

Refractaria S.A.U. – Krosaki Group

1. General information



Fig. 1 Office building

With over 70 years of experience in the Refractory Industry, Refractaria S.A. is located in the Principality of Asturias, Spain, one of the most important refractory regions in Spain thanks to its wide miner and steel tradition. As current information, Refractaria holds 94 employees, has 60,000 MT/year of production capacity within a factory area of 63,000 m² in which an unshaped automated plant, shaped plant and a pre-casting plant are located (Table 1). The major industry for Refractaria business is the cement industry, in this market the company has been growing continuously and stably in the last decade thanks to the continuous R&D process and intensive investments (Fig. 2). In 2009 Refractaria began an ambitious national and international development process, focused on offering customized high quality refractory solutions and services. The export sales development has been outstanding, the company has grown from having presence in only 10 countries in 2010 to more than 55 countries nowadays. Also Refractaria is one of the most diversified companies in Spain, serving several industries and becoming one of the major refractory companies in Spain. (Fig. 3). As sales increases, Refractaria has enlarged its production facilities accordingly to increase capacity, and productivity (Table 2, Fig. 4).

Table 1 Refractaria General Information

Establishment	1948
Location	Principality of Asturias, Spain
Holding company	Krosaki AMR Refractorios, S.A.U.
Own funds	5.525.326 €
Business Activities	Manufacture and development of refractories, design, installation, and supervising works
Employee	94
Area of factory	63,000 m ² Total Surface
Quality certificate	ISO 9001 (2000)
Environmental certificate	ISO 14001 (2019)
Total production capacity	60.000 mton/year

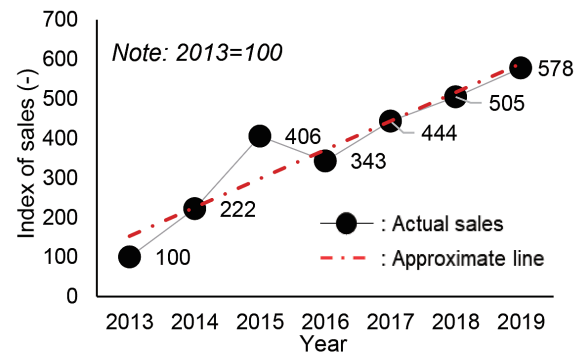


Fig. 2 Growth of Sales in cement industry.

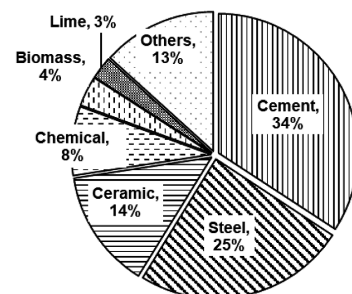


Fig. 3 Sales by industry.

Table 2 List of most recent enlarged facilities.

LAEIS 2000 (Automatic pressing)	Palletizing robot for pressing process	Automated loading robot for firing process	Tunnel Dryer
1 Unit	2 Units	1 Unit	1 Unit

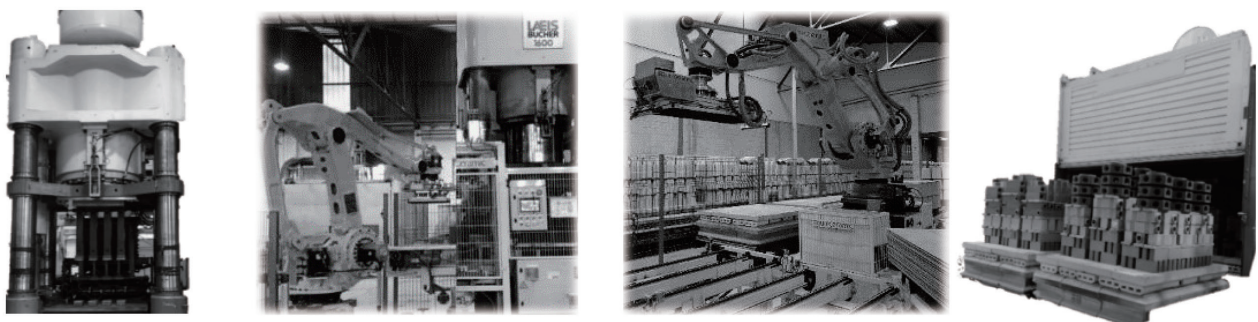


Fig. 4 Pictures of enlarged facilities.

2. Engineering and Installation

Refractaria's engineering department is providing valuable services to customers. Proof of this is the large number of new projects and developments created to satisfy the most demanding needs of customers worldwide.

2-1. Refractaria's Vortex Finder : Refractaria developed the first 100% ceramic Vortex Finder manufactured by pressing, it was designed to work at temperatures up to 1400°C, making it the first Vortex Finder capable of working at temperatures above 850°C without affecting its capabilities or chemical structure.

2-2. Refractaria's Elastic retainer for rotary kiln: Designed to create a self-bracing-locking ring but without any risk of brick falling by an excessive thrust effect. We achieve a reduction of at least 10% of the axial load with our specific brick's design.

2-3. WjET FREE® Project: Is positioned as one of the most innovative solution for cement production plant towers, where infiltration and build ups formation disturb the correct operation. Our EffSiC & SYNTHCAST® technologies along with a bespoke engineering solution ensure a life expectancy x3 compared to a conventional project, cutting out the risk for operator (No Cardox or Wjet are needed) and improving productivity (reducing energy losses & maintenance works).

Correct installation is as important as correct design, Refractaria has an experienced team of professionals with extensive experience that support our clients from the conceptual phase of the project through installation.

3. Refractory evolution on cement kiln

SiC is the best solution to provide: Infiltration Protection and Abrasion Resistance. Refractory manufacturers always needed to deal with oxidation of SiC during firing process. Our EffSiC technology overcomes the problem of oxidation, and it could show the best performance of SiC bricks below 1300°C in the cement kiln avoiding oxidation of SiC and preserving its capabilities.

3-1. Acris®: Patented solution for rotary kiln, provide the best performance in Upper transition with AF due to:

- ✓Zero infiltration - no spalling unlike Mag-Spinel.
- ✓No coating, even under liquid phase. (Great solution to excessive coating)
- ✓Shell temperature <300°C due to its low heat conductivity (2.2 W/m·k)
- ✓Long lasting, life campaign above 3 years keeping it 2Ø from stable coating

3-2. CARBAL : One of the most efficient solutions in Safety and Calcining areas due to:

- ✓Highest resistance against alkali according to Alcoa Alkali Test. (ASTM / Fig. 6)
- ✓Prevention of ring formation and build-ups due to its SiC content. (not oxidized, Fig. 7)
- ✓No spalling, giving a durability above 8 years in Safety and Calcining Zone.
- ✓Prevention of chemical attack due to penetration into bricks by its low porosity.

3-3. SYNTHCAST®: Apart from our range of bricks, Refractaria has SYNTHCAST® castables made up of synthetic raw material + SiC & ZrO₂

✓SUPERTAB 255CS is a low cement castable +35% SiC which provides great abrasion resistance and the best resistance against chemical attack (Fig. 8).

✓NORCAST 365ZCS has best abrasion resistance (ASTM 704<2.3 cm³).

✓Refractaria provides Sol-Gel and Gunning version of both castables, and for the whole range of SYNTHCAST® concretes.

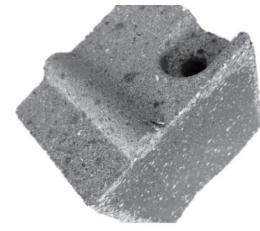


Fig. 5 Brick with EffSiC technology.

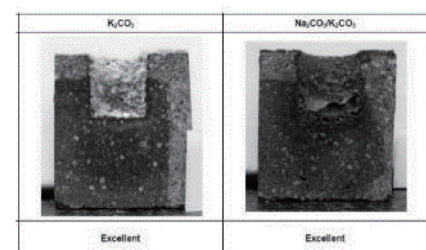


Fig. 6 ASTM TEST -CARBAL-.

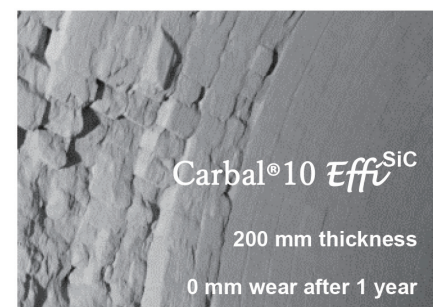


Fig. 7 Carbal 10 performance.

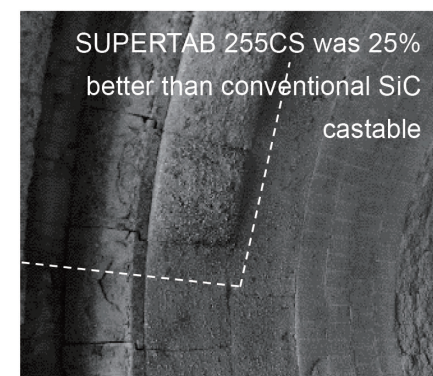


Fig. 8 Comparison with conventional SiC castable.

4. Refractory evolution on ingot casting

Our patented refractory system **CLEANCAST®** minimize wearing, eliminating refractory inclusions taken by the steel stream into the ingots, achieving a cleaner steel thanks to:

- ✓Innovation in fluid dynamics during casting.
- ✓Preventing the slag generated during casting from reaching the mold.
- ✓Minimizing the dragging of the refractory pipes.
- ✓Reducing the oxidation phenomenon that occurs during steel driving and entering the mold.
- ✓Reducing air occlusion inside refractory channels.
- ✓Innovative Low porosity refractory (<15%) without Clay and CaO Content.

Example of performance

Vercast N95 (Fig. 10 and 11): Critical wear such as indicated as broken circle in Fig. 10 increases the inclusions taken by the steel stream, reducing steel quality and promoting turbulences in the flow. Vercast N95, which was developed without water and clay (+ Dry pressing), can overcome such phenomena thanks to its <15% porosity ("Mirror copy of mold" Fig. 11).

CLEANCAST®: Energy dissipation in our patented spider "CLEANCAST" (Fig. 12) is much higher than obtained in conventional design of spider.

5. Ceramic industry

Spanish ceramic engineering companies are world-wide leaders thanks to their R+D+I investments, quality of the products, design, and innovation. Their prestige is recognised around the globe, and from Refractaria we have been working side by side during this growth process positioning ourselves as a benchmark for quality and innovation for the Ceramic Industry.

5-1. Tunnel kiln suspended roof: ANDAL 50X & Carbal 1050 (Table 3) were developed as the most optimal solution for a ceramic tunnel kiln where a high percentage of alkalis are present.

- ✓Special Andalusite base bricks which mean low content of fluxes, stable structure, and greater resistance to chemical attack.

5-2. Tunnel kiln car: Due to constant heating and cooling, the kiln car is the part of the tunnel kiln exposed to the most severe stresses. CORDAL T present top chemical and physical properties such as:

- ✓Lightweight and energy-saving.
- ✓Long life service, thanks to a great thermal shock resistance (Cycles >40 EN993-11).
- ✓Our automatic press process ensures the best airtightness.



Fig. 9 Ingot casting -infographic-

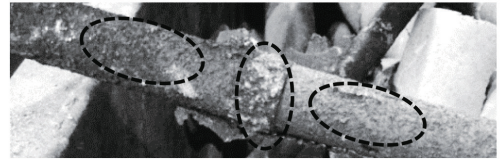


Fig. 10 Conventional product made by Bauxite.

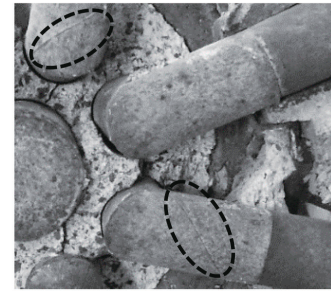


Fig. 11 Spider with Vercast N95.

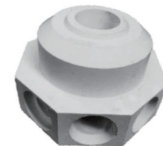


Fig. 12 CLEANCAST.

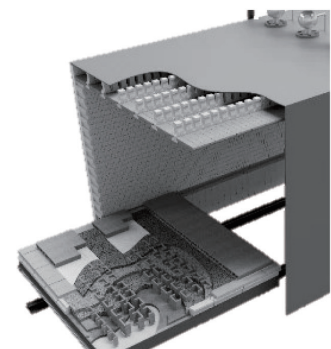


Fig. 13 Tunnel kiln & Kiln car.

Table 3 Special qualities for ceramic industry.

Quality	Raw material	Bulk Density / g/cm ³	Apparent porosity / %	Cold Crushing Strength / MPa	Chemical composition / %			
					Al ₂ O ₃	Fe ₂ O ₃	MgO	SiC
ANDAL 50X	Andalusite	2.45	15.5	58	50.0	1.0	-	-
CARBAL 1050	Andalusite - SiC	2.53	14.0	100	49.0	0.9	-	11.0
CORDALT	Cordierite	2.10	20.0	35	38.0	1.9	4.0	-