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A Long Track Record of Successful Drying

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A renowned German pharmaceutical company had counted for years on the so-called heat pump based condensation drying. Drying and cooling processes were optimized using this technology in many domestic and foreign facilities. The manufacturer of pharmaceutical products launched a new project to modify their existing drying-cooling system to integrate an additional cleaning process. To do this, drying system manufacturer Harter, who had developed heat pump based condensation drying, had to change the design of the system.

The starting situation was as follows. 5, 10 or 20 ml plastic ampoules are sterilized in a hot water cascade process. The sterilizing medium is demineralized water with sodium fluorescein added. The ampoules are placed upside down in plastic baskets 600 mm long and 400 mm wide. 9, 12 or 15 tiers – depending on ampoule size - of four baskets each are stacked on a pallet (ref. fig. 1). Pallet dimensions are 1,200 mm long, 800 mm wide and 1,600 mm high. Top tier baskets have lids necessary for the sterilization process.

The fluorescent substance in the demineralized water becomes visible when exposed to ultraviolet light. This way, the ampoules are leak tested. Ampoules which are not completely clean and dry are rejected by the optical test system although they are tight. This is why complete drying of ampoules is a must. Another imperative requirement is that any remaining sodium fluorescein be removed from the surfaces tested. For the project at hand, the client's specification required that the system not only dry and cool but also clean the ampoules. Also, the drying temperature was required to be low enough not to impose a thermal load on the ampoules so as to prevent deformation. Plus, the final temperature of the ampoules was required to be only about 30 °C to allow immediate subsequent labelling.

Fig. 1 – Following sterilization, ampoules in baskets stacked on pallets are rinsed completely, dried perfectly at 60 °C and then cooled to 30 °C ± 5 °C.
(All illustrations by courtesy of Harter)

Tests for Successful Drying

First, an original pallet assembly was subjected to testing in Harter's pilot plant station. The drying system manufacturer holds that this is a reasonable approach to establishing the basics for subsequent system layout and design. The tests are used to determine the relevant parameters such as time, humidity, temperature, air speed, air flowrate and air routeing. Only by fine tuning these parameters may a successful solution for such challenging projects be found.

The system built is a combined cleaning, drying and cooling type (ref. fig. 2). The system holds a total of six pallets. Pallets leaving the autoclave are moved to the system on a roller track. The existing cycle time provides 175 minutes for rinsing, drying and cooling. Ampoule temperature after sterilization is 60 °C.

First, the whole load is subjected to a spray of demineralized water applied through nozzles to remove any and all sodium fluorescein. The temperature upon rinsing is about 60 °C, but may be freely selected to between 10 °C and 75 °C. Following 10 minutes of rinsing with 1.5 cubic metres maximum of water, the drying process starts. The drying temperature is also 60 °C. The drying

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Fig. 2 – The fully automated system rinses, dries and cools. It is a closed air type with extremely low energy consumption and carbon emission.

period varies between 90 and 105 minutes as required for the specific load. The time available for cooling is 60 minutes. Using air at 10 °C the ampoules are cooled to 30 °C ± 5 °C and may be subjected to immediate further processing.

The drying-cooling system with inbuilt cleaning unit consists of a tunnel and a dehumidification module beside it. In other applications, dehumidification modules were placed on top of the tunnel where space precluded level installation. The tunnel has two entrance and exit doors each. A conveyance system runs along the interior of the tunnel. The spray nozzles are installed in the tunnel ceiling. The air recirculation fans are placed on top of the tunnel for protection from water splash. The recirculation fan speed is controlled by a frequency transformer as required for the specific load. The whole tunnel floor is covered with pans. The pans are used to collect both the cleaning water and the water dripping from the ampoules, and to drain the water from the system. An insulated air ducting system connects the tunnel with the dehumidification module. This module provides the air required for the process. The system is controlled through a touch panel attached to the tunnel. The system is operative with either full or partial loads while fulfilling all requirements.

Air Dehumidification and Air Routeing

Two features form the basis for successful drying by the Harter developed technology, namely efficient air dehumidification using a heat pump and perfect air routeing. Harter uses an alternative physical approach for this technology.

The dehumidification module strips the process air of very much of its moisture. This extremely dry and, thus, unsaturated air is passed into the drying tunnel and over or through the products to be dried. Moisture present is absorbed by the air in this process. Upon return to the dehumidification module, the air is cooled and the moisture condenses. The process air is then reheated and passed to the tunnel again. Drying may be effected at temperatures between 40 °C and 90 °C as required for the specific application.

Air dehumidification must be combined with targeted air routeing. Even the driest air is of no avail unless forced to take the route to where it is supposed to absorb humidity. Harter is most experienced in designing adequate air routeing provisions. Any excess thermal energy is dissipated through a plate heat exchanger. It may then be used to heat water for other production processes, for example. Harter's closed air system with integrated heat pump technology provides energy efficiency and reduced carbon emission in drying. This technology has meanwhile become eligible for government subsidy.

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