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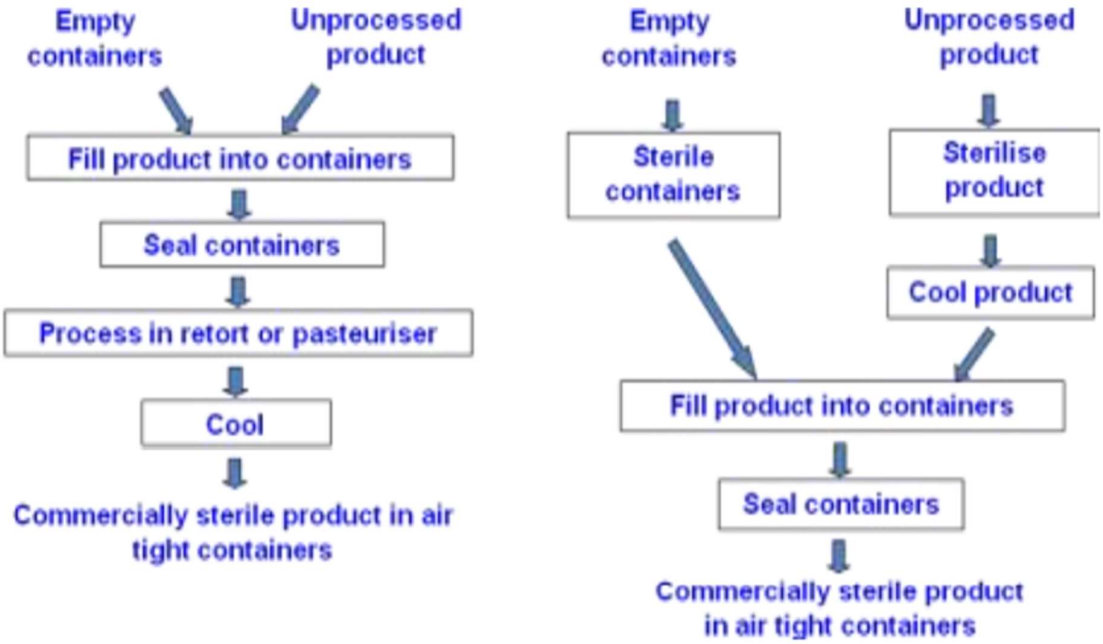
Preservation of Milk and Milk Products
Milk Sterilization

Sterilization is a term referring to any process that eliminates or kills **all forms of microbial life**, including transmissible agents (such as fungi, bacteria, viruses, spore forms, etc.) present in milk and milk products.

The sterilization of milk has the following characteristics.
• Temperature more than 100°C is used in the process.
• No chilling is required for storage.
• Excellent storage life at room temperature.
• High operating pressure is employed to prevent milk from boiling at the processing temperature.

Conventional method (In-bottle sterilization): Packaging is done before heat treatment. The processing is usually carried out at **105-110°C for 30-45 min.**

The difference between the **conventional method** and **UHT aseptic method** can be better understood with the help of below figure:



Conventional method (In-bottle sterilization) **UHT aseptic method**

Retort

Retort:
The equipment which is used for the sterilization process is called a **retort** and the processing is often called retorting.
The batch retorts can be either **horizontal** type or **vertical** type. The retort has a lid or door with good fastening. It has necessary controls for temperature, pressure and safety devices.

The batch retorting process can be explained as follows:

- The bottles are loaded onto crates and then the crates are travelled into sterilizer with the help of a trolley/truck.
- After the commodity is packed, the door is closed, the vessel is supplied with steam at required pressure.
- The processing time and pressure are properly maintained by controls (110 °C, 15 psi, 30 ,minutes).
- After desired processing time, steam is vented to atmosphere.
- After this the crates (bottles/cans) are immediately cooled by air (fans) to avoid further cooking of the product.

Cold Sterilization of Milk by Irradiation:
Milk and dairy products irradiation used as a preservation process of exposing milk to high-energy rays to improve product safety and shelf life. Milk and milk products may be irradiated to prevent growth of food poisoning bacteria, eliminate parasites, or delay ripening and spoilage. Also, irradiation could be used as a replacement of chemical preservatives in milk.

Shelf-life extension and/or sterilization of dairy products using radiation treatment by Gamma rays which is not a widely accepted practice. The reason for its limited use is that **ionizing energy**, through the formation of **radiolytic products** especially in high **lipid-based foods**, generates **unacceptable off-odors and flavors via oxidation**.

Dehydration/Drying of Milk

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 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. 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.

Three types of dryers are used in the production of dried milk products—spray dryers, drum dryers, and freeze drying:

1. **Spray Drying:**
   The liquid milk is generally **preconcentrated** by evaporation to economically reduce the water content. The concentrate is then introduced as a fine spray or mist into a tower or chamber with heated air. As the small droplets make intimate contact with the heated air, they flash off their moisture, become small particles, and drop to the bottom of the tower. The advantages of spray drying include a low heat and short time combination which leads to a better-quality product.

Spray Drying Process:

A- Separation:

The conventional process to produce 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.

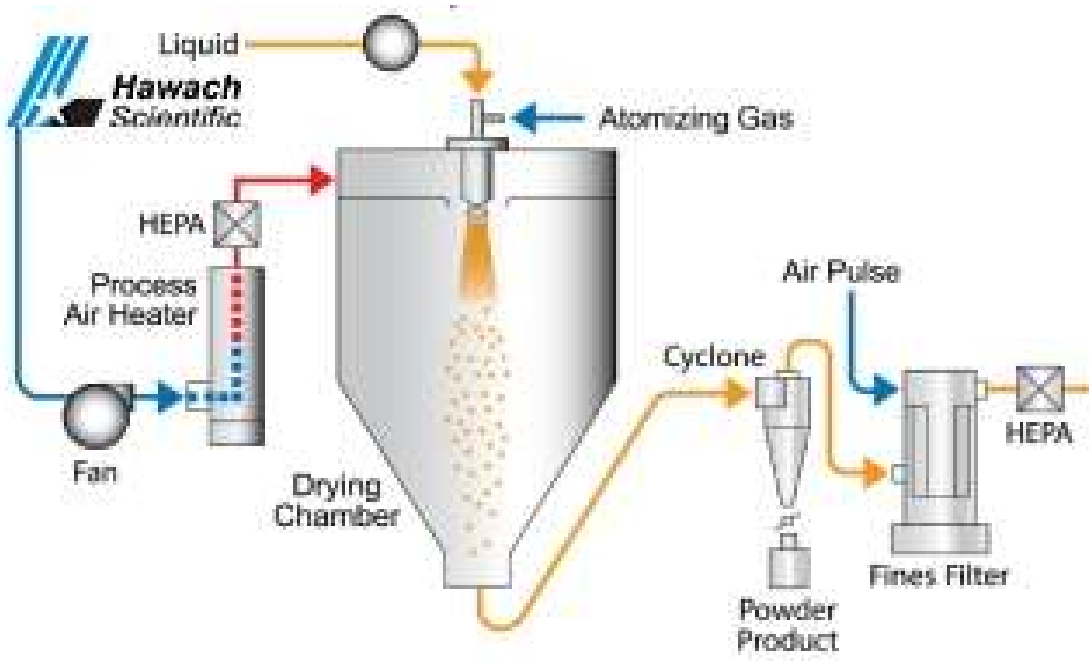
B- Preheating:

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.

C-Evaporation:

Concentrated milk is achieved by boiling the milk under a vacuum at temperatures below 100°C in a falling film on the inside of vertical tubes and removing the water as vapor.

Spray drying involves atomizing the concentrated milk 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 processing time in the spray drying chamber is very short (**approximately 20 – 60 s**).



Main advantages of spray drying:

• Very short drying time.
• Large scale continuous production.
• Low labor costs.
• Relatively simple operation and maintenance.

Disadvantages

• Much heat is lost in discharge gates.
• Higher volatile losses.

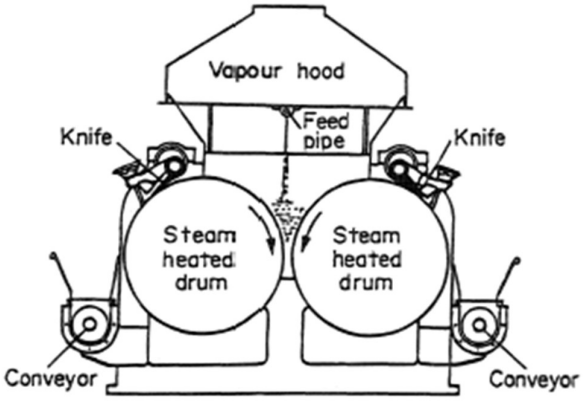
2. **Drum Drying:**

Roller drying involves direct contact of a layer of concentrated milk with the hot surface of rotating rollers or drums. The drum body of the drum dryer is heated on the inside by steam.

The main characteristics of a drum drying system are as follows:

• Slowly revolving drum(s) 0.6-3 m in diameter, 0.6 to 4 m long. (revolving at 1 to 10 rev/min).
• Steam is supplied to heat the surface of the drum.
• **Single drum, double drum or twin drum.**
• Dip feed / spraying.
• Scraper or doctor blade to collect the product.

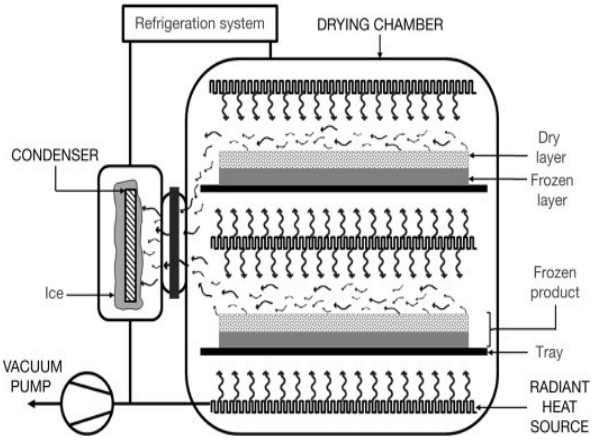
• Drums may be enclosed in a vacuum chamber.
• High temperature drying (over 100°C).
• Rapid drying (Residence time 30 to 60 seconds).
• Exposure to high temperatures may cause browning or burnt flavor, protein denaturation.



3. **Freeze Drying:**

Freeze drying of milk uses a process called **lyophilization** to gently freeze the product, then the water is extracted in the form of vapor using a high-pressure vacuum. The vapor collects on a condenser below the freezing chamber, returns to ice and is removed. A gradual temperature rise extracts all remaining 'bound' moisture from the product. This process retains the physical structure of the product and preserves it for storage or transport.

Lyophilization is a process in which water is removed from a product after it is frozen and placed under a vacuum, allowing the ice to change directly from **solid** to **vapor** without passing through a liquid phase.



The process of freeze drying is divided into three steps:

- Firstly, the shelf is cooled to − 5 °C rapidly and hold at − 5 °C for 20 minutes.
- Then the shelf is cooled to − 50 °C quickly. When the temperature of the samples is cooled to − 45 °C and held for one hour, the primary drying begins.
- Finally, increase the shelf temperature to 5 °C, holding for 5 hours and increase the shelf temperature to 35 °C, holding for four hours. Then the whole freeze-drying process ends.

Advantages of Freeze-Drying Dairy Products:

With freeze drying, both solids and liquids can be preserved without damaging their basic structure. The natural color, size, flavors, nutrients and consistency of the fresh product are retained.

Freeze-dried dairy products don't require refrigeration or chemical preservatives and can be either consumed directly or re-hydrated easily.

Disadvantages:

- Volatile compounds may be removed by high vacuum.
- Long time needed.