Milk Powder Production

Powdered milk in general

Powdered milk or dried milk is a manufactured dairy product made by dehydrating liquid milk through several drying processes until it is a powder. One purpose of drying milk is to preserve it; milk powder has a far longer shelf life than liquid milk and does not need to be refrigerated.

Milk Powder Facts

- In the last three decades, world milk production has increased by more than 50 percent, from 482 million tons in 1982 to 754 million tons in 2012.
- India is the world's largest milk producer, with 16 percent of global production, followed by the United States of America, China, Pakistan and Brazil.
- Since the 1970s, most of the expansion in milk production has been in South Asia, which is the main driver of milk production growth in the developing world.
- Milk production in Africa is growing more slowly than in other developing regions, because of poverty and – in some countries – adverse climatic conditions.
- The countries with the highest milk surplus are New Zealand, the United States of America, Germany, France, Australia and Ireland.
- The countries with the highest milk deficits are China, Italy, the Russian Federation, Mexico, Algeria and Indonesia.
- An evaporator supplying concentrate for a 15 tons per hour spray dryer contains up to 100,000 meters of tubes. Approx. 150,000 cows are needed to keep the plant running continuously.

History and Production

In the 13th century, Marco Polo reported that soldiers of Kublai Khan carried sun-dried milk on their expeditions. In more recent times, milk has been dried in thin films on heated rollers. The earliest patents for this process date from the turn of the last century. Such roller drying was the main method of producing milk powders until the 1960s when spray drying became prevalent. The manufacturing of milk powder is a very big business in the 21st century.

Milk powder manufacture is a simple process able to be performed on a large scale. Production involves the gentle removal of water at the lowest possible cost under stringent hygiene conditions while retaining all the desirable natural properties of the milk such as color, flavor, solubility and nutritional value.

Whole (full cream) milk contains about 87% water. Skim milk contains about 91% water. During milk powder production water is removed by boiling the milk under reduced pressure at low temperature in a process known as evaporation. The resulting concentrated milk is then sprayed in a fine mist into hot air to remove further moisture thus forming a powder. Approximately 13 kg of whole milk powder (WMP) or 9 kg of skim milk powder (SMP) can be made from 100 liters of whole milk.

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ROTRONIC HUMIDITY FUN FACTS

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Why the need to measure humidity?

Optimum dryer performance can be attained by monitoring the inlet and outlet flow to and from the dryer. Both, air temperature and relative humidity are measured.

In most cases two probes are installed on each dryer. One is installed on the inlet and one on the outlet exhaust. The relative humidity and temperature measurement will then be used to balance the dryer for optimum drying, thus reducing energy costs.

Milk powder processing plant.

Milk powder production process

SEPARATION / STANDARDIZATION

The conventional process for the production of milk powders starts with taking the raw milk received at the dairy factory and pasteurizing and separating it into skim milk and cream using a centrifugal cream separator. If WMP is to be manufactured, a portion of the cream is added back to the skim milk to produce a milk with a standardized fat content (typically 26-30% fat in the powder). Surplus cream is used to make butter or anhydrous milk fat.

PREHEATING

The next step in the process is "preheating" during which the standardized milk is heated to temperatures between 75 and 120 °C. The milk is held in this condition

for a specified time ranging from a few seconds up to several minutes (pasteurization: 72 °C for 15 s). Preheating causes a controlled denaturation of the whey proteins in the

milk and it destroys bacteria, inactivates enzymes, generates natural antioxidants and imparts heat stability. The exact heating/holding

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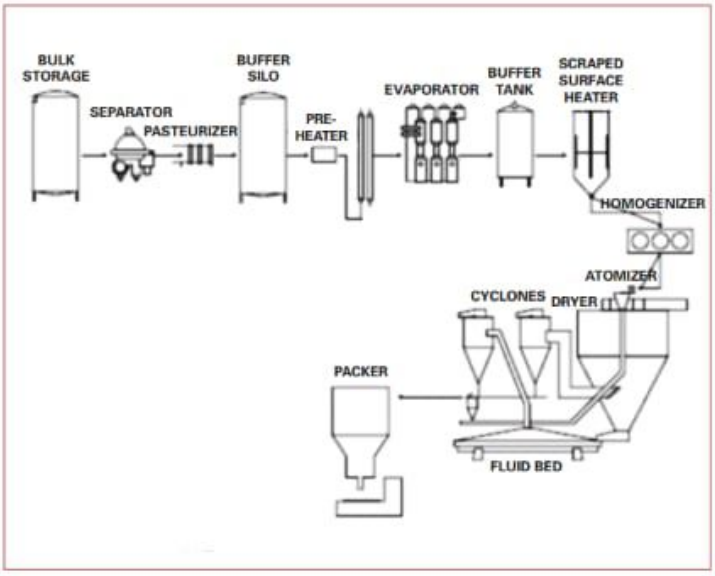


ROTRONIC HUMIDITY FUN FACTS

Milk powder production process

PREHEATING *(continued)*

regime depends on the type of product and its intended end-use. High preheats in WMP are associated with improved shelf life but reduced solubility. Preheating may be either indirect (via heat exchangers), or direct (via steam injection or infusion into the product), or a mixture of the two. Indirect heaters generally use waste heat from other parts of the process in order to reduce energy costs.

EVAPORATION

In the evaporator, the preheated milk is concentrated in stages or "effects" from around 9.0% total solids content for skim milk and 13% for whole milk, up to 45-52% total solids. This is achieved by boiling the milk under a vacuum at temperatures below 72 °C in a falling film on the inside of vertical tubes, and removing the water as vapor. This vapor, which may be mechanically or thermally compressed, is then used to heat the milk in the next effect of the evaporator which may be operated at a lower pressure and temperature than the preceding effect. Modern plants may have up to seven effects for maximum energy efficiency. More than 85% of the water in the milk may be removed in the evaporator. Evaporators are extremely noisy because of the large quantity of water vapor travelling at very high speeds inside the tubes.

Clockwise from above: powder milk being bagged. . . . Milk powder stored in a warehouse in California, US.

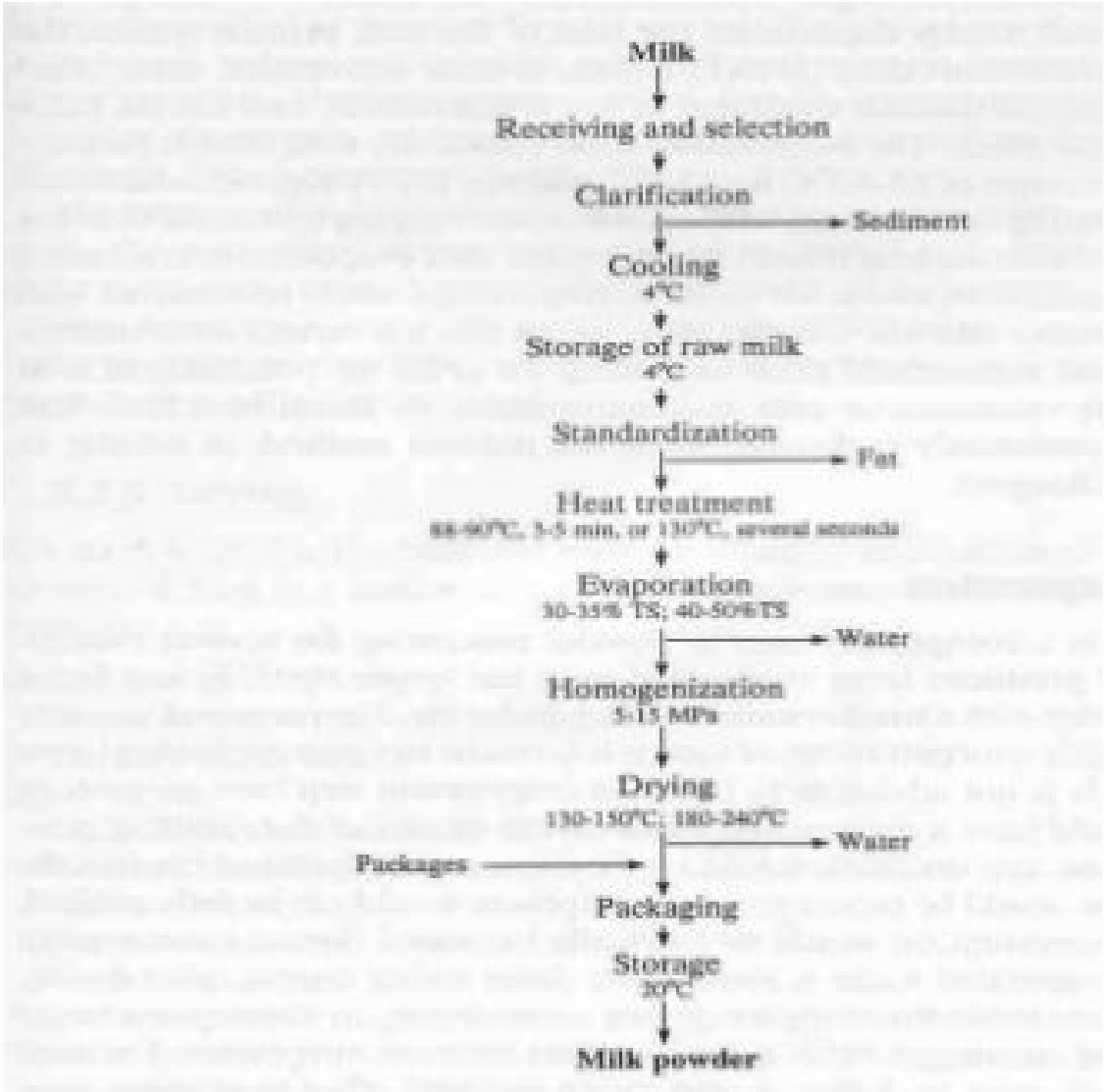
SPRAY DRYING

Spray drying involves atomizing the milk concentrate from the evaporator into fine droplets. This is done inside a large drying chamber in a flow of hot air (up to 200 °C) using either a spinning disk atomizer or a series of high pressure nozzles. The milk droplets are cooled by evaporation and they never reach the temperature of the air. The concentrate may be heated prior to atomization to reduce its viscosity and to increase the energy available for drying. Much of the remaining water is evaporated in the drying chamber, leaving a fine powder with around 6% moisture content with a mean particle size typically of <0.1 mm diameter. Final or "secondary" drying takes place in a fluid bed, or in a series of such beds, in which hot air is blown through a layer of fluidized powder removing water to the point of a moisture content between 2-4%.

PACKAGING AND STORAGE

Milk powders are immensely more stable than fresh milk but protection from moisture, oxygen, light and heat is needed in order to maintain their quality and shelf life. Milk powders readily take up moisture from the air, leading to a rapid loss of quality and caking or lumping. The fat in WMPs can react with oxygen in the air to give off-flavors, especially at higher storage temperatures (> 30 °C) such as found in the lower lattitudes of the Tropics. Milk powder is packed into either plastic-lined multi-wall bags (25 kg) or bulk bins (600 kg).

End



Flow chart diagram of Whole Milk powder production