Over the past decades, thanks to continuous research and development of Manfredini & Schianchi, there has been a remarkable evolution in the Dry Milling technology so that today it is possible to produce a high quality mixture for the following products:

- Once fired red & white body floor tiles
- Monoporosa wall tiles
- Rapid twice fired wall tiles
- Glazed porcelain stoneware with special applications in the glazing line
- Highly prestigious extruded products (terracotta vases, cotto floor tiles, extruded porcelain stoneware, roof tiles etc.)

The main goals of using such a technology instead of wet system with spray dryer are summarized as follows:

- Improvement in the final product quality.
- Far lower costs in the final product due to energy savings (the utilization of fuel & electricity can be lowered by up to 80% with the dry milling method).
- Possibility to use more economical raw materials and recycling of rejects
- Almost total elimination of water consumption.
- Elimination of pollution created by the spray dryer
- Increased production from the kilns

The dry process, in order to guarantee the above mentioned points, undergoes 7 extremely important stages:

1. Drying of raw materials with humidity content above 20%
2. Feeding & batching of mixture components
3. Primary milling
4. Final milling-drying-particle size grading
5. Check screening & iron removal
6. Homogenizing, agglomerator, humidity control
7. Storage and press feeding rotating screen mixer
8. Supervision and Intelligent electronic management of the plant
DRYING OF RAW MATERIALS

The following is necessary for mixture components with a humidity content higher than 20%

- Natural drying
- Installation of a drying system positioned in the raw materials deposit.

The first solution is definitely the most convenient from an economical point of view and mainly consists in "spreading" the raw materials under the sun until they dry out, after which, they are stockpiled in the quarry and then stored under a shed at the factory.

Another solution in warm countries could be the storage of raw materials inside boxes with transparent roof covers and having exhaust openings between wall and box roof. Thanks to the sun rays generating the "greenhouse effect" thus producing heat inside the shed, the water contained in the raw materials is transformed into steam which is released outside.

The above solution is ideal in warm countries and by customers who can operate with their raw material suppliers in order to make the abovementioned arrangements.

In different conditions a good yield drying system with limited energy consumptions utilizes the combination of the crushing-drying stages.

With lumpy raw materials, a preliminary crushing stage by means of a "caterpillar" apron feeder, and a lump breaking mill is required. Once the dimensions of the raw materials have been reduced, the drying stage takes place.

The material entering the mixer is projected by means of mechanical paddles towards the dryer that is installed above. The airtight depressurised system enables the inner body to maintain constantly dry and warm, reaching filter with a temperature lower than 90°C, and subconsequently without any condensation. The system has a low fuel consumption (with an output of 10-12 ton/hr, only 2.000.000 Kcal/Hr are needed to reduce the humidity from 28% to 14%).

After this stage, the raw materials are then stored in their special storage boxes.

FEEDING & BATCHING OF MIXTURE COMPONENTS

The mixture components are conveyed to the load hoppers where they are stored. Extraction occurs, depending on the size and humidity, by means of vibrating channel extractors (1), MS double rod extraction valves (2), which alternately feed the weighing/batching conveyor belts (continuous or discontinuous) (3).
From the weighing/batching conveyor belts, the various components of the ceramic mixture are transported in a “sandwich” manner (in layers) onto one conveyor belt only (4), for the primary grinding stage; At this point the mixing and homogenization process begins. 
It would be advisable to always install a magnet plate (5) on the belt, and also a Metal detector (6). These control instruments are indispensable in order to avoid unpleasant and dangerous iron impurities and non magnetic metals to cause damages to the equipment.

**PRIMARY MILLING**

One of the most frequent conceptual errors in the traditional dry systems is entrusting the finishing mill to carry out all of the milling on its own, with the aim of getting the highest possible amount of material.

By doing so, the following problems are encountered:

- Low mechanical resistance and subconsequent difficulty in realizing larger sizes
- Loading difficulties
- Low number of press strokes per minute.
- Excessive wear and tear of the moulds
- Longer drying & firing time

This is the reason why we deem it necessary to integrate the grain shape obtained with the primary hammer mill type MS/P.I.G. to the body.

This mill has a high production capacity and receives feed sizes up to 150-200mm (it is possible to use the ceramic fired and green rejects) and at the output obtain 50% of the product below 400 microns (of which 40% under 100 microns).

In order to mill raw materials with a humidity content up to 15%, it is necessary to insert the Heating System in the mill which will prevent any clogging phenomena.

**FINAL MILLING- DRYING & PARTICLE SIZE GRADING**

At this point, the material is sent to the pendular finishing mill type MS.

These mills, thanks to a double feeding device and also the presence of internal ploughshare distributors that optimize the loading in the milling chamber, guarantee high production rates and extremely low grading levels by means of a classifier installed above the milling chamber.
The final milling is carried out by sturdy pendulums, that, under the action of the centrifugal force, exert, during the rolling action, a strong pressure on the sector track lodged at the base of the mill.

The material is then collected in the upper part of the mill by means of depressurization from the process filter connected downstream and classified through a separator.

The configuration of the separator depends on the type of material and particle size desired.

The rejected particles from the separator fall into the grinding chamber to be simultaneously milled with the “fresh” material which derive again from the double feeding system, guaranteeing a perfect mixture homogenization between the heavy and light particles.

This operative system (called “open cycle” milling) is entirely sealed and does not disperse fine dust into the environment.

The Process Filter MS57000 may also be used as an environmental filtering unit as well, therefore the relevant investment can be avoided.

In the MS Pendular Mills, it is possible to insert hot air by means of a burner with excellent thermal results (not more than 400 Kcal/lt of evaporated water) and the guarantee of consistent humidity in exiting material that brings about remarkable advantages in the downstream humidification and agglomeration stage.

The product that exits the primary hammer mill has a versatile form and a homogeneous granulometric curve (25% below 140 mesh), and as we previously mentioned, the milled particles are intimately mixed with the powder from the pendular finishing mill.

The final result is that such versatile particles build up the tile skeleton conferring a high mechanical resistance to the green and dried product (approx. 50% higher compared to the spray dried and 70 % higher with traditional dry milling), and subconsequently with the possibility of carrying out many more operations along the glazing stages.

CHECK SIFTING AND IRON REMOVING

The M&S high efficiency inclined screens are installed after the filter because their function is to guarantee and monitor the ceramic quality. In fact, their goal is essentially to detect the small impurities that may be present (wood, rubber, plastic etc) in the milled body which cannot be detected with the air classifier.
The M&S high efficiency sieves must be equipped with special devices that further emphasize the control quality and grading efficiency such as: the self-cleaning automatic system for the nets; the oleodynamic opening of the screening front; the automatic control instrument for screen netcloth; and the heating system through electrical resistances, in case the humidity of the material is particularly excessive.

Immediately after the screening stage iron removal takes place with global guarantees about the efficient removal of iron impurities from the ceramic body by means of a self cleaning iron removing equipment with magnetic neodymium bars (Actual Power 7000 Gauss).

This stage is essential so as to safely manufacture glossy glazed tiles

**HOMOGENIZING, AGGLOMERATOR & HUMIDITY CONTROL**

The homogenizing & agglomerating stages constitute a prominent part of the process.

The Vertical Agglomerator MS/38KSTB carries out a double function:

1. supplies the correct water content to the body, operating through nebulizing nozzles.
2. Through the central shaft, complete with paddles that make a helicoidal movement combined to the ultrafine sprayed water, an agglomeration is obtained in very small granules (less than 1mm. ~18 mesh, in a woolen ball shape) and homogenizing the humidity addition throughout all fractions of body grain size.

The main advantages of this technological stage are found above all during pressing. In fact, a reduced compression ratio of powder to press is the subsequent result with elimination of dust. Speed of pressing is at least equivalent to spray-dried powder.

An important and fundamental humidity control and management function of the of the wetting machine is carried out by the Automatic moisture gauge MS/100 PATHFINDERS that are able to determine, with a high precision and in continuous mode, the humidity percentage of the material exiting the agglomerating stage.

**STORAGE AND PRESS FEEDING**

The material is stored inside the silos and preferably matures for at least 24 hours, and then conveyed to the presses, passing however, through the homogenizer rotating screens located behind each press. These represent the fourth and last important stage of the dry processing plant.

The MS/ROT homogenizer rotating screens, in fact, have more than one function: they mainly effect a check screening just before the mould cavity feeding, this allows the elimination of all superficial defects caused by plaques, lumps or occasional impurities that have entered the body during the processing stages of the plant. They contemporaneously mix the grain sizes and homogenize the mass, with subsequent optimization of shrinkages, elimination of squaring defects and press setting defects.

**SUPERVISION AND INTELLIGENT ELECTRONIC MANAGEMENT OF THE PLANT**

The brain of the process lies in the Electrical Switchboard which thanks to its supervision program, is able to control and monitor all the processing stages.
The revolutionary FREQUENCY MODULATING UNITS MS 6000 studied and patented to operate on main motors of processing machinery, guarantees a substantial reduction of energy consumption (up to 40%) as well as a considerable yield of the equipment without any production drop even when the milling parts subject to wear require replacement.

The Intelligent Electrical Switchboard management is further equipped with remote assistance through modem enabling the servicing centre in M&S to operate whenever Customers require that.

Another important feature is the introduction of a maintenance reminding timer which through appropriate settings can facilitate the operators with their maintenance schedule on the equipment.

**CONCLUSIONS AND EVALUATIONS**

The raw materials preparation process DRY-TECH is the technological solution of Manfredini & Schianchi to the growing demand of dramatically cutting down processing costs with same quality standards in the manufacturing of tiles.

A painstaking research is conducted on customers’ raw materials and Manfredini & Schianchi thanks to its skilled technical team, labs and pilot plant, develops the ideal body composition to perform through its DRY-TECH process, a seamless and consistently repeatable ceramic endproduct.

The fundamental advantages of DRY-TECH are as follows:

- Very strong reduction of thermal and electrical consumption levels
- Utilisation of cheaper raw materials normally set apart in the traditional system due to viscosity issues
- Absence of deflocculants.
- Smaller space needed by the plant,
- High automation,
- Consistency of the endproduct
- Overhaul procedures definitely lowered compared with the traditional plant.
- Almost total elimination of water consumption and emissions of environment harmful exhaust fumes.
The DRY-TECH process of Manfredini & Schianchi is already the most worldwide spread alternative system in raw materials processing stage with more than 850,000,000 m²/year of floor and wall tiles manufactured by its customers in several kinds.

Further the latest evolution into DRY-TECH enables dry preparation technology to benefit any production and the relevant ceramic results are fully complying with running UNI rules.

<table>
<thead>
<tr>
<th>Incidence</th>
<th>DRY-TECH</th>
<th>Traditional wet system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (L/ton)</td>
<td>36</td>
<td>266</td>
</tr>
<tr>
<td>Electricity (kW/ton)</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Natural Gas (m3/t)</td>
<td>5 with 12 % humidity in the raw materials</td>
<td>45</td>
</tr>
<tr>
<td>Personnel</td>
<td>2 People</td>
<td>3 People</td>
</tr>
<tr>
<td>Global Mainteneance Costs (€/ton)</td>
<td>0,8</td>
<td>1,5</td>
</tr>
</tbody>
</table>

The data shown is indicative and may vary without notice.