EVOLUTION OF PORCELAIN TILE DECORATION AND PRODUCTION TECHNIQUES

Carlos Martínez Guinot, Juan Payá Sáez

Innovaciones Técnicas Aplicadas a cerámicas Avanzadas, ITACA, S.A.

INTRODUCTION

Porcelain tile was conceived as an unglazed ceramic product, with excellent technical characteristics, capable of being decorated in the press.

Its precursors lie in the low porosity vitrified ceramic products found in Northern Europe in the middle of the XIXth century.

Some specialists have called the birth of porcelain tile the second great revolution in the tile sector of the XXth century after single firing, and it has been the ceramic flooring and wall cladding product with the greatest growth in the last twenty years. Taking Italy, the country where the evolution of ceramic products has been most pronounced as a reference, in 1980 porcelain tile production accounted for 1.3% of total ceramic production. In 2000 this had become 42.5% (including glazed porcelain tile).

BACKGROUND

Porcelain tile precursors are found in Northern Europe: England ("fine stoneware") and Germany ("Steingut" a type of clinker). These materials already exhibited very low water absorption values, which meant high frost resistance. Structurally they had crystalline phases "embedded" in a vitreous matrix, a feature common to porcelain, and were unglazed products.

By the middle of the XIXth century, production of pressed tiles made up of coloured clays began in Stoke-on-Trent (England). Their use in flooring provided the advantage that surface colour did not disappear with wear. The original plain tiles were followed by polychrome pieces (known as *encaustic tiles*), in which powders of several colours were incrusted in a non-coloured matrix, forming geometric, floral patterns, etc, yielding a single body on firing.

The Spanish pioneers in the production of plain tiles established themselves in the surroundings of Valencia. This mosaics production began in 1857, with the appearance of a second producer in 1866. As for the materials used in the production of these tiles, a Royal Charter of June 9, 1864, mentions a procedure for manufacturing "matt porcelain mosaics".

In France, industrial-scale production of "grès cérame" started around 1935. This material was manufactured using refractory and vitrifiable clays together with alkaline fluxes (feldspars), and firing was carried out with coal at about 1200 °C in muffle kilns for about 30 days. The production of this type of ceramic material was further fostered by the availability of deposits of these raw materials in Germany (Westerwald) and France (Normandy, Centre and Pyrenees), leading to the appearance of "grès cérame fin vitrifié". This was manufactured in tunnel kilns fuelled by gas or electricity, with firings lasting 8 days, yielding a product that had no rival for a long time. However, the energy crisis of the 70s negatively affected production of this ceramic material; around 1975 small sizes were only being manufactured by a limited number of companies.

Italy was much more conservative with regard to the substitution of materials such as "cotto forte" and majolica by the so-called ceramics "of the north". Until the 50s, production of unglazed low porosity ceramic material was only effected with white vitrifiable clays. These materials were dry milled and fired in tunnel kilns with three-day cycles at about 1200 °C. The resulting material had very low porosity and was resistant to acid attack and frost, although it was aesthetically very poor.

One of the main problems associated with this product was control of shrinkage and porosity, which limited it to small sizes. Before the 70s, only a minor group of tile manufacturers produced this material, always outside the Sassuolo area. Clinker was also produced in Italy during the 60s with reasonable success.

Toward the end of the 70s, the Sassuolo area struck on "porcelain tile" as we understand it today. A true technological revolution took place: wet milling, high tonnage presses, spray drying and fast single firing in single deck roller kilns provided greater production control, allowing larger sizes to be manufactured. It was at the beginning of the 80s, when the term "gres porcellanato" was coined and associated with a high range product. The following steps led to aesthetic enhancement of the product by incorporating coloured bodies, soluble salts, granulates, polished finishes, etc.

Other porcelain tile predecessors can be found in Asia. In Japan, at the beginning of the 60s, a production process was established using compositions in the "porcelain tile" line (white clays and feldspars), which were wet milled, filter-pressed, dried and granulated. The pieces were formed by pressing at high pressure and fired in tunnel kilns. The resulting material was used in high traffic areas as flooring and the glazed version was used for claddings. The latest versions incorporate bodies that are fully coloured throughout. Makers of this product are still found in some countries like Malaysia and Japan.

THE EIGHTIES

This was when some manufacturers put their stakes on this type of ceramics, which initially had clear aesthetic limits. Product differentiation among the few manufacturers of the time is minimal with regard to colours and range, practically only differing in the textures of the technical or stony profiles. In the catalogues, the products are basically divided into two lines:

INDUSTRY

A high percentage of production goes to industrial floors, usually with profiles and a natural finish, (non-polished) in sizes ranging from 15x15 to 30x30 plain tiles or with a mixture of different coloured spray-dried bodies, commonly known as granites.

HOUSING

Use of porcelain tile in the housing industry was influenced by the capacity to produce larger sizes, 40x40, as well as the incorporation into ceramics of polishing and grinding techniques. This type of finish provides tiles with an added value, which despite the aesthetic limits of the base composition, plain and granite bodies, has facilitated its introduction into this building sector.

THE NINETIES

We can divide this decade into two parts as far as the evolution of porcelain tile decorating techniques is concerned. During the first half, glazing lines begin to be incorporated into production systems for decoration with soluble colourants, which thanks to their ability to penetrate into the ceramic body enable using polishing processes. As for the rest of the product, there still continues to be a marked dependence between the industrial equipment used and the aesthetic results. Two issues thus acquired high-priority. On one hand, product differentiation between the different manufacturers was required, and on the other, the search for new aesthetic possibilities. It is during the second half of the decade when, as a result of both demands, the tendency to personalise the product came to dominate by combining existing techniques and materials to produce tiles with enhanced aesthetic qualities.

To achieve this goal, R&D teams of the ceramic companies and of machinery builders started research work devoted to developing new effects. A great part of these aesthetic innovations has been possible as a result of the development of new equipment linked to the body feeding and pressing operation, while heterogeneous charging and double-charge systems, using different materials (spray dried, micronised, agglomerates, etc.), have given porcelain tile its final definitive push to widespread acceptance in the market. New systems of finishes have also been developed in polishing, and in producing satin and smooth finishes, which provide warmer, softer surface textures for rustic products.

Another of the techniques driving increased porcelain tile production is the dry colouring of spray-dried bodies, because when there is a moderate demand for colour homogeneity (glazed porcelain tile or decorated rustic products), it enables colouring the bodies with a lower capital outlay than for wet preparation facilities. Moreover, this technology represents an excellent alternative for double-charge products with micronised spray-dried powder, even allowing subsequent polishing.

PRODUCT TRENDS

If catalogue products of the same manufacturer over the last seven years are compared, the evolution in decoration techniques applied to porcelain tile has been dizzying. But it is also evident that till recently, few machinery builders supplied equipment for this type of product, so that this equipment has become established in the market worldwide as standard equipment. Thus, until recently, it was easy to know which production technique had been used when you saw a tile.

In the last few years we have seen how porcelain tile has become the target of great transformations in production and decorating systems. Many ceramic machinery builders that had not yet engaged in developing machines specifically for porcelain tile and press decoration are launching new facilities, so that it is no longer so easy to establish at first sight which techniques have been used for tile decoration. Advances are essentially taking place in:

- Increasing production flexibility in the plants: mobile bins, dry colouring, spray dryers and mills for small batches of coloured bodies.
- Combination of techniques for surface or body decoration.
- Systems for press decoration: new fillers, articulated arms, plotters, etc.
- Development of ceramic materials capable of being used in combination with spray-dried bodies, semi-transparent compositions, superwhites, spray-dried glazes, etc.
- Improvement of dry colouring for polished products.

Lastly to be noted is the novel technique of twice pressing or using pre-compactors, which is starting to be implemented industrially. This process consists of using two presses for tile forming, the first one pre-compacts the body at low pressure, providing it with a minimum mechanical strength for transport and decoration; the second compacts the tile at high pressure with all the foregoing decorating applications. This technique offers enormous possibilities for the incorporation of different materials for tile decoration between both forming operations.