# Pre-Drying in the Production of Sanitaryware – KOHLER's Experience

Drying is an important process in the production of sanitaryware, due to the critical issues related to the process itself and to the importance of the physical time spent in the entire production cycle. Space, manpower for loading and unloading and handling of the ware trucks, parking buffers, time and energy required, all are critical and with the increasing need to reduce in process times are required. Low consumption of power, with optimization of the available thermal energy and recovery, and near zero losses in drying are what every factory tries to achieve. However, there are limits related to the types of pieces, their shapes, their complexity with even the same model of piece from the same manufacturer, behaving differently if made in different factories, this can have different effects on the pieces drying behaviour. It is true that drying takes place mainly in the drying room, but it should be remembered that it begins as soon as it is removed from the mould. It then continues in the parking areas in the casting room and ends after final drying at the exit from the dryer. It is right from the start that the most critical phase begins, the contraction and where the material is most vulnerable to thermal changes, air flows and movements.

## Correct management of the phases prior to drying

There are intermediate stages preceding the dryer that must be carefully analysed as they are sensitive and critical to the integrity of the piece throughout the following processes.

The temperature values of 30–32 °C with 65–60 % humidity maintained in the casting room by an adequate air conditioning system are correct for the first stage of the pieces production, along with an appropriate choice of air diffusers directing air flow of on the pieces surfaces. This first phase is often crucial in more complex shapes where the piece still needs its own settling time.

Once conditioned to move from the cast shop which is prepared for drying, there are normally two types of dryers: those that have a low-speed but constant and uniform flow of air, and those with a high-speed, but a more turbulent air flow.

The low-speed air constant uniform flow helps with the initial drying of the piece when the pieces are still very humid (where the piece contraction can occur in the dryer), but the second stage with higher speed and more turbulent air flow is suitable at the end of the piece contraction where the dryer can deliver controlled maximum air speed without problems.

**Fig. 1** Entrance view

In other cases, the pieces, initially demoulded onto a polyurethane support, have to be removed from the support only after a pre-drying phase.

This type of piece also includes supports which act as a support to the piece in this critical time allowing the most fragile items to be moved only after reaching a certain degree of hardening.

For all these situations, the pre-dryer comes into play. The pre-dryer it is a chamber with controlled temperature and humidity, with low impact, uniform flow (one- or two-way) of the air speed onto the pieces. This manages the critical shrinkage phase of the material accurately.

## Marcheluzzo's pre-dryers developed for KOHLER in China

These pre-dryers are based on a series of rooms with controlled temperature and humidity, with low impact of air velocity on the pieces, uniform unidirectional flow.

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**Fig. 2** Doors opening

**Fig. 3** Internal view

(Figs.: Marcheluzzo)

The pieces enter the pre-drying chamber after de-moulding, with all their initial humidity, and the pre-dryer is used for the initial drying in a controlled manner so that the pieces can be moved onto the dryer. This process reduces the parking time, frees up production space, reduces potential loss and increases productivity.

The pre-dryer air flow is laminar, from one side to the opposite side of the chamber, the working temperature usually ranges from 32–42 °C, while the relative humidity varies from 80–70 %. The cycle can have a flat profile (same values for the entire parking time) or with a curve in which the temperature rises over time and the humidity drops. Marcheluzzo's experience can design the process curve to accurately fit the production requirements of the customer.

The temperature of the pre-dryer can be controlled by an air handling unit (single for several cells) or by single hot-water heat exchanger coils. The humidity, on the other hand, is maintained by a fog pump or a steam generator system. The production cycle is usually calculated to fit the production flows of the dryer and further processing of the pieces, with the pre-dryers positioned in front of the entry doors to the main dryers. This leads to a seamless flow of products.

## The benefits using pre-dryers

- The pre-dryer avoids parking of the pieces in areas not managed thermo-hygrometrically (humidity and temperature), which would expose the ware on the trucks to harmful air currents. Varying temperatures and too low humidity values are a possible cause of cracks and loss. The movement of ware trucks inside the factory is also reduced further reducing the risk of damage to the pieces. Parking of the ware trucks in the cast shop would occupy space. The loss of humidity (from the pieces) would be an issue. An Air Conditioning System (AHU) would be needed to avoid the formation of colder and wetter areas in the cast shop, which could lead to lower production and increase loss of ware.
- Pre-dryers control the initial stabilisation and contraction phases of the piece with an appropriate management of the parameters. This is critical in the few hours after de-moulding of the piece.
- Pre-dryers allow the piece to enter the main dryer with high-speed air without incurring problems of breakage due to different internal contractions or strong localized air flow. This results in speeding up the drying time and production output by reducing overall drying time.
- Pre-dryers allow the pieces to be semi-finished halfway through drying, and if necessary, the removal of any special substrate which are not suitable for high temperatures in the main dryer.

A good pre-dryer can compensate for loss in some critical areas of production which is not insignificant in production and should not be overlooked.

Pre-drying is a solution to be taken into consideration when considering shape complexity, productivity, and lower loss. Along with complex pieces with higher value, pre-dryers can help manufacturing products that need a dedicated treatment before entering the final dryer.