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# Processing Trends in Tile Manufacturing

*The development of floor and wall tile products has undergone a dramatic evolution*

*By: Albert H. Burgess, Director of Engineering, Florida Tile Industries Inc., Lakeland, Fla.*

The U.S. ceramic tile manufacturing industry has become increasingly more competitive since the end of World War II. With the flood of imported tile created by the enormous growth of this industry worldwide, U.S. manufacturers have been forced to adopt new processing methods, search for new raw materials and purchase state-of-the-art equipment in an attempt to remain competitive.

This challenge to maintain market share and reduce manufacturing cost by adopting new technology is escalating rapidly. The U.S. economy is improving. There is an unsatisfied demand for new housing that will gain momentum as consumer confidence returns. However, there is surplus in capacity worldwide that is causing off-shore manufacturers to consider expanding their share of the U.S. market. Additionally, foreign currency continues to weaken, resulting in lower landed prices for these products.

What are some of the opportunities that U.S. manufacturers can pursue that would provide potential technological advantages? Before this question is answered, it is important to review how ceramic tile products have changed due to both customer preference and technology.

## Driving forces

The history of glazed wall tile sales in the U.S. market has been driven by the ever popular 4 1/4-in. by 4 1/4-in. size for residential use and the 6-in. by 6-in. size for most commercial jobs. The once popular 6-in. by 3-in. and 6-in. by 4 1/4-in. commercial formats have all but disappeared.

A major change occurred in the 1980s with the development and introduction of monoporosa products

manufactured in Spain and Italy. Wall tile manufactured by the monoporosa process are distinctive due to their brilliant finish and colorful decoration. However, the most dramatic change was the departure from square formats to rectangular formats. These new monoporosa products were introduced in 6-in. by 8-in. sizes and were instantly successful. These formats have continued to increase in dimensions from 10-in. by 12-in. to 12-in. by 16-in. and larger.

Keeping pace with this change in format was the increasing sophistication in decoration. The competition by European tile manufacturers to become a world leader in decoration has progressed from double and triple firing to an impossible number of intricate application techniques.

The floor tile sales of U.S. manufactured products were dominated for years by the handsome, durable and popular unglazed quarry tile. However, due to the limited number of colors and shapes being offered, homeowners and decorators had little to choose from for the residential market. They longed for style, fashion, color and design. With the development of the two-fire bicottura glazed floor tile manufactured in Italy, they now had a wide selection of residential products to choose from.

U.S. ceramic tile manufacturers were forced to review their



*The American-made 100-ton Cammerzell press forms a rope accent molding shape. Cammerzell presses can use a #3 Crosley die set.*

*Photo courtesy Florida Tile Industries Inc.*

## Isostatic concept for tile dies

product offering and decide what changes must be made if they were to compete with these imported glazed floor tile. Several U.S. manufacturers, including Florida Tile Industries Inc., developed and introduced these bicottura or two-fire glazed floor tile.

Expanding Italian technology soon developed the monocottura or one-fire glazed floor tile and the race was on, not only in Italy but throughout the world.

### Processing trends

Today, we see beautiful glazed floor tile being manufactured in most countries of the world. Size formats range up to one square meter. A full line of trim and angles is being offered together with beautiful listellos and accent pieces in every conceivable color and design.

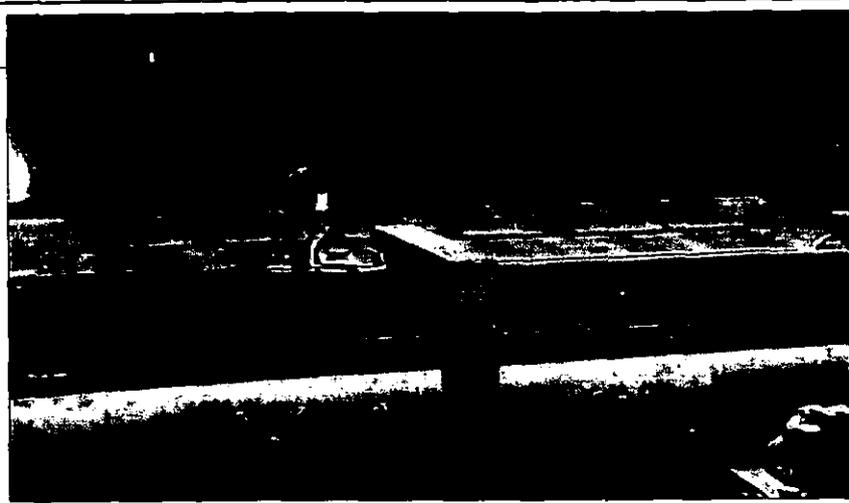
The following are some trends in processing that have made the evolution of these products possible. The manufacture of mosaic and porcelain paver products has been excluded from this discussion, since their processing methods and raw materials are uniquely different when compared to the traditional wall and floor tile products.

### Bodies

Wall tile bodies being developed for compatibility with today's technology must meet the following criteria:

- Be suitable for roller hearth firing cycles of 60 min or less;
- Be able to produce tile that meet established industry standards for breakstrength;
- Have a low cost to meet competition;
- Be environmentally friendly, especially regarding the presence of hydrogen fluoride in kiln stack emissions.

Floor tile bodies must meet the same criteria but have the added requirement of producing tile of low absorption to be marketed as frost-proof or freeze-resistant. The fired color of the floor tile body also is important. The majority of floor tile glaze colors are pastel or variations of white or bone. Dark colored bodies require an engobe application to



*A 500-ton Dorst hydraulic press forms the trim shape S-4449 and transfers the pressed greenware to the spray line where several glaze coats will be applied.*

*Photo courtesy Florida Tile Industries Inc.*

mask over the dark body and thus reduce the amount of expensive stain required in the glaze formula. For this reason, low cost, light color burning clays should be investigated.

### Body preparation

The spray dryer has become the standard method of body preparation. It produces a uniform, homogeneous body that provides excellent die filling properties on the high speed hydraulic presses. Furthermore, it is an ideal method for recycling greenware waste and dust collector fines. These advantages are somewhat offset by high maintenance and fuel costs in addition to the substantial capital investment.

There appears to be a trend today to return to the former dry mix method of body preparation. This has been made possible by design improvements in the mixing equipment, advanced design in the multiple cavity dies and, most importantly, in the sophisticated electronic controls of the large hydraulic presses. These controls provide the press operator with precise adjustment over die fill, die entering, de-airing of the cavities and die separation of the ejection phase. The memory capability of these units allows immediate production start-up following die changes without a long period of press adjustments.

The dry mixing concept also has cost advantages that should be considered.

### Pressing

The availability of increasingly larger presses permits the use of large die formats with a vast number of cavities. This results in reduced press cycles with better die filling to achieve the same rate of desired production. The trend is not only to larger presses but to fewer presses per kiln or glazing line. In plants today, you seldom observe presses being installed as backup or reserve presses. Florida Tile is following these concepts in the expansion or retrofits of their plants.

### Dies

The development of the isostatic concept for tile dies will play a major role in cost reduction as the technology evolves and more production experience is gained. Florida Tile is pleased with success to date on large format floor tile isostatic dies.

### Drying

The trend to roller kilns and short firing cycles demands that tile be carefully and fully dried upon entering the kiln. New plants and older plants being upgraded are installing the efficient in-line horizontal roller dryers either single level or multiple level. These dryers not only require



*Surface bullnose trim greenware tile exit a Sacmi horizontal dryer before moving forward to the glazing line.*

*Photo courtesy Florida Tile Industries Inc.*

substantially less fuel per square foot produced but are low maintenance and require virtually no adjustments when there is a die format change on the press.

### Glaze formulation

The trend continues to reduce the cost of glaze and develop glazes that are environmentally friendly. The most difficult challenge is the monoporosa type glazes which use an inordinate amount of expensive imported frits. Domestic frit manufacturers are working with U.S. tile manufacturers to develop cost-effective domestic frits to replace these imported frits and prepared glazes.

### Glazing

The glazing operation historically has required the maximum amount of process control, due not only to the high cost of the raw materials being applied, but also to the ultimate end result or appearance of the finished product exiting the kiln. This remains the same today; however, the magnitude of the problem has increased many times over.

With the vast number of applications required to produce both wall and floor tile in today's market, glazing production lines are becoming longer and more sophisticated. A typical glazing line in a 1950 vintage contemporary plant would average between 60-75 ft in length. A state-

of-the-art glazing line for monoporosa floor tile today will range from 328-393 ft in length.

A U.S. manufacturer planning to install a new glazing line for producing glazed floor tile should consider providing the following in its design: horizontal roller dryer; equal spacer device; water spray booths; engobe application; one or more bell glazers; three to five screen deco machines; dry glaze applicator; roll print machines; fixative booths; glaze recovery systems; 90° turn devices; in-line drying between applications; compensators strategically placed; several double disk glaze booths; one or more SMAC-type machines; miscellaneous devices for blow-off, edge cleaning and kiln wash application.

Florida Tile is incorporating all of the above in the design of new glazing lines and the retrofit of existing lines.

### Tile storage

There appears to be a trend in numerous countries to abandon

the concept of extensive and costly roller storage car systems to provide 20-48 hr of storage for the kiln operations. Plants in Brazil, Mexico, Italy and even U.S. Ceramic Tile Co. in Ohio schedule their production lines to operate continuously—24 hr/day and seven days/wk.

The benefits include greatly reduced capital investment, lower work in process inventories and maximum utilization of the manufacturing equipment. Florida Tile has implemented a project to explore this concept and is designing a futuristic production line for its wall tile operations.

### Kilns

The roller hearth kiln continues to be the standard kiln in use throughout the ceramic world. It is available in various widths and lengths, with single level or multiple level designs, and with a wide selection of electronic packages and refractory linings.

Multiple level roller hearth kilns are frequently seen in European plants. These kilns are usually installed when available factory space



*The bell glazing process provides a high-grade gloss and smoother glaze application on the monoporosa production line.*

*Photo courtesy Florida Tile Industries Inc.*

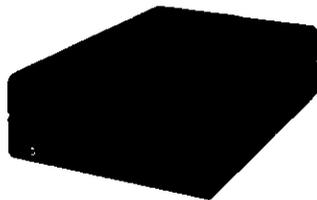


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## Two-fire manufacturing process



Tile exit from the end of a Sacmi Forni kiln through a gating system operation. The mechanism holds the fired ware up while a release system offbears the tile to a belt feeding into a storage box loader.

Photo courtesy Florida Tile Industries Inc.

is limited and additional firing capacity is required.

There is a renewed interest within the glazed wall tile industry to return to the two-fire manufacturing process because fast kiln cycle speeds are easily obtained and the overall two-fire cycle can be competitive with single fire kiln cycles. Furthermore, the two-fire concept permits the use of domestic frits rather than expensive imported frits to obtain superior glaze textures similar to monoporosa.

The disadvantage is the escalated capital investment for two kilns rather than one kiln. The added cost could be offset if available body materials are not compatible for one-fire and if improved glaze textures and sorting recoveries are substantially improved.

The spectacular growth of the demand for decorated wall and floor tile together with matching trim, listellos and insert tile has generated a new family of smaller roller kilns for this production. This type of kiln, sometimes referred to as a third-fire kiln, ranges in length from 12-40 m and can be designed to fire at low temperatures for use on rare metals like gold or platinum or decal products. It also can be designed for much higher temperatures to produce the monocottura decorated products.

These kilns have process controllers that permit the use of various

kiln cycles and firing curves. The use of fiber refractories allows them to be safely idled for the weekend with rapid turnup capability for Monday morning start-up.

Florida Tile is in the process of installing three kilns of this type. The Shannon, Ga., plant is installing two kilns, one of 21 m in length, the other of 35.7 m. The Lakeland, Fla., plant is installing a turnkey third-fire decorating operation based upon a 21-m kiln. All of these kilns will be operational in the first quarter of 1994.

### Selection and packaging

With the adoption of the continuous production line concept with no roller car storage, tile are now sorted and boxed directly from the kiln. This is a significant departure from the practice of sorting products from an inventory of fired tile from roller storage cars.

### Conclusions

The changes in the industry today are both exciting and intimidating. It is essential that a strong manufacturing base be maintained in the United States. There is a wide range of foreign-made products that U.S. manufacturers can import to complement their product lines. However, if industry takes advantage of every cost-saving opportunity, U.S. factories can remain competitive and productive in the years to come. □