FILLING & PACKAGING OF MILK

Food is packaged for four primary reasons:

(a) to protect the product from contamination by micro-organisms

(b) to retard or to prevent either losses or gain of moisture

(c) to shield the product form oxygen and light, and

(d) to facilitate handling.

The packaging material for dairy products

Liquid milk is filled mostly in packs made of paper board, in folding cartons or in pouches made of polythene. Glass bottles are suitable as returnable packs. Bottles made from LDPE or PVC are used for packing liquid milk. For aseptic packaging of UHT milk, board laminated to aluminium foil and coated with polythene on the inside is used. This provides light protection and thus increases the shelf life.

The higher competitive cost of plastic bottle compared to paperboard and glass has led to the development of returnable plastic bottle. The problems inherent in returnable polyethene bottles are odour absorption and hydrocarbon contamination detection. It has been found that 150-200 return trips are attainable.

Since clear plastic does not offer adequate shelf-life, an opaque laminate is required. All plastic film pouches for milk are prepared from two ply, LDPE lay flat tubing.

Glass bottles and plastic bottles are used for sterilized milk. Bottles made from LDPE can be used at temperature of upto 120^{o}C and bottles made from polycarbonate at upto 150^{o}C.

Process cheese is hot filled into aluminium cups which are coated with a protective lacquer. It may also be wrapped in heat sealed lacquered aluminium foil.

Butter is largely packed in laminated aluminium foil (9 μm). Paper improved by plastics (PE, PVDC) and waxes (paraffin 10 g/m^2) is also used, but does not give sufficient light protection. A laminate of aluminium and polythene has also been successful.

Evaporated milk is mainly packed in cans made of electrolytically tinned mild steel which are closed either by soldering, or by a seamed-on-lid. The thickness of the tinned steel is between 0.15 and 0.25 mm, depending on the size of the can. Glass bottles with crown cork closures are also used.

Dried milk products are packed in cartons line with aluminium foil on the inside and outside, in aluminium PE foil bags or in the bags of plastic coated paper. Baby food is filled into tin can with or without an inner bag. For long storage times, a membrane of aluminium foil is used in addition to the snap-on lid to provide an additional seal.

Liquid milk filling

The systems used for metering and filling liquids and pastes may be divided into two main groups:

(a) filling by gravitation, and

(b) filling by metering

Gravitation Filling

In **gravitational filling**, the filling process is stopped when the pre-set filling height has been reached. Only packing materials such as glass bottles which cannot be distorted are suitable for this filling process. It requires the accuracy of the dimensions of the package since otherwise differences in the volume of the contents may result.

In the filling by **metering process (volumetric filling)**, definite volumes are filled. The shape and the distortion of the package do not matter since the amounts to be filled are fixed before filling.

Filling by gravity is used in the filling of thin liquids such as milk into glass bottles. The milk is contained in a circular filler bowl under vacuum. The filler valves are mounted in the bottom of the bowl with vacuum pipes rising above the level of the milk.. The empty bottles are lifted by pedestal and the rim of the neck of the bottle pressed against filler valve rubber. Further lifting of the spring loaded filler valve rubber results in the formation of an annular orifice in the valve, through which the liquid enters the bottle. As the bottle rise towards the valve, this first connects the bottle to the vacuum space; the bottle is evacuated up through the vacuum tube. The valve rubber is then lifted compressing the spring; this allows milk to flow down the annular passage into the bottle. As the bottle drops away from the valve, the milk line is sealed as the spring returns the rubber seal.

The filler valves do not open unless a bottle is in proper position. The air and foam are allowed to pass up and out through the hollow central vacuum tube. The filler valves do not fill broken or cracked bottles, because milk will only flow if the vacuum in the bottle is built up. The use of the vacuum speeds the rate of filling and also prevents milk from dripping from filler valves when a bottle is not under the valve.

Valveless filler

A form of vacuum filler which is widely used for sterilized milk is the so-called ‘valveless’ type. This avoids the difficulties of milk solids drying on valves and interfering with their operation, and of designing a robust mechanical valve to work within a narrow neck. Milk is supplied through a float operated valve to the main supply tank. The filler bowl is connected to a multistage centrifugal vacuum pump; the vacuum used to about 53 cm water

gauge, and is sufficient to draw milk up the bowl return space to the bottom of the bowl chamber. As the filling head is fully open to atmosphere when no bottle is in place, pressure is atmospheric in the head and the milk level is at A, determined by the float level. Air is being continuously drawn through the head and vacuum pipe into the bowl.

When a bottle rises on its pedestal, the bottle mouth seals on the nozzle rubber. The bottle is then evacuated through the vacuum pipe and the inner tube of the filling nozzle. As the pressure in the filling head falls, the milk level at A rises, until milk flows into the bottle through the outer tube of the nozzle. Milk flows until the level in the bottle reaches the bottom of the vacuum tube, when it is sucked up the vacuum pipe and back via the bowl chamber to the float tank. The level of the bottom of the filling nozzle in the bottle, determines the filling level.

As the pedestal drops and the bottle leaves the filling head, the head pressure becomes atmospheric once more, the milk level falls back to A and the milk remaining in the vacuum pipe is ejected by air flow into the bowl.

Sachet Foam – Fill-seal system

A simple cheap form of container for liquid milk is the pouch. Heat-sealable plastic film is used, fed continuously from a roll. The container material moves continuously downward in a strip, the film is folded longitudinally and the edges heat sealed to make a flat vertical tube. As the continuous cylinder moves downwards, transverse heat seals are made by jaws which have the effect of closing the bottom of the pouch, so that measured volumes of liquid product can be filled into the space above a seal. A further seal above the liquid produces a pillow-shaped flexible pouch or sachet which can be separated from the tube as an individual pack.

The liquid milk dozing in the liquid filling machine in based on the electron time based digital circuit. The filling machine consists of a constant level tank with special float valve to maintain a constant head of liquid to be filled. After the requisite signal is received, the dispensing valve opens to allow the flow of liquid for a particular pre-set time. The flow of liquid through this valve is directly proportional to the time for which it is kept open because it is flowing against constant head (by gravity).

The machine can be calibrated in terms of time (in microseconds) to allow requisite quantity of liquid to be dispensed. The total volume which can be dispensed in a calibrated time is a function of specific gravity of liquid. It is imperative that the time be adjusted according to the liquid density. The machine can control only one variable, i.e., time which is function of quantity to be dispensed provided all other parameters remain constant. It is

normal phenomenon that there is always batch to batch variation in bulk density and flow characteristics which necessitates adjustment of the machine in accordance with the varying density.

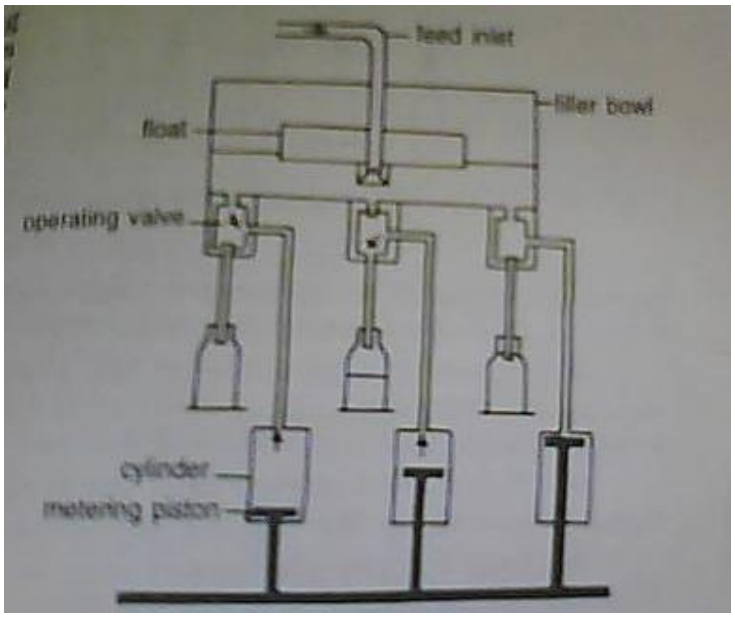
The main systems of the machine are pneumatic, film feed, horizontal seal, vertical seal, paper looping and forwarding, filling electrical and electronic systems.

Filling by metering

Piston type filling system

The piston type filling system works on the metering principle. Fillers are equipped with different filling positions. In many machines dosing can be adjusted accurately and continuously for all the filling positions from a central point. Thin liquids as well as more viscous products can be filled with this filling system.

The operating valve opens by mechanical operation, by metering piston. The product enters from the filler bowl into the operating valve, and simultaneously closes the inlet from the operating valve to the container to be filled. The metering piston sucks the liquid to be filled into the cylinder. When the cylinder is filled, the connection to the filler bowl is closed and the one to the container opened and the liquid pushed into the container by the metering piston.



Metering cup filling system

A good filler for milk is the metering cup filling system which is also based on the metering principle. A high accuracy of filling can be obtained with calibrated metering cups.

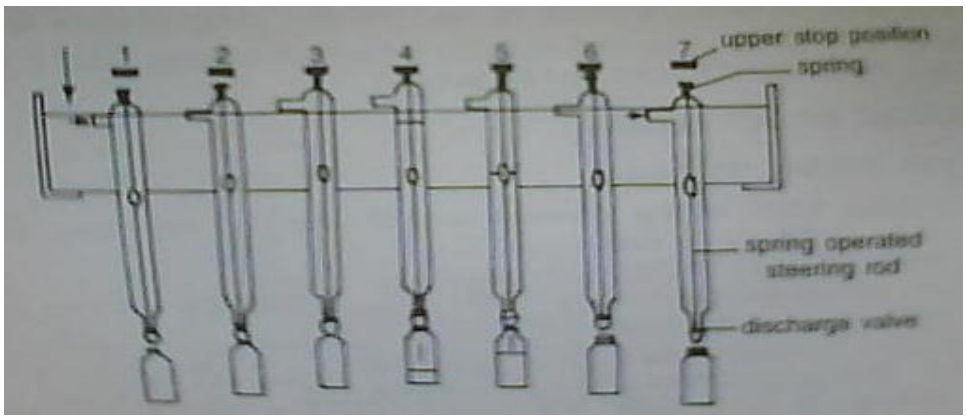
1. The calibrated cup is lowered until the filler tube dips into the liquid product in the filler bowl and becomes filled.

2. and 3. The calibrated cup is moved upwards by the bottle pressed against it from below which seals it and excess liquid flows back into the filler bowl until the predetermined mark is reached.

4. The discharge valve at the lower end is opened by the steering rod, situated in the axis of calibrated cup, by pressure against the upper stop position and the metered amount of liquid flows into the bottle.

5. The metering cup and the bottle are lowered and the discharge valve is closed by the spring operated steering rod.

6. and 7. The calibrated cup is again filled with liquid while the filled bottle is removed from the filler.



Filling of Pasty products

In a filling by metering system for pasty products which may contain small pieces of solids such as pieces of fruits, small berries, nuts etc. from the filler bowl, the product is pumped by a mono pump with minimum damage to the product. The metering time or the revolution time of the rotor is controlled by a timing relay and a magnetic coupling. The filler bowl is filled by a pump and the level control maintains a constant filling height by switching the motor on and off. This filling system can be used for liquids of low or high viscosity and even for stiff pastes which may contain solid particles. Drinking yogurt containing fruit is such a case. Particles which have a tendency either to sink or to rise must be kept evenly distributed by an additional mixing device in the filler bowl.

Metering and filling of dry product

The varied shape of dried products such as particles with rough surfaces, flakes, dust-like powders, small platelets, granules or mixed products are difficult to make accurate metering according to equal volumes. The fillings of equal volumes lead generally to considerable deviations in weight, since there are deviations in bulk density. It is therefore

important to deliver the product evenly to the package and to obtain equal amounts by weighing. When the required amount has been filled, the feed must be interrupted.

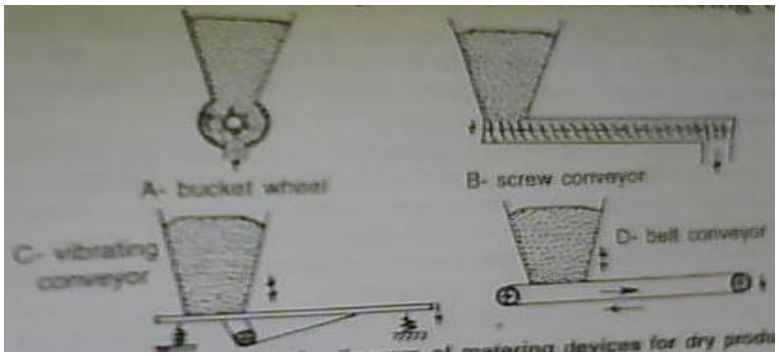
A dry product which is strictly, because it has too high moisture content or because it is thermoplastic at too high temperature, is not suitable for continuous metering.

When metering dry products capable of flow, care should e taken not to exert too high mechanical pressure, to avoid their being pulverized or forming lumps due to pressure. As metering and dosing devices, screw conveyors, bucket wheels, vibrating conveyors, chutes and conveyor belts have been found suitable. These metering devices usually convey the product from a small hopper in which it is roughly pre-dosed to a certain level. To obtain a uniform stream of product, the deviation from this level should be small.

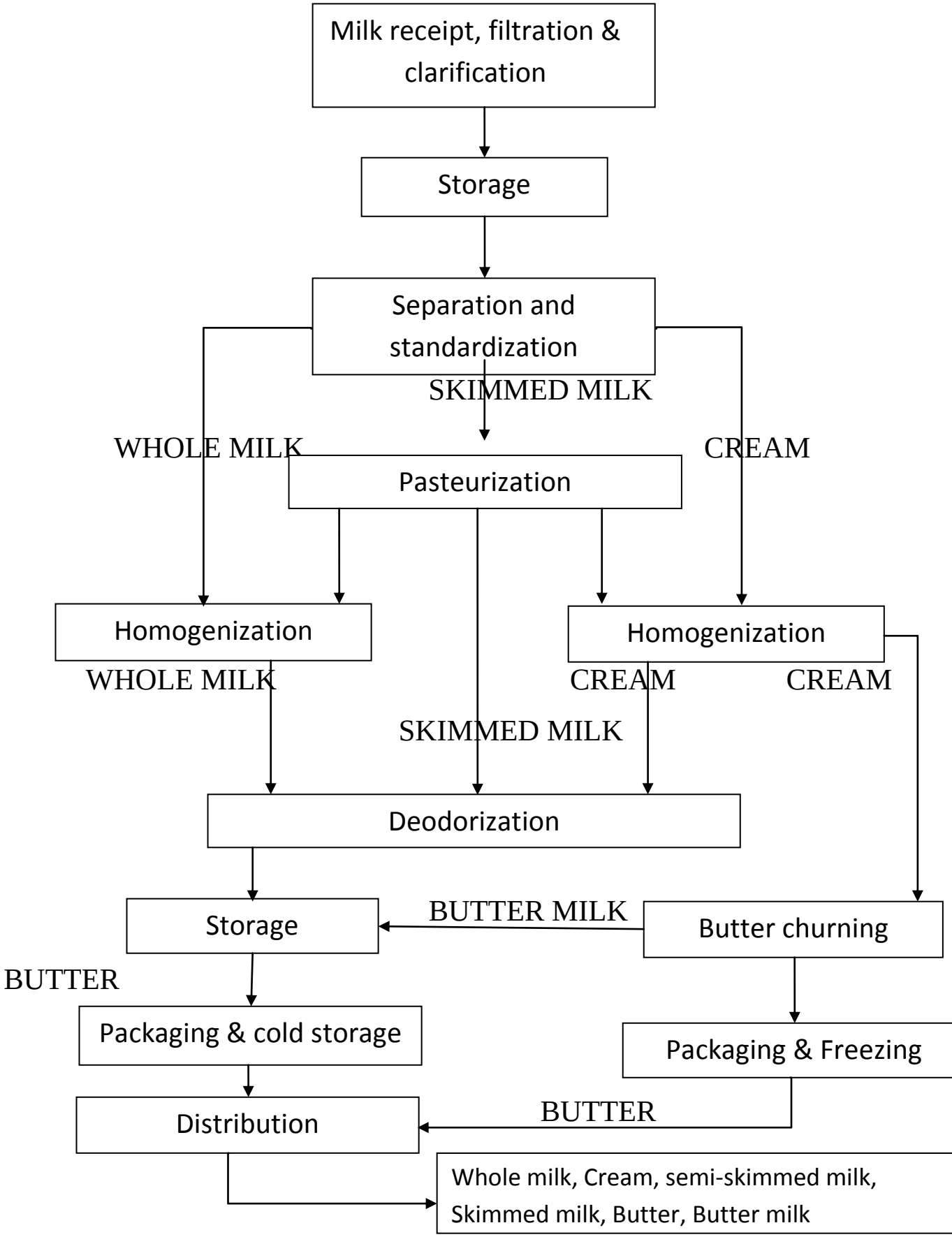
There is screw metering devices with either horizontal or vertical axis. Care should be taken, in both cases, to ensure that the screw is properly filled with the product. This is achieved by increasing the pitch and the diameter of the thread in the direction from the outlet to the hopper, as well as installing revolving spiral bands which loosen the dry product and allow it to flow into the screw threads. The product mass flow rate is regulated by the number of revolution of the screw conveyor. The mass flow of the product is more accurate and uniform if the diameter of screw threads is smaller and the number of revolutions of the screw is higher.

Bucket wheels are suitable only for metering dry products into large packs since they are relatively inaccurate. Metering is not strictly continuous since the content of a whole bucket of the rotating wheel is emptied at once.

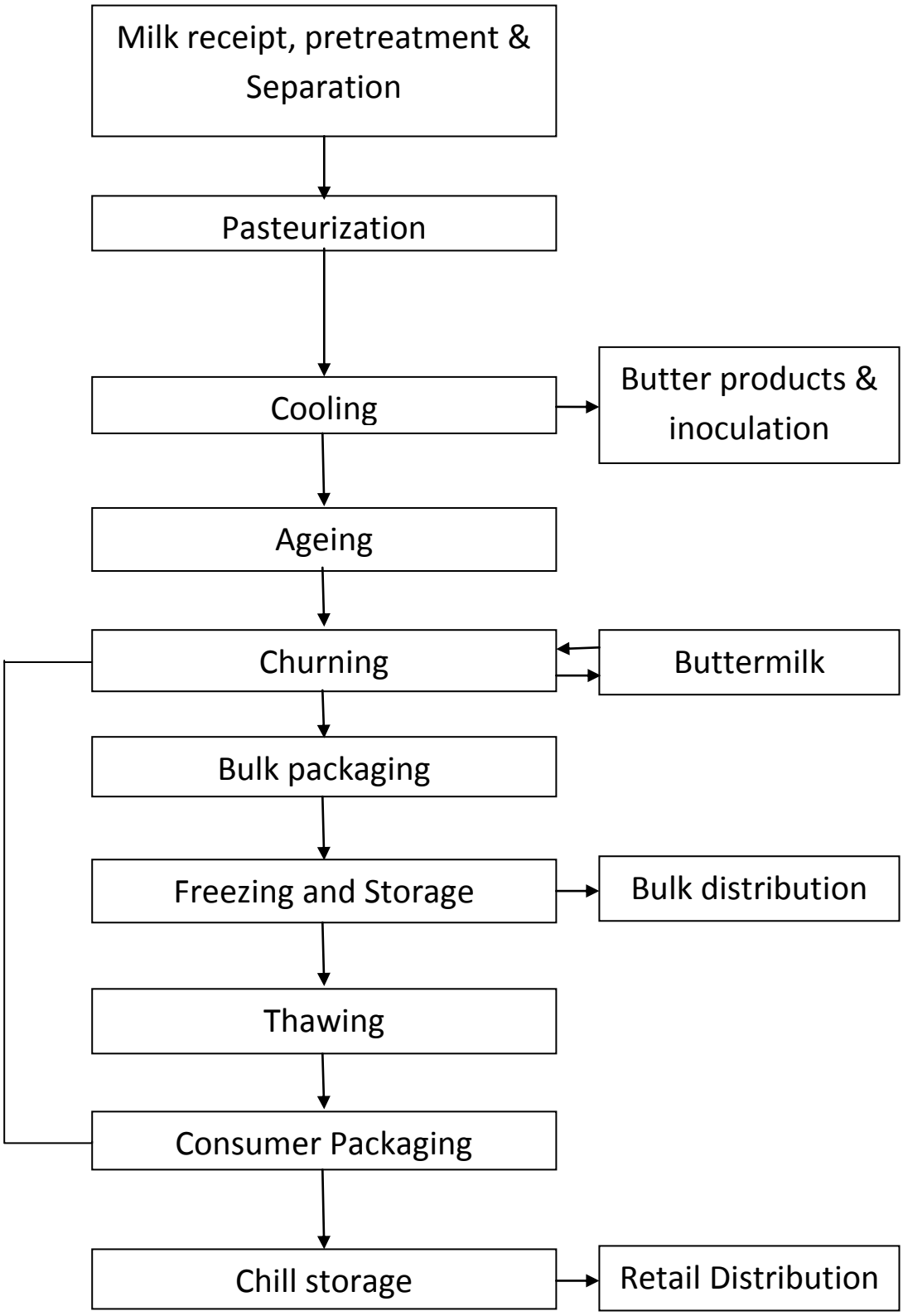
Vibrating conveyor chutes and conveyor belts are suitable for continuous and accurate metering. By adjusting the dimensions of the orifice outlet, by installing side-walls and by regulating the frequency of the vibrations or the speed of the conveyor belt, the mass flow rate can be accurately adjusted.



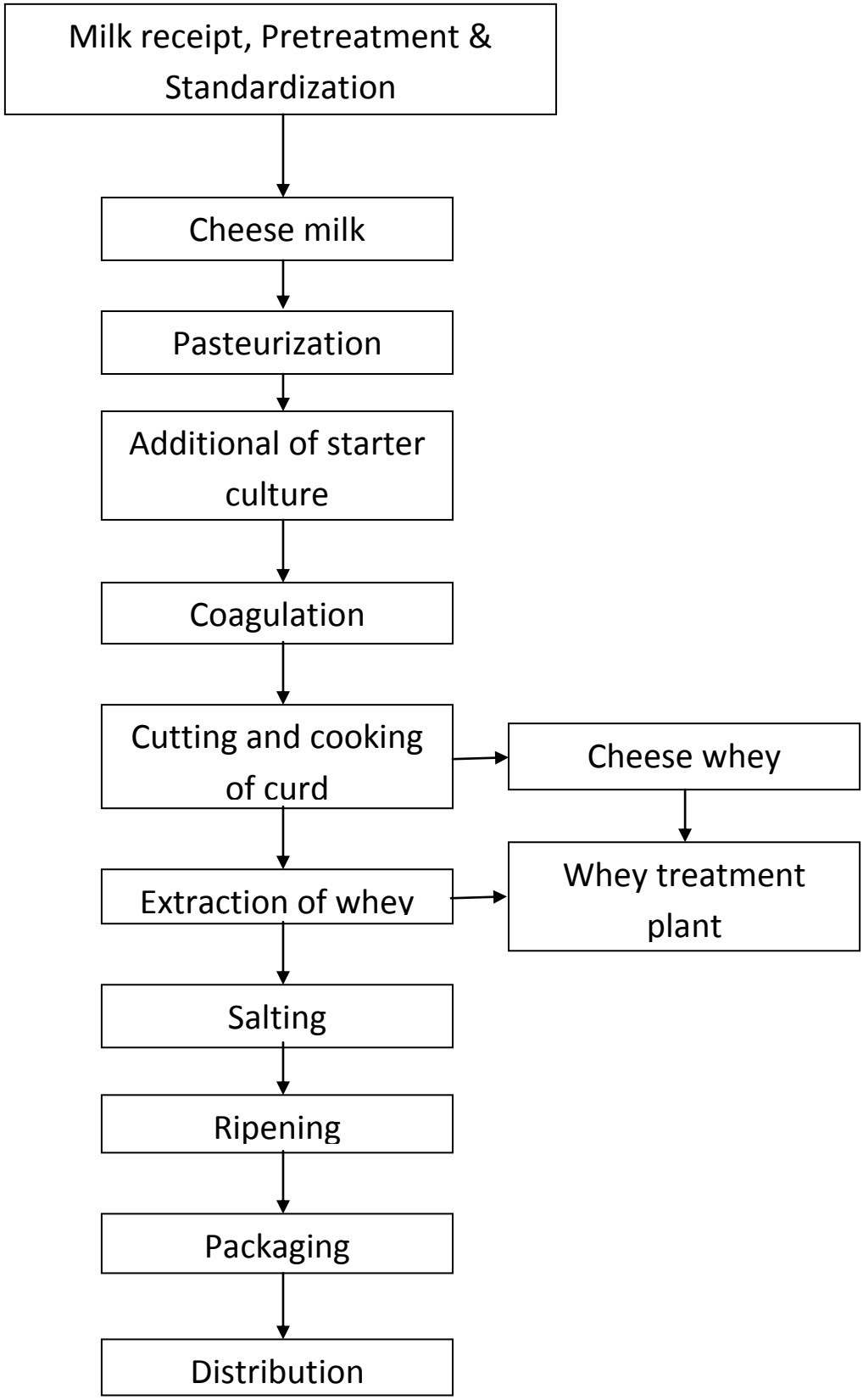
Flow chart for production of whole milk.



Flow chart for production of butter.



Flow chart for production of cheese.



Flow chart for production of milk powder.