WHAT TILE FOR WHAT PURPOSE ?

by Hubertus Reh (Germany)

- Ceramics engineer since 1956
- Since 1956, activities such as ceramic engineer in Germany, Switzerland, Sweden and South Africa in the areas of electrical porcelain, chemical stoneware, tiles (wet and dry presed), advanced ceramics and refractories.
- Since 1983, Chief Editor of Verlag Schmid (Germany) for Interceram, Tile & Brick International and Keramische Zeitschrift magazines.
- Own Ceramics Consultancy.

A short survey of the history of tile production is given, followed by information on available materials. Shaping variants with detailed explanation of the dry and plastic lines are listed. This is succeeded by a description of the different fields of tile application according to their production process. Finally the relation between quality and market volume is contemplated.

1. HISTORY

The production of tiles dates back far into ancient times. It cannot be determined exactly today when ceramic floor tiles were laid for the first time - certainly it was long before Christ. Originally, bricks were probably used for covering the floor. Glazed wall tiles, used for the first time in Egypt for adorning the graves of the Pharaohns about 2.700 B.C., were produced with alkali-blue colours. Both tile types, which today can be fixed often optionally either to walls or floors, formerly served for completely different purposes. Floor tiles were particularly purpose-oriented: Coverings as durable as possible, easy to be cleaned, mechanically resistent (vitrified), safe for walking, could be achieved perfectly with ceramic materials. By no means was it decisive in the beginning, whether a vitrified (thus non-abrasive) piece was obtained. Including the relatively soft terracotta was even better than rammed loam or rotting wood.

Wall tiles, on the contrary, served only for decorative purposes in the beginning, used by the rich, distinguished people for tiling their walls. Exterior wall cladding, carried out relatively early, was reserved almost exclusively for buildings of religious practices. As Northern Africa and Minor Asia, respectively, are free from frost, primarily mosques received ceramic wall tiling.

2. FOUR MATERIALS AVAILABLE

In the run of the century development naturally depended on many things. Materials as well as processing technique, of course, exerted the most decisive influence on product design and manufacture. Table 1 gives a survey of materials, products and processes in the field of wall and floor tiles. Today most commonly used materials are:

-Terracotta (950...1150°C), water absorption generally >10%

-Earthenware (1000...1250°C), water absorption 7...18%

-Stoneware (1150...1300°C), water absorption 0...6%

-Fine stoneware (1150...1300°C), water absorption 0...3%.

Table 1

HISTORY OF TILE PRODUCTION

YEAR	PRODUCT/MATERIAL	PROCESS	ORIGIN
6000	Potteryware		Middle East
4000		Kiln	Middle East
3600		Potters' Wheel	Middle East
2700	Glazed Wall Tiles		Egypt
1300		Plaster Moulds	Egypt
100	Stoneware		China
650	Chinaware		China
800	Majolica/Faience	Tin-Opacifier	Middle East
1020	Floor Tiles Germany		Germany
1280	Vitrified Stoneware		Germany
1768	Earthenware		England
1795		Hydraulic Press	England
1809		Dry Press	France
1850	Tile Factories	Ball Mill	England, France
1853		Filterpress	England
1855		Extruder	The Netherlands
1873		Tunnel Kiln	Germany
1922		Vacuum Extruder	U.S.A.
1930		Fast Firing Tunnel	K. U.S.A.
1962		Spray Drier	Danmark
1965		Silk Screen	England, Italy
1968		Roller Kiln	U.S.A.
1970		Punching Device	The Netherlands
1969		Buffer Cars	Italy
1983		Built-Up Granulate	The Netherlands
1985		Contin. Wet Mill	Italy
1986		I.T.P. Kiln	Italy
1987		Roller Drier	Italy

Fig. 1

Classification of tiles according to the shaping processes and their water absorption as per ANSI 137.1 - 1980

<table>
<tr><td>Water absorption</td><td>Impervious
E < 0,5%</td><td>Vitreous
0,5% < E < 3%</td><td>Semi-Vitreous
3% < E < 7%</td><td>Non-Vitreous
E > 7%</td></tr>
<tr><td>Shaping</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Dust-pressed</td><td>Glazed/ Unglazed Porcelain Tile:
> 39 cm2
Paver Tile
< 39 cm2
Ceramic Mosaic Tile</td><td colspan="2" rowspan="2">Glazed Natural Clay Paver Tile</td><td rowspan="6">Glazed Wall Tile:
E < 18%</td></tr>
<tr></tr>
<tr><td colspan="2">Unglazed Natural Clay Paver Tile</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Glazed/Unglazed Natural Clay Ceramic Mosaic Tile</td></tr>
<tr><td rowspan="2">Plastic</td><td colspan="3">Glazed/Unglazed Quarry Tile
E < 5%</td></tr>
<tr><td>Glazed/ Unglazed Porcelain Ceramic Mosaic Tile</td><td colspan="2"></td></tr>
</table>

In recent times standard specifications name an additional group, which is the "impervious tile", with water absorption rates of < 0,5% - in principle a piece with a high content of glassy phase, similar to porcelain (Fig. 1). However, as tiles are not made from purely white bodies, this is actually a stoneware product as well - reason for better denominating it "impervious stoneware".

3. TILE - SHAPING WITH EIGHT DIFFERENT PROCESSES

For a long time tile production was performed by hand shaping. Relief was achieved for the first time when power machines replaced human force in the 18th century and efforts were made to develop suitable working machinery. Already at the beginning of the 19th century the first hydraulic press was tested in Great Britain; during Napoleon's heydays (at the beginning of the 19th century) one was able to compact powders by using machines: dry pressing was invented. Halfway through the 19th century another machine for shaping plastic bodies was added: the extruder (at first without vacuum). This means that the two most important shaping variants had been introduced already 130 years ago - which stands for 4 generations.

What does production look like today? World production is estimated optimistically at 2.200 million m^2, the market, however, "buying" only 1.650 million m^2. Consequently many a tile producer finds himself in a tightened situation.

Installed capacities correspond to approx. 4500 production lines with one kiln for glost firing each (in case of double firing biscuit kilns have to be added). About 300 production lines, which is approx. 7%, shape tiles from plastic bodies - 90% of the lines work with powder, i.e. they press dry. This is primarily due to the lacking plasticity of the clay raw materials. The following methods are available today:

-Dry pressing(for single or double firing)
-Extrusion of split tile(plastic, single firing)
-Extrusion of quarry tiles(plastic, single firing).

Moreover, in some cases tiles are shaped by electrophoresis, rolling, casting, tape casting - and, of course, still by hand. These are all special processes often used for the production of large-sized (incl. exterior wall) elements. For quite a few years it has already been possible to produce decorated, very thin (2 mm thick) tiles in large dimensions, like a sheet of glass. The product indeed consists mainly of the aesthetically appearing layer of glaze, which in a normal tile amounts to only 5% of its total mass at the very best - which, on the other hand, is decisive for the buyer's selection in almost all cases.

4. TILES COVER MANY FIELDS OF APPLICATION

The expert knows that the material (and to a certain degree also the production process) influences the quality of the finished product and with it the suitability for defined fields of application. Just as before tiles still serve for aesthetic or technical purposes. Table 2 shows how to specify individual fields of application:

Table 2

Fields of application of tiles

Object	Wall	Floor	Dry pressed tiles	Split tiles	Quarry tiles
Private homes	x	x	x	(x)	x
Shops	x	x	x	x	x
Public buildings	x	x	x	x	x
Craftsmen's work halls	x	x	(x)	x	(x)
Food industry	x	x	(x)	x	(x)
Industry (general)	x	x	x	x	(x)
Acid-resistant claddings	x	x		x	
Facades	x			x	
Pools	x	x	(x)	x	(x)

x = preferably used (x) = less used

Not included are the varieties of shapes, common for mosaics and innumerous tiling patterns made possible by combinations, which are used for representative purposes in private homes, in public buildings or also shops.

The advantages of the various products are based on their production methods, however, at the same time determine their prime field of application. Table 3 reflects the corresponding information. Basically assignments can be made for the three main types of tiles as follows:

Dry pressed tiles

-excellent dimensional stability
-exact edges
-thin products possible
-producible from mosaics to tiles sized 60 x 60 cm^2
-elegant decoration possible (double firing; screen printing)

Split tiles / Terracotta tiles

-thick pieces possible
-deep, single-directed profiles possible
-"natural" appearance possible
-better gripping on the rear side (dovetailed)

Quarry tiles

-large variety of profiles possible
-quite good dimensional stability
-exact edges possible.

To explain it more simply: dry pressed tiles meet with the aesthetic requirements of qualities permanently improved in recent years with respect to abrasive stability (floor). If ice-resistant tiles or pieces of increased thickness, with marked profile, or naturally looking products are to be manufactured, primarily split or quarry tiles are chosen. However, also terracotta tiles have proved to be convenient if the microstructure of the piece is favourable - the piece has not always to be impermeable.

5. TILE INDUSTRY WELL - PREPARED

In the meantime international standards have established worldwide to a degree that the customer can obtain an appropriate material to meet his desires. Remaining gaps - such as e.g. colouring by penetrating stains - are being closed at present. It can be taken for granted that especially these efforts for standardization have shifted extra market shares from competing materials to ceramic floor and wall coverings.

It remains to the tile producers to gain this territory. In Europe the imminent Common Market will swap the partially still existing taste tendencies by crossing the borders. The "tile developing country" USA is experiencing a market upswing, which will be propelled with the next economic rise. In many third world countries tile producers have established who provide these countries with inexpensive products.

This appeal goes to everybody: No quality-compromises with respect to prices - one might have to pay dearly for it, as proven by examples from the beginning of the 70s in Europe! At that time tiles were launched on the market, which resisted practical strain only for a short time. The pro proves himself by making the same mistake only once - and tile producers ought to be pros!