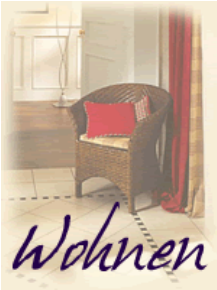
Industrial Ceramic Tile Manufacturing

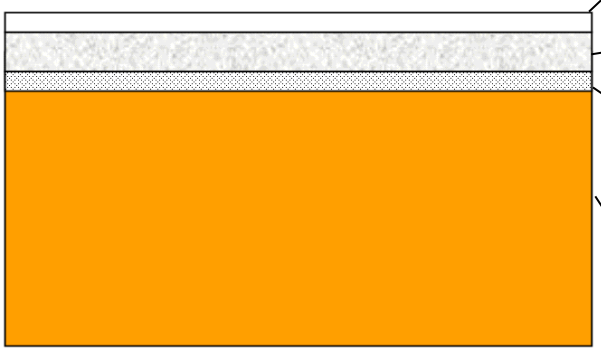


Introduction to Ceramic Tiles

- Ceramic tiles are made from clay compositions and other inorganic raw materials, that are ground and/or slipped, molded and subsequently dried and fired at temperatures from 950°C to 1250°C to make them acquire the required properties in a stable way.
- Tile sizes vary from 10x10cm (4x4”) to 5’x10’. 90% of all tiles produced are up to 60x60/60x120cm (24x24” / 24x48”)
- There are two basic types of tiles: glazed or unglazed
  - Glazed tiles have a vitreous coat applied on top of the body, which provides additional wear resistance. For decoration (digital or trad.) glazed tiles are required.
  - Unglazed tiles undergo a single firing and are not decorated

Turkish tile from the 16. century

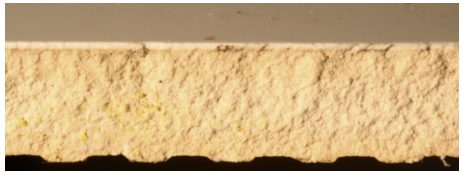
Ceramic Tile Composition



Additional Protection Layer
Used primarily for floor tiles to protect the decoration from abrasion and to reduce the slippery effect

Ceramic Glaze
A nonporous, protective glass coating. The decoration is printed directly onto the glaze. Provides wear resistance and seals it against liquids.

Engobe
Thin layer applied before the glaze (mostly white color) to cover defects and unevenness of the body and to block the body color.



Body
A mixture of clay compositions and other inorganic raw materials (Quartz, Kaolin, Feldspar, etc.)


Press


Glazing


Digital printing

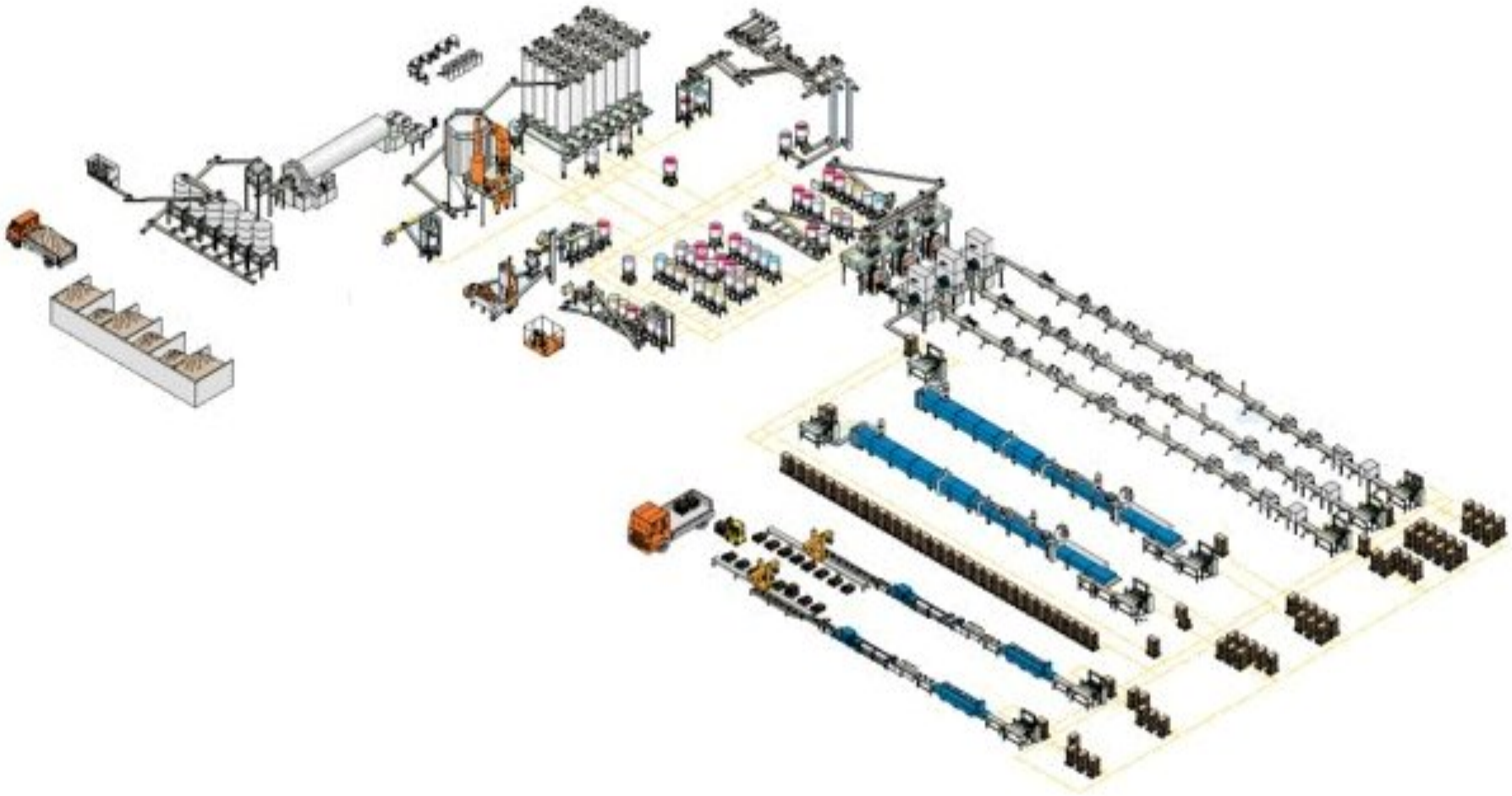

Firing

Industrial Ceramic Tile Manufacturing Process

The ceramic tile manufacturing process consists of a series of successive stages:

- Raw materials preparation
- Pressing and drying of the green body
- Applying different optional layers (engobe, glaze,etc.)
- Decoration (today primarily with digital printing equipment, before with screen and flexographic printing)
- Applying additional layers (special optical and haptic effects, wear resistance, anti-slip, etc.)
- Drying to reduce the water content before firing
- Firing (temperature vary with tile type – trim piece to porcelain 900 – 1300°C)
- Finishing (rectifying, polishing, grinding)
- Quality control
- Sorting and packing

Ceramic Tile Factory Layout



World Ceramic Tile Production & Top Manufacturing Countries

TOP MANUFACTURING COUNTRIES								
	COUNTRY	2009 (Sq.m Mill.)	2010 (Sq.m Mill.)	2011 (Sq.m Mill.)	2012 (Sq.m Mill.)	2013 (Sq.m Mill.)	% on 2013 world production	% var. 13/12
1.	CHINA	3,600	4,200	4,800	5,200	5,700	47.8%	9.6%
2.	BRAZIL	715	754	844	866	871	7.3%	0.6%
3.	INDIA	490	550	617	691	750	6.3%	8.5%
4.	IRAN	350	400	475	500	500	4.2%	0.0%
5.	SPAIN	324	366	392	404	420	3.5%	4.0%
6.	INDONESIA	278	287	320	360	390	3.3%	8.3%
7.	ITALY	368	387	400	367	363	3.0%	-1.1%
8.	TURKEY	205	245	260	280	340	2.9%	21.4%
9.	VIETNAM	295	375	380	290	300	2.5%	3.4%
10.	MEXICO	204	210	219	229	228	1.9%	-0.4%
	TOTAL	6,829	7,774	8,707	9,187	9,862	82.8%	7.3%
	WORLD TOTAL	8,581	9,619	10,599	11,194	11,913	100.0%	6.4%

Source / Fonte: Acimac Survey dept. "World Production and consumption of ceramic tiles", 2nd edition 2014

Back in 2004 Durst has started the digital revolution in the ceramic tile decoration with the introduction of the first Gamma Digital Printer using pigmented ceramic ink.

In close cooperation with the customers Durst over the years has continued with important innovations contributing to the success of many leading ceramic tile manufacturers around the world.

Durst Gamma inkjet printers have quickly become the industry standard and reference for print quality with high uniformity and strong colors, flexibility, productivity and reliability. With close to 500 digital ceramic printers, Durst has the biggest market share of all (non-Chinese) printer manufacturers.

Time Line of Digital Conversion

2004 First introduction of production digital tile decoration
Two primary vendors: Durst and Kerajet

2009 Durst, EFI Cretaprint, Sacmi, System Ceramic and others all have digital offerings
Many of these were former analog equipment manufacturers

2016 Approximately 70% of tile is produced digitally worldwide with higher and lower % varying from country to county (30% to 90%) of total decoration production now digital

At the November 2015 Acimac Annual Meeting on digital ceramic tile decoration technology Prof Paolo Zannini suggested that inkjet decoration of tile is widely considered to be "mature" and the sales and usage data for dedicated machinery suggests that we are at the beginning of a new period of consolidated sales worldwide. However, he believes that this technology is likely to undergo much more research and development and will reach true maturity in a few years time.

From introduction to maturity in a total time of 12 years is remarkable.

What factors drove the change to digital?

1. Possibility of 1 shade of color per tile design, eliminating or reducing inspection and inventory

   In analog systems transfer from the glaze to the printing surface contributed to color variations and the need to sort and inventory and ship by “shade” of tile. Well controlled digital decoration can eliminate this “shade” issue

2. Variety in tile imaging: analog repeats the same image over and over, digital can use a rendering or digital photo capture of a natural stone and randomly crop sections of it to allow reproduction of varying portions of the design resulting in random design tile to tile much like achieved with natural stone.

3. Ability to do short runs, print to order of designs reducing inventory costs and reacting to changing sales requirements.

4. Quick changeover from one design to another to meet order requirements, just in time delivery of product rather then maintaining large inventories to meet demands.

5. More flexibility in design especially in reproducing natural stone and product such as wood grain which is quite popular in many markets.

There are many more reasons other then those listed I am sure.

Challenges in ceramic digital conversion

1. environment: very dusty, little or no control of ambient temperatures
2. Jetting very high pigment loads of inorganic dyes in the ceramic ink, nozzle reliability with requirement of up to 100 grams/sq M for high contrast designs such as natural stone
3. Surface temperature of raw glazed tile body coming from drier, issues with vapor and aerosols depositing on nozzle plates and impacting nozzle reliability and purge requirements
4. Printing on the glazed surface
5. Not a traditional CMYK workflow due to the nature of the inorganic dyes, requires the use of multiple available colors to achieve design requirements, a true Magenta color is only obtained with the use of finely ground gold, an expensive solution only needed for true pictorial reproduction. 6. Color management with multiple white point base colors due to the use of tinted coatings on the tile body depending on the tone of the design being reproduced which reduces ink costs.

7. High line speeds from 40 m/min to over 70 m/min common in some manufacturing processes
8. Need to match small trim tiles with main floor and wall tiles to obtain harmony upon installation
9. Need to maximum uptime, limited purge cycles, ability to quickly resolve nozzle failures by on site staff.

All of these issues were resolved incrementally by engineering, new technology, adaptation and collaboration by the equipment and ink manufacturers and the end users. Some resolutions occurred quite quickly others required years with new technology and new ways of thinking by engineering staffs.

All the time digital continued to run at whatever state it could achieve due to its inherent value to the production process. Equipment was sometimes better at doing lower contrast designs while other equipment offered higher density jetting to achieve a more natural look in high contrast imaging like natural stone demonstrates.

Much the same as the photographic image capture change from analog to digital, users did not wait for perfection but adapted to what was available at the time and forged ahead pushing the growth of the technology and engineering required to achieve their needs and goals.

New Innovations

1. Dry decoration: the ability to print glaze only where needed and decorate in registration, This allows structure to be created digitally and increased special effects in design are possible.

2. Full Digital: replace all analog processes with digital, this will require considerable innovation to achieve all color, effects, dry material application and glazes along with texture to be created digitally rather then in the tile body mold.

3. Materials and digital effects including metallic effects, reactive and sinking inks, white, glossy and matt glazes as well as water-repellent and multifunctional materials.

   None of this will happen overnight and early adaptors will be faced with obstacles that will be overcome.

- Summary:

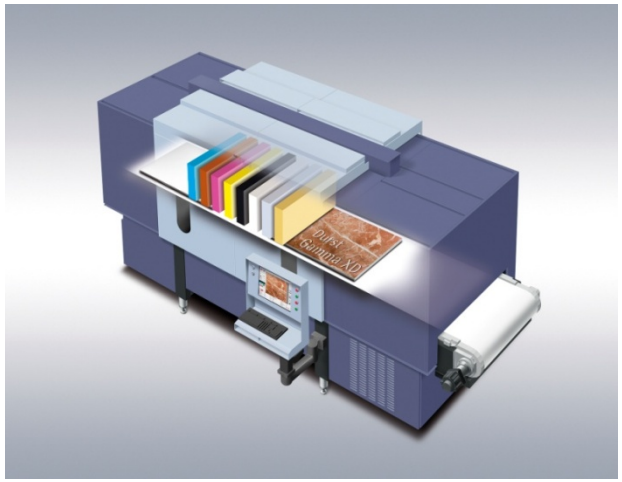
- Innovation requires risk taking and a sense of timing. There is bleeding edge and cutting edge which both have their place in the marketplace, each company has to weigh the positive and negative factors of each and the impact on their particular market and growth.

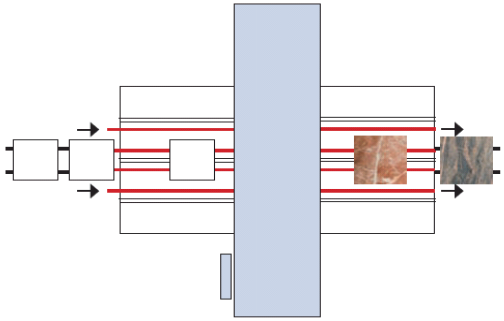
- I would encourage you to consider the story of two major changes that have already occurred
- Digital Image Capture
- Ceramic Tile Printing
- Consider the trials and rewards of each of these experiences and use them to judge what can happen as we see changes in new areas such as:

- Wider format offset to digital
- Corrugated
- Packaging
- Flooring

Durst Gamma – High Performance Single Pass Ceramic Tile Decoration Printers

- Durst Gamma single pass printer series for unique creativity and unrivaled production efficiency
- Customers with yearly production over 3 million sqm per printer and glazing line
- Over 3000 sqm/h
- Up to 8 color bars
- Different versions with printing widths up to 140 cm / 55”
- Innovative design for easy customer service
- Premium HD print head technology
- Easy and fast print head replacement by operator
- Banding-free printing thanks to new „Adaptive Dot Placement Technology”
- Best rated printer software





© Keramedia, Vietnam (large format ceramic tile printed with Pictocer)

Pictocer HD – Ceramic Plotter

Special multi-pass digital ceramic printer / plotter with Advanced High Definition Technology for the digital decoration of ceramic tiles, short run productions, development of new tiles / designs, production of listellos, photoceramics and processing special customized print jobs with frequent design changes in an offline production process.

- Best rated ceramic plotter (print quality, evenness, consistency)
- Simulation of Gamma print quality with ink cost calculation
- Unique transport system with hand fed loading boards for non-stop operation
- Max. printing width of 155cm
- Tile thickness up to 50mm - Optional up to 250mm
- Up to 6 colors
- Permanent ink recirculation in both ink circuits including the print heads and automatic maintenance cycles
- Fast and automated testing of new designs and repeat jobs

Required equipment and parts

- Infrastructure for file creation, preparation, retouching and Color Management workflow (Scanner, iMac with calibrated montitor, Photoshop and Caldera CopyRip Durst Industrial Edition, ICC profiling, etc.)
- Ceramic tiles with unfired ceramic glaze layer:
  - Glazed monoporosa bisquits (double fired tiles) to be purchased from a tile manufacturer (Monoporosa tiles can only be used for indoor application because they are not frost resistant.
  - Glazed porcelain tiles (single fired tiles) to be purchased from a tile manufacturer (porcelain tiles are frost resitant and can be used indoor and outdoor. Unfired porcelain tiles are difficult to transport as they easily break and get microcracks.
  - Storage space to warehouse these tiles in different sizes as required (tiles must be transported from the tile manufacturer on special frames to avoid damage including the glaze layer (like a powder) which cannot be touched.
- Durst PictocerHD Plotter – 10 - 12m^2/h – to be operated with pigmented ceramic inks (enduser price ranges from 160.000€ to180.000€ depending on configuration)
- Ceramic inks (reduced color space compare to UV inks as they have to be fired with temperatures up to 1200°C). Ink prices are approx. 25-35 € /kg. Magenta, based on gold costs approx. 600 € /kg.
- Small kiln to fire the tiles (depending on max. tile size and output power requirement up to 160KW and cost up to 200.000 €)

Applications

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© Johnson Tiles, GB

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Durst Company

- **Leading manufacturer of digital high-end printing systems** for ceramics, textile and wood industry, label industry, pre-press, in and outdoor advertising & signage, and packaging market
- **In-house development and manufacturing** of mechanics, electronics and software
- **In 1994 introduction of the first large format digital printer:** revolutionary Lambda System with full continuous tone printing at 4000 dpi apparent resolution (256 levels of Grayscale)
- **Over 5.000 installations** of industrial scale digital printers worldwide
- **500 ceramic printers** installed worldwide
- **Manufacturing facilities** in Brixen (South Tyrol / Italy) and Lienz (East Tyrol / Austria)
- **Durst Subsidiaries for Ceramics (Sales & service offices)** in Italy, France, Spain/ Portugal, United Kingdom, Germany, USA, Mexico, Brazil (Rio Claro, SP), China, India and Singapore for South East Asia.
- **Exclusive Durst Distributors for Ceramics (Sales & service offices)** in all other countries

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