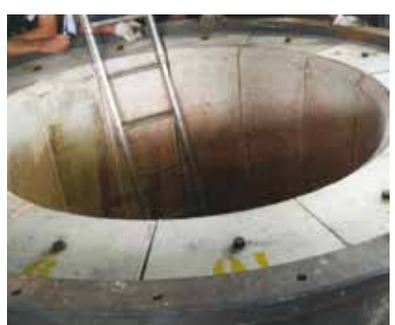
Stronger and more reliable charging area with Flextrong®



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® is designed for the installation via bolts and/or welding brackets provided. Flextrong® HT, with a new combination of ceramic matrix and metal reinforcement, has been developed for applications requiring greater strength to resisting mechanical stress at high temperatures, even in oxidising atmospheres.

The customer is an international leader on the copper rod market. With a production capacity of over 250,000 tons/year, and more than 60 years' experience, the company is a benchmark for all production and trading companies in the electrical engineering, electronic and system construction industries. The customer needed to solve a series of problems around the charging area of its shaft furnace, initially lined with copper impact plates. The problems included: sticking of copper cathodes to the impact plates causing the formation of bridges, a very high temperature on the charging mouth structure, requiring forced-air cooling, and unsatisfactory impact strength and lifetime.
In response, Eredi Scabini developed a new charging area lining using Flextrong® HT, a preformed ceramic matrix composite reinforced with heat resistant steel, generally used as a substitute for both refractory linings and metal castings. This lining was installed by simply bolting in place, in just half a day.
Apart from the benefit of extremely fast installation, this solution solved all the other problems, with no more sticking of cathodes or bridge formation, a dramatic fall in the metal structure temperature from 400/600°C to about 170°C and thus no more need for forced-air ventilation, and excellent mechanical strength. Four years after a continuous operation, none of the Flextrong® blocks in the impact area has ever been replaced or maintained. The success of this Eredi Scabini solution encouraged the customer to assign more complex projects to us, including the complete relining of the shaft furnace (impact area excluded), using the innovative ABT (Advanced Block Technology) solution in Ultrablock®, implemented by the adoption of Big Block in Flextrong® HT in the first portion of the pre-heating zone (under the impact area).

REF. N.42

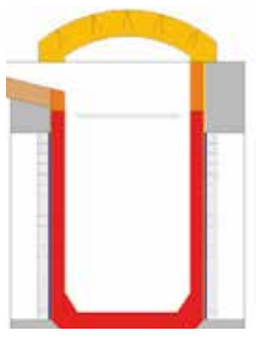


Flextrong® installation completed in half a day

After 8 months in service, the Flextrong® HT is perfectly intact

Detail of the impact area entirely made of Flextrong® HT after 3 years of operation

Cps® (Crucible preformed system): still the best solution on the market for coreless induction furnace linings.



Eredi Scabini is the only company which has introduced and continually implemented the CPS® (Crucible Preformed System), an innovative solution for coreless induction furnace linings. Every furnace is a one-off therefore each CPS® is customized to meet the specific condition.

The customer is a long-established European company that leads the world in the manufacture of heat exchangers in copper and copper alloys. The plant is equipped with a coreless induction furnace with capacity 7,4 tons, used to remelt returns of various weights and sizes to produce billets.
The original refractory lining consisted of dry ramming mix. The lining's lifetime was highly variable but never satisfactory.The critical point in the lining was around the lower edge of the structural rings. In fact, most stoppages and lining replacements were due to the formation of through cracks in this point.
Tired of the continual failures of the dry ramming mix lining, in 2014 the customer decided to try Eredi Scabini's CPS® solution. First and foremost, use of the CPS® would avoid the use of the expensive copper formwork otherwise necessary for construction of the ramming mix lining. It was also expected to solve the greater problem of the continuous failures, since the lining consists of a monolithic preformed crucible. After meticulous design work, the first CPS® lining was supplied in August 2014.
The first immediately obvious major difference between the previous solution and the CPS® lining was that the latter was much easier to clean. What's more, this solution eliminated the metal infiltration around the spout, which in the conventional design was complex in geometry, requiring it to be installed using several materials; with the CPS®, on the other hand, it is integral with the rest of the crucible.
Another problem solved with the CPS® was the overflow of metal during tapping; the crucible was designed and built with an integral barrier in the upper part to prevent any overflows. The furnace with the new CPS® lining was to operate continually for 12 months, with stoppages only for routine cleaning and to check the general condition of the refractory lining. The first CPS® lining was followed by another, again with very satisfactory performance, and then another, which is still in operation. The customer is completely satisfied with the Eredi Scabini preformed solution, to the point where it is also considering the use of our preformed for lining more of its furnaces.

REF. N.44

Cracks in the conventional lining

CPS ready to process its first charge

1st CPS after 33 weeks in service

1st CPS after 55 weeks in service

ECO SIL™+ Flustone®: an unbeatable pair for coreless induction furnaces!

Eredi Scabini promotes the use of LD (Low Dust) dry ramming mixes for a healthier working environment. All products are premixed with the exact quantity of binder, which is in anhydrous form to avoid releasing moisture to the furnace and reduces the porosity of the refractory lining.

The customer is an iron foundry producing about 60,000 tons per year of ductile and austempered iron castings for the earth-moving equipment market. The foundry has three 28-ton coreless induction furnaces, a 6-ton pressure-pour ladle supplying a casting line, and 6 treatment ladles with different capacities. Both the furnaces and the ladles are lined with Eredi Scabini materials.
A special solution was designed for the lining of the coreless induction furnace with the aim of increasing its lifetime by limiting its wear and resolving the problems that generally occur during operation. These include wall thinning, cracking caused by thermal shock and breaks when loading the material to melt.

The solution designed and installed by Eredi Scabini to meet the customer's needs involved the construction of a permanent lining in castable Flustone® X FINE, the installation of a slip plane in ECO-CLOTH® and a wear lining in ECO-SIL® LD, a high-purity Silica ramming mix. This material is formulated to maintain a loose backup to prevent metal infiltrations. Furthermore, the ECO-SIL® LD dry ramming mix has a special grain size distribution to guarantee high installation density, while the high purity level of the raw material guarantees excellent thermal shock and chemical resistance (photo 1). Last but not least, ECO-SIL® LD is a very easy-to-use product as it is pre-mixed and ready for use.

Using the Eredi Scabini solution, the lifetimes of the coreless induction furnace linings were increased considerably, for as long as 18 months in operation, with very few lining repair operations (photo 2).

REF. N.54

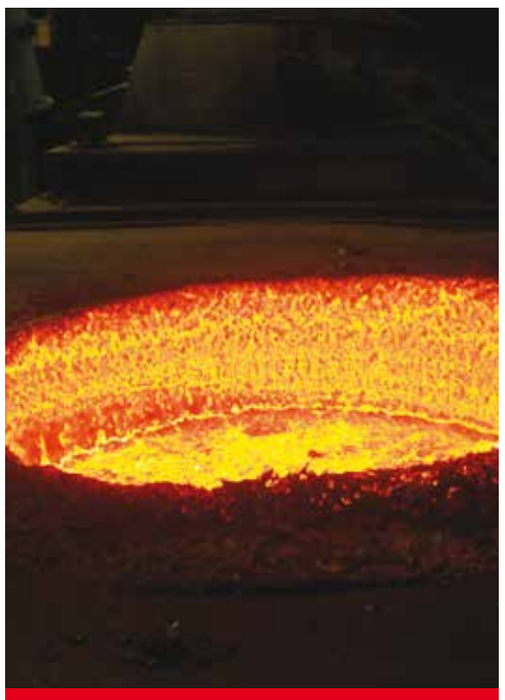


Photo 1 - Eredi Scabini solution: furnace in operation after 12 months

Photo 2 - Eredi Scabini solution: lining with wear repair after 18 months

More resistant, longer-lasting launders for copper with Flustone®.

Flustone® is a line of microionic setting dense castables with excellent fluidity allowing application by self-distribution. These products are used mainly for the realisation of linings requiring high resistance to abrasion and/or corrosion by metal parts and/or slag. They are self-bonding, allowing linings to be repaired by applying the same product to the worn surface without changing the whole lining.

The customer is a leading European producer of copper wire rod. With a production capacity of over 400,000 tons/year, 2 production locations, and more than 60 years' experience, the company is an industry benchmark.
In the initial phases of contact with the customer, Eredi Scabini was asked to supply a castable suitable for lining the molten copper launders. Linings were required for section 1, immediately downstream of the shaft furnace tap hole and leading to the holding furnace, subject to the heaviest level of wear and thermal stresses, and section 2, downstream of the holding chamber to the tundish.

The aim of the trial was to test and assess a material with multiple properties of mechanical resistance to the thermal shock and wear caused by the flow of hot copper, which was versatile and with a good quality/price ratio, and would allow the customer to keep in stock just one product for realisation of the wear linings of all its equipment, thus also simplifying stock management and the work of the refractory lining team.

Sector of launder no. 5 "section 1", 6 months, after easy cleaning

"Section 2" tank, after 6 months in operation, awaiting cleaning

"Section 2" tank launder and Pool Pot in operation

Eredi Scabini suggested a Flustone® line product, a corundum-based microionic setting self-distributing castable with good mechanical and thermal shock strength and excellent non-wetting properties. Thanks its specific characteristics, the product is consolidated, well known and very popular in the red metal sector.

When the product was tested on all parts of the line, the customer was immediately very impressed with its resistance, and over time an increase in durability of about 50% was noted in even the most heavily stressed areas, which could be repaired by simple filling after cold cleaning operations increasing the launder lifetime up to 120,000 tons of transited copper. The easy installation and easy management also found favour with the refractories manager and workers. In view of these initial results, the customer went on to choose Eredi Scabini for other, more and more complex projects, culminating with the construction of the copper blocks of the charging mouth with Flextrong® composite, the complete lining of the shaft furnace with the innovative ABT (Advanced Block Technology) system and, in the near future, the complete reconstruction of the holding furnace.

REF. N.63

Engineering+specific products = Exponential improvement in Upper Case + Inductor Performance!

Eredi Scabini specialises in the supply of engineering, products and services for iron foundries. The combination of state-of-the-art products and specific expertise delivers outstanding performances in terms of durability and energy saving.

The customer is a foundry which produces grey and ductile cast iron for the boiler and radiator market. The foundry is equipped with 2 cupolas and a pressurised induction furnace with capacity of 15 tons, which supplies a moulding line. Both the uppercase and the inductor of this furnace are lined with Eredi Scabini refractories.
The uppercase lining was designed to guarantee minimal heat loss and maximum lifetime. The insulating and safety lining was constructed with two different microporous insulating castables from the PATCH-LITE™ line, which in addition to excellent mechanical strength and very low heat conductivity are also free environmental and occupational health and safety restrictions on their use. The wear lining was constructed using DYSTONE® a large aggregate castable with excellent thermal shock and impact resistance, guaranteeing a very long working lifetime (photo 1).
With the Eredi Scabini solution, the customer replaced the uppercase lining after about seven years in operation, achieving perfect coupling with the inductor right to the very last operating cycle.
The inductor lining is designed to ensure insulation and wear resistance appropriate for the stresses and shocks it has to withstand during operation.
The insulating layer consists of ISOLINE® MICROPOR line microporous vacuum panels, which guarantee impressive temperature reduction, while the wear lining was constructed with a DRISTONE® line product consisting of electro-melted Magnesite and Spinel, ensuring excellent mechanical and corrosion resistance (photo 2).
The inductor lining's lifetime was extended to about 24 months in operation.
Without a doubt, one of the factors behind this impressive result was the perfect mating between throat and inductor.

REF. N.65

Photo 1 - Eredi Scabini Solution - Upper case after 5 years in service

Photo 2 - Eredi Scabini Solution - Inductor lining

Eredi Scabini Solution - Inductor after 24 months in service

With RESISTONE™, the flooring is 6 times more resistant.

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 with temperatures of 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.

Photo 1 - Conventional Solution - Installation of construction concrete

Photo 2 - Conventional Solution - Construction concrete flooring after 6 months

Photo 3 - Eredi Scabini solution: preparation of new installation

The customer is an iron and steel foundry which produces special pieces for the milling market, especially components used for crushing aggregates. The foundry is equipped with two 10 ton rotary melting furnaces and seven 10 ton casting ladles.
The customer used to pave the floor underneath the two rotary furnaces - where there was a constant build-up of slag - using construction castables (Photo 1 – Photo 2).
The flooring had a very short lifetime, and the whole surface had to be re-laid during every scheduled stoppage, about every 6 months. Moreover, with the standard construction concrete solution the customer continually experienced problems and inconvenience for the workers assigned to clean the slag box.
For this customer, Eredi Scabini recommended a new solution in RESISTONE™, a special castable with outstanding mechanical, thermal shock and abrasion resistance (Photo 3).
By using this new solution, the customer eliminated the complete re-laying of the floor, with just some partial repairs every three years' service. Access to the slag box became no longer problematical and costs considerably reduced.
5 years later, the Eredi Scabini solution is still in use.

REF. N.70

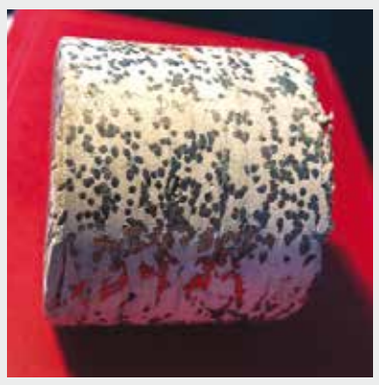
Papers

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.

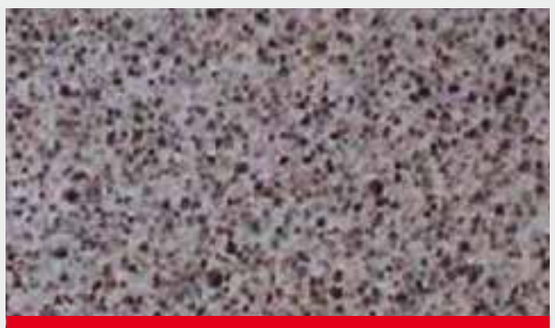
The role of water

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