



Firing supports

Aptalite[®], a solution to fight higher energy costs

Located in the Audomarois region, the Wardrecques site covers an area of approx. 10 hectares at the crossroad of the Boulogne, Flanders and Artois regions. It holds ISO 9 001 and ISO 14 001 certifications and employs 54 people for an annual average production of about 61,000 tonnes of tiles through its 2 units (WarA1 and War02) including 1,000 tonnes of accessories. Unit WarA1 is dedicated to manufacturing accessories for interlocking tiles and War02 to interlocking tiles such as the Monopole n°1 and n°3, S pan tiles and double S pan tiles. We should point out that accessory firing on line WarA1 is still carried out using 1,800 U shape supports. The revamping work carried out on this line will be described in more details in an article to be published in *icv* 1026.

widen the range of products by incorporating new products and colours which more closely meet market expectations and to optimise the quality of the tiles by replacing the U shape supports with H shape single supports which allow to considerably improve the aesthetics and flatness of the products (glaze and satin finish tiles). Where a few years ago, a flatness tolerance of 0.5 mm or where light specks of glue due to the use of powder engobing slips were still acceptable, today a tile manufacturer cannot allow himself these discrepancies. Not forgetful of the fact that a greater energy efficiency of thermal aggregates and of their corresponding supports should help to more easily adapt to the evolving costs of energy and to more accurately control their impact on production costs.

An upgrade required by the market

This recent investment is aimed at developing the production facility in order to efficiently meet the needs of the markets in the North of France, Belgium and England. Revamping the plant allows among other things to

Speeding-up the process

Revamping the production unit involved nothing less than a mini-revolution as the firing cycle was shortened on average, depending on the products, from about sixty to about twenty hours as the water seal kiln was replaced by a sand seal kiln. As a result,



1. The Wardrecques site was founded in the beginning of the XXth century

The unit 2 of the Imerys roofing plant of Wardrecques produces interlocking roofing tiles. It had a new face lift with an 80 % upgrade of its earth preparation up to and including the pallettisation of its finished products. Revamping of the unit was carried out in partnership with Keyria, the specialist in construction materials engineering, and Imerys Kiln Furniture (IKF), who belongs to Imery's Building Materials & Monolithics division, provided the design and fabrication of the reversible supports supplied to the unit. These supports represent the major technical innovations which are discussed in the following article.

rotating the supports is in fact accelerated. To achieve this transformation, it was necessary to have a support providing optimal performances in terms of dimensional reproducibility, and service life in terms of thermal and mechanical stresses (up to 3,000 cycles depending on operating conditions). Today, there are thousands of reversible supports, which are suitable for both the large and small mould formats, which are circulated on the kiln cars of the War02 unit. A support can accommodate one large format size tile (10/m²) or two small format size tiles (2 x 22/m²).

U or H shaped supports?

U shape and H shape supports meet client requirements and different design configurations. The U shape supports are used for vertical and long firing periods (25-50 hours) and firing temperatures of less than 1,050°C,



whilst the H shape supports are used to fire the tiles flat down where the firing cycle (up to 1,200°C) is between 10-12 hours and subsequently allows all kind of surface treatments (powder, glaze, slip). Therefore, the revamping project at Wardrecques made the transition from the U shape to the H shape essential. It should be noted that IKF also offers its clients H shape cassettes for firing accessories, with or without the combination of inserts to provide greater flexibility of operation on the production line.

Aptalite®

IKF is the number 1 leader worldwide for supplying supports for firing heavy clay products. One of its strength is that it has the necessary resources in-house to design, supply, and service its clients and to optimise the solution provided throughout its industrial service life. Although it already has a very wide portfolio of "white" products (cordierite; mullite, alumina, porcelain and zirconia) for various applications, the H shape Wardrecques supports have been designed from a new material based on cordierite and named Aptalite®. This material which is 20 % lighter than cordierite, according to IKF, must provide a 4 to 10 % energy and CO₂ emission savings to the manufacturer. The programme is attractive, but let us closely examine the composition and the properties of this material...

Aims

The primary aims of the manufacturer are to improve his product and to lower his energy bill. The challenge for the designer and the support manufacturer is to provide a solution which meets these aims whilst maintaining the thermomechanical performances commonly required and acknowledged in the trade. Therefore, IKF has revised and optimised the microstructural design of its cordierite. The case at Imerys is somewhat special to the extent that the Group is both a manufacturer and a user of supports. Should we see this as an advantage? Probably in terms of being able to carry out testing in situ but the industrial challenge and efficiency requirements still remain. The physical properties such as water absorption, density, porosity, rupture modulus, thermal shock resistance or high temperature creeping should not be impacted negatively because of a lower specific density.

Development

Cordierite remains a reference material for designing supports for heavy clay products given the optimal balance it provides between thermo-physical properties, service life and production costs. Its low coefficient of thermal expansion explains its more than satisfactory thermal shock resistance and therefore its ability to resist to thermal cycling, all the more as part of a revamping project such



as at Wardrecques where the firing time has been dramatically reduced. The application of cordierite in heavy clay has some limitations per se in regards to the fairly weak rupture modulus of cordierite and to its temperature of decomposition (1 420°C). The rupture modulus of cordierites

2. The range of products produced in Wardrecques efficiently meet the needs of the markets in the North of France, Belgium and England

A little history...

The roofing tile plant was established in the early 1900's. Roofing tiles, hourdi bricks and concrete floors constituted the production of that era. It was acquired in 1987 by the Imerys Group (former Imetal) and the plant was fully revamped in 1990. Today, the plant supplies the Nord-Pas de Calais region, Belgium and English markets. 2009: "Imerys Heavy Clay" is making a new investment: converting «U» shape supports into «H» shape supports. The roofing tile plant is one of the 19 French plants of Imerys Terre Cuite which employs 1,700 people (Sales for 2008: €479 m.).

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3. An ingenious 360° synchronized rotation system on the two fork holders of the dry product stacking robot prior to firing, allows to eliminate any possible soiling of the product without direct contact

4. War02 produces S pan tiles and double S pan tiles



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conventionally used for the IKF supports (example Aptakorit ZSA) is 18.2 Mpa at 1 200°C and 24.8 Mpa at 20°C. One must therefore be careful as the scope for manoeuvring is not enormous even if it does exist. As regards temperatures, Wardrecques fires at a temperature of 980°C, therefore the threat for decomposition is still remote.

A revised and optimised microstructure⁽¹⁾

The lightening of the cordierite support without a sudden or fatal fall of its rupture modulus has already led to product developments in the field of ceramics. Manufacturers of refractory concrete commonly use hollow refractory spheres in their matrix but in the case of cordierite this approach is still quite new. The essential properties of cordierite based ceramics are determined by the matrix that bonds all of the compounds together. The lightening of construction materials or refractories is usually aimed at reducing their thermal conductivity. For materials which have a purely insulating role and which are not in direct contact with the products like

for instance the superstructure elements of kiln cars, this is not perturbing, but for firing supports subjected to high mechanical stress, this is more so. Consequently, the challenge is to lighten the material by increasing its porosity, while keeping high mechanical strength characteristics.

A cordierite based ceramic matrix contains coarse particle size aggregates; it therefore meets the basic laws of microstructural design for refractories. Given that the support is produced by pressure casting, redefining the casting slip must not bring about any detrimental segregation to the quality of the finish product. IKF has therefore carried out surveys and extensive simulations on different compositions based on the different properties of the passive and active compounds in the matrix. They developed a compound that allows to incorporate hollow ceramic microspheres, that fulfil the role of passive microstructural compounds in association with a mullite base compound. SEM examination has revealed the formation of a dense network of mullite needles originating from a partially amorphous phase.

Although high-temperature creeping increases very slightly whilst the rupture modulus slightly decreases, the cordierite matrix is not weakened by the microspheres. The classical cordierite and Aptalite® tend indeed to stabilize at identical MOR values, the difference observed on brand new supports tends to fade away after some cycles of use. In-house at the IKF plants, the body has required a few adjustments to facilitate the mass production of the supports. Tested at several industrial sites, the performances of the Aptalite® supports in terms of chipping, geometrical stability, corrosion resistance and mechanical strength have shown results that are compatible with those of standard supports.

Conclusion

Apart from the risks of breakage and chipping of the supports occurring during the automatic stacking and unstacking operations, which are usually eliminated during the running-in period of the facility, the supports seemed to give the manufacturer complete satisfaction. An ingenious 360° synchronized rotation system on the two fork holder of the dry product stacking robot prior to firing, allows to eliminate any possible soiling of the product without direct contact. The visitors of the Ceramitec trade show will have the leisure to inquire in-depth about the potential improvements that Aptalite® can provide...



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IKF's organisation

4 business units (or BU) based in France, Hungary, Spain and Thailand

550 people in 4 countries

Turnover 2008: €45 m.

Geographical sectors:

- Western Europe: IKF France with an engineering department and sales management (Chapelle Saint-Mesmin, France);
- Central and Eastern Europe: IKF Hungary with a plant in Hódmezővásárhely (supports for the heavy clay (U and H cassettes), the tableware, the sanitaryware and the technical ceramics);
- Southern Europe and Americas: IKF Spain with a plant in Cedonosa (Cuntis): rooftile supports (U and H shape cassettes), kiln cars, tiles and a Lomba plant (La Guardia): supports for tableware, sanitaryware or tiles;
- Asia and Middle East: IKF Thailand with a plant in Saraburi (supports for tableware, tiles and sanitaryware).

(1) Please see the article published in the *CFI 85* (2008) n° 1-2 by Dr. Andreas Sonntag, Monika Weber, Sandor Kiss and Zoltan Bonomi (IKF)