RAW MILK & PROCESSING

What Makes Milk Different?

Composition:

1. Water
2. Physical Form
3. Neutral pH
4. Nutrients
5. Proteins

Raw Milk Quality at Plant

S. No.	Parameter	Limit
1	Cleanliness of Tanker/Can	Satisfactory
2	Time from Milking to Chilling	2-3 hours
3	Time from Milking to Processing	< 24 hours
4	Temperature	≤ 4 °C
5	Foreign Matter	Absent
6	Organoleptic Quality	Clean Flavour
7	Clot – On- Boiling (COB) Test	Negative
8	Titratable Acidity (as lactic acid)	0.117 – 0.135 %
9	Methylene Blue Reduction Time (MBRT)	30 min
10	Alcohol Number	Negative
11	Protein on SNF Basis	34 % min.

Raw Milk Quality at Plant

S. No.	Parameter	Limit
12	Butyro-Refractometer (BR) Reading at 40 °C of Milk Fat	40-43
13	Reichert-Meissle (RM) value of Milk Fat	28 min.
14	Antibiotic Residues *	Negative
15	Sodium Ion on 8.5% SNF Basis	450 ppm max.

Adulterants : -

- **For Preservation:** The perishable nature of milk coupled with unsanitary conditions results into spoilage of raw milk . In order to maximize profit the unscrupulous milk trader use adulterants such as caustic soda/ baking soda, hydrogen peroxide, formalin etc.

- **Unknowing Addition:** Disinfectants like chlorine, iodine, and quaternary ammonium compounds are likely to enter the milk, if used carelessly for sanitization of equipments.

- **Increase Solids:** Salt, urea, sugar, glucose, urea, starch maltodextrin sorbitol etc are added so as to increase gravity of milk for financial gain.

- "**Synthetic Milk"** is a misnomer recently popularized by the media. By synthetic milk one would normally understand a product analogous to natural milk in its physical & chemical properties. But there is no similarity between the two. Synthetic Milk is reported to be the mixture of water, pulverized soap/detergent, vegetable oil, caustic soda, salt, urea, etc.

Raw Milk Adulteration Checks

S. No.	Parameter	Limit
1	Maltodextrin (by Enzymatic Method)	Absent
2	Nitrate compounds *	Negative
3	Formalin *	Negative
4	Hydrogen Peroxide *	Negative
5	Mineral Oil *	Negative
6	Neutralizer	Negative
7	Urea	Negative
8	Ammonia Compounds	Negative
9	Starch and Cereal Flours	Negative
10	Salt	Negative
11	Sugars	Negative

Additional Parameters for UHT

S. No.	Parameter	Limit
1	Methylene Blue Reduction Time (MBRT)	>3.0 Hours
2	Somatic Cell Count	< 400,000/ml
3	Total Bacterial Count	< 10 Lakh cfu/ml
4	Psychrotropic Bacteria	< 50,000 cfu/ml
5	Coliform Bacteria	Absent in 1:100 dilution
6	Total Spore Count	<100 cfu/ml
7	Thermophillic Spore Count	<10 cfu/ml

Procurement Methods

Type	Description	Collection Periphery
1: Village Level Collection	Collection-Transport in cans at ambient temp (30-40 km) to Plant	30-40 km
2: Chilling Centre	Transport from Village to Chilling centre in cans at ambient and further to plant at 4 deg C In Tanker	60 km
3: Bulk Milk Chiller	Chilled in Village immediately and Transported in Tankers	Upto 100 km
4: Animal Farm	Chilled instatantly on milking	Upto 200 km

Milk Microbiology
An important Quality Parameter

Source of Contamination : -

Sources	Count per ml	%
Normal udder	500-2000	0
Infected udder	1.5-2.0 Lakh	5.0
Milking person	10000-15000	0.5
Utensils, Cans*	2.5-3.0 Million	60
Dust	0.5-1.0 Lakh	1
Dung	5-10 Lakh	20
Flies	2-5 Lakh	10
Others	1-5 Lakh	2.5

* Unclean Utensils, Other than SS Containers, Dented Cans lids without rims hammering, etc.

Effect of storage temperature on bacterial growth in milk : -

Milk held for 18 hours at temperature (C°)	Bacterial growth factor*
0	1
5	1.05
10	1.8
15	10
20	200
25	1,20,000.00

*Multiply initial count with this factor to get final count.

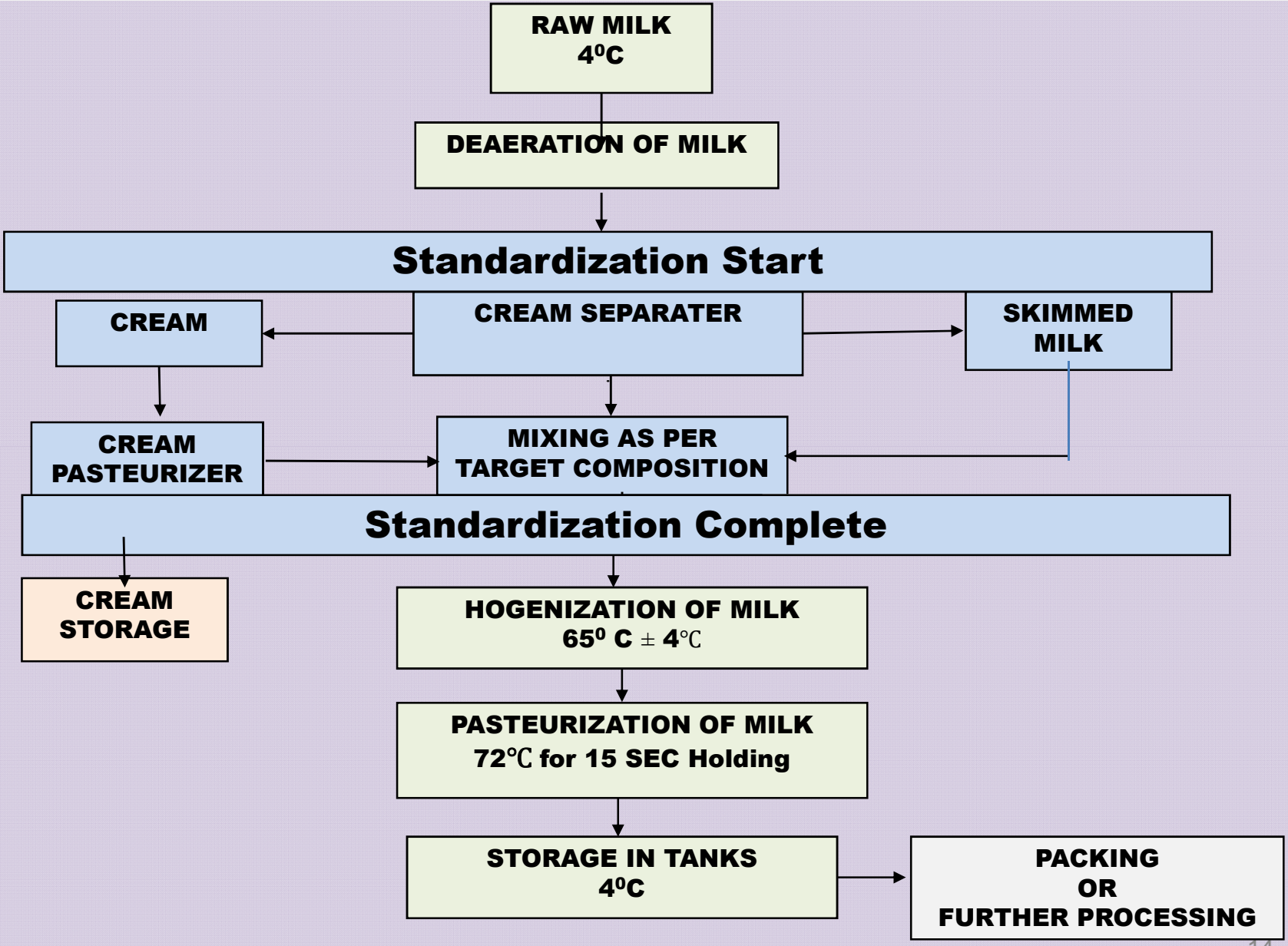
Impact of heavy microbial load on Milk/SMP quality

- Production of aromatic compounds leading to bad smell unacceptable to consumers
- Breakdown of fats leading to bad keeping quality.
- Removal of the polar head of phospholipids in the milk fat globule membrane results in poor emulsifying ability
- Breakdown of proteins
  - impacting it's functionality in further application
  - reduces milk viscosity impacting mouthfeel
  - Production of bitter peptides impacting taste
- High Spores count in Milk Products affecting overall Quality
- Endotoxins produced by the Pathogens in case of delay in processing

Various steps to achieve milk quality : -

- Clean Milk Production System
- Active Procurement Team
- Appropriate Milk Collection Mode:
  - Shortest milk routes to ensure Chilling of milk within 4 hours,
  - Logistics & scheduling movement of vehicles
- Use appropriate technology:
  - Appropriate CIP Systems at each stage
  - Chilling Methods
  - Storage and management of Temperature of milk
- Quality linked Price incentives.
- Receiving Dock Design to minimize waiting time for milk vehicles
- Regular monitoring of the raw milk quality, particularly bacteriological

MILK PROCESSING



Different Types of Heat Treatment

- **Thermization:** Heat the milk to between 57°C to 68°C and hold for 15 minutes. Thermization targets pathogenic bacteria while leaving the good bacteria in the product. The low temperatures do not alter the structure and taste of the milk.
- **Batch pasteurization:** Also known as low-temperature long time (LTLT) pasteurization. Heat the milk to 63°C for 30 minutes. The extended holding time causes the alteration in the milk protein structure and taste.
- **Flash pasteurization:** Also known as high-temperature short time (HTST) pasteurization. Heat the milk to between 72°C to 74°C for 15 to 20 seconds. Targets resistant pathogenic bacteria spores (Clostridium botulinum spores).
- **Ultra-high temperature (UHT):** Heat the milk to between 135°C to 140°C for 2 to 4 seconds. The extreme heat targets *Coxiella burnetii*, which causes Q-fever. The heat kills all the vegetative forms of bacteria and the milk can survive for 9 months.
- **Batch Sterilization:** This is a wet treatment of packaged milk products in an autoclave/specialized treatment chambers. Heat to between 115°C to 121°C for 10 to 20 minutes.

Steps of Milk Processing

1. Milk chilling

- Chilling is a necessary step when dealing with large volumes of milk.
- Milk leaves the cow's udder at temperatures above the ambient, which encourages rapid bacterial multiplication that speeds up spoilage.
- However, reducing the temperatures to between 2°C to 5°C arrests bacterial growth and metabolism.
- This provides a head start at keeping the quality before proper pasteurization commences.

2. Pre-heating (regeneration) and Standardization Stage

- After bulking, the chilled milk is heated to about 40°C to facilitate easy separation of butterfat during standardization.
- The system uses regenerative heating, i.e., it uses the heat of the already pasteurized milk to heat up the incoming chilled milk. The chilled milk, in a counter current flow, cools down the pasteurized milk.
- The purpose of standardization is to obtain a product with uniform content of butter fat.

3. Clarification stage

- Clarification is essential for removing all foreign matter from the product.
- Large solid particles are removed by straining the milk through tubular metallic filters.
- A centrifugal clarifier (not the one used for standardization) is used to remove all soil and sediments from milk.
- The filters, usually fitted in parallel twins permits continuous processing as one can be cleaned while the other is running.
- Clean the filters regularly (between 2 to 10 operational hours depending on the level dirt) to avoid growth of bacteria.

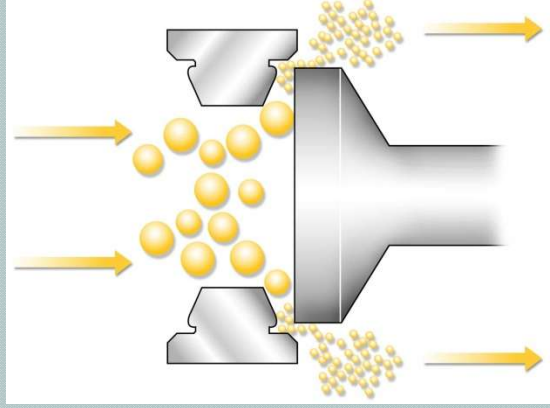
4. Standardization stage

- It is important to standardize milk fat to ensure that you end up with a product of consistent quality in the market. Different consumers prefer different products.
- There are customers who will consume skim milk only while there are those who will take low fat milk. There are those who will take standardized milk while there are those who prefer high fat milk.
- Standardization is necessary to ensure that all the customers are catered for. Again, it is during the process of standardization that you get to separate the butterfat that is used for making cream and other fat based products such as butter and ghee.

5. Homogenization stage

- Homogenization is a physical process of breaking down the the milk fat globules into tiny droplets to discourage cream separation.
- Tiny droplets of fat do not rise in a milk column since reducing their sizes also increases their density in the milk.
- A milk homogenizer working at between 100 to 170 bars splits all the fat globules into very tiny droplets that increases the level of integration of the fat in the milk.
- As a result, the milk fat remains uniformly distributed in the milk.

5. Homogenization stage



What is a homogeniser ?

It forces the product under pressure thru a small adjustable gap between the valve seat and the valve ,causing turbulance and intense mixing

Homogenisation is the process of emulsifying one liquid to another

Or

Uniformly dispersing solid particles thru out a liquid to improve:

- Consistancy
- Stability
- Shelf life
- Flavour

6. Heating

- Utilizes heat from steam to raise the temperatures of the milk from about 60°C to the required 72°C that is effective to kill the Clostridium botulinum spores.
- The steam exchanges heat with the milk across the PHE plates in a counter currentmotion.
- At the end if this section, there is a temperature sensor, which controls the flow diversion valve.
- Any milk that does not attain the required temperature is diverted back to the heating section until it attains the required temperatures.

7. Holding

- After heating, milk flows into the holding tubes whose lengths have been calibrated with the milk flow rate to ensure that milk takes at least 16 seconds in the tubes. All the milk must maintain the required pasteurization temperatures at the end of the tubes.
- In case of a breach, a sensor will trigger the flow diversion valve to take the milk back to the heating section to bring the milk to the required temperature.
- Once the milk has attained the required temperatures at the end of the holding tubes, milk flows back to the regeneration section to heat the incoming chilled milk while in itself being cooled down to about 30°C.

8. Cooling/chilling

- After regenerative cooling of pasteurized milk, it moves to the cooling section of the PHE where chilled water/PHE coolant lowers the temperature of pasteurized milk to 4°C.
- The chilled milk is then pumped to the packaging machines for packing and subsequent storage in the cold room.

PASTEURIZATION

FSSAI Definition of PASTEURIZATION

The terms “Pasteurisation”, “Pasteurised” and similar terms shall be taken to refer to the process of **heating every particle of milk** of different classes to **at least 63^0 C and holding** at such temperature continuously for **at least 30 minutes or heating** it to **at least 71.5^0C** and holding at such temperature continuously for **at least 15 seconds** or an approved temperature time combination that will serve to give a negative Phosphatase Test.

All pasteurised milk of different classes shall be **cooled immediately** to a temperature of **10^0 C, or less**.

Significance of Pasteurization

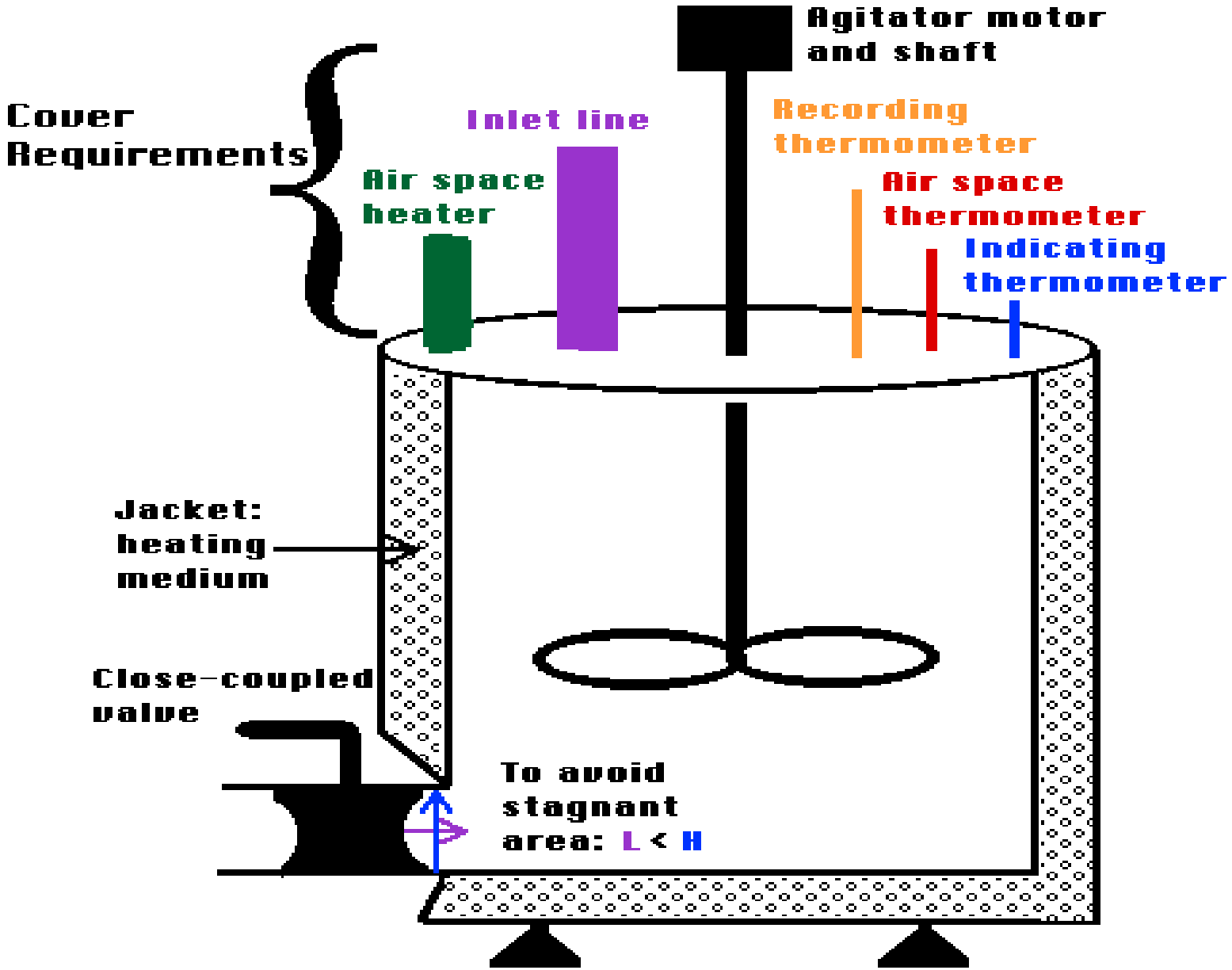
Proper pasteurization is necessary for the following reasons:

- The chief objective of milk pasteurization is to destroy pathogenic bacteria that could have a public health concern. By destroying these microorganisms, the product becomes safe for public consumption.
- Secondly, pasteurization eliminates destructive bacteria and enzymes that could cause spoilage of the product. This leads to a prolonged shelf life of the milk.
- There is need to ensure that the product can keep for longer periods without expensive storage equipment. Pasteurization will eliminate spoilage bacteria and enzymes and extend the shelf life of the product.

Batch Pasteurization method

The batch method uses a vat pasteurizer which consists of a jacketed vat surrounded by either circulating water with added steam or heating coils or hot water or direct steam

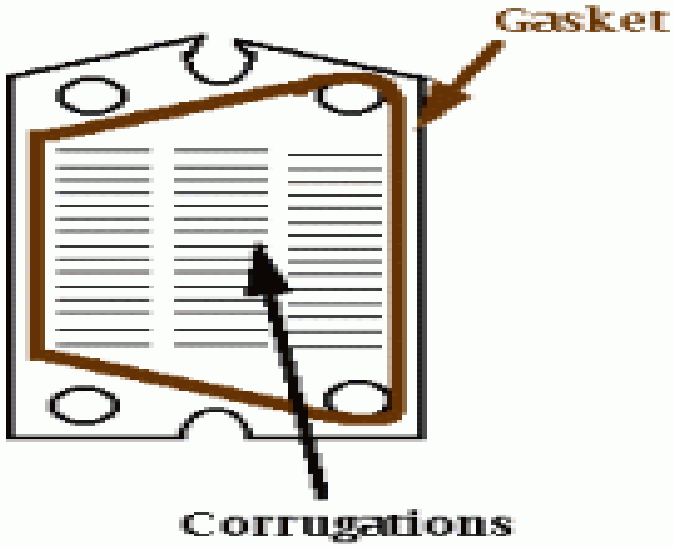
Batch Pasteurizer



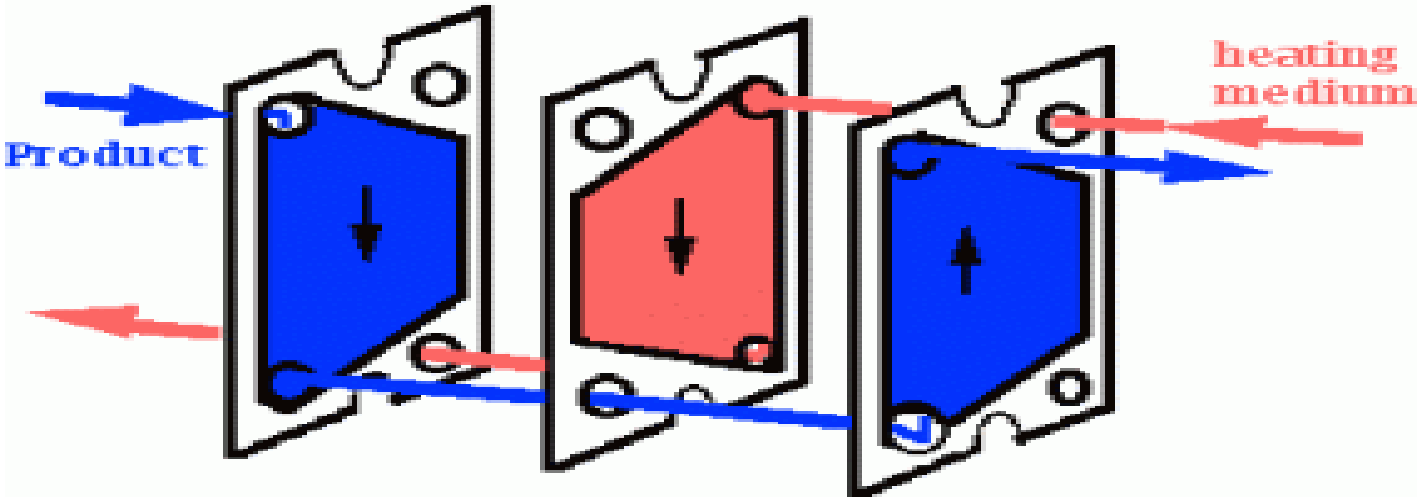
Continuous Method

- Continuous process method has several advantages over the vat method, the most important being time and energy saving. For most continuous processing, a high temperature short time (HTST) pasteurizer is used. The heat treatment is accomplished using a plate heat exchanger. This piece of equipment consists of a stack of corrugated stainless steel plates clamped together in a frame. There are several flow patterns that can be used. Gaskets are used to define the boundaries of the channels and to prevent leakage. The heating medium can be vacuum steam or hot water.

Single Plate



Flow Pattern in Series of Plates



Non-thermal Processing:

- Pulsed electric field (PEF)
- High-pressure (hydrostatic) or “cold pasteurization.
- Thin-film UV light treatment.
- Ultrasonication (manothermosonication, or MTS
- Microwaves (electromagnetic waves)

Sterilization-

Sterilization of milk is aimed at killing all microorganisms present, including bacterial spores, so that the packaged product can be stored for a long period at ambient temperature, without spoilage by microorganisms. Since molds and yeasts are readily killed, we are only concerned about bacteria.

FSSR Definition of STERILISATION :

The term “sterilisation” when used in association with milk, means heating milk in sealed container continuously to a temperature of either 115^0 C for 15 minutes or at least 130^0 C for a period of one second or more in a continuous flow and then packed under aseptic condition in hermatically sealed containers to ensure preservation at room temperature for a period not less than 15 days from the date of manufacture

Sterilization of the product is achieved by rapid heating to required high temperature, holding it for few seconds followed by rapid cooling.

Ideally, heating and cooling should be as quick as possible.

UHT products are in a good position to be able to improve the quality image of heat-processed, ambient stable foods.

Advantages:

- Remarkable keeping quality; does not need refrigerated storage;

Disadvantage:

- Increased cost of production;
- More loss in nutritive value than pasteurization
- Gerber test by normal procedure not so accurate.

Various UHT systems

There are two main types of UHT systems on the market.

A. Direct UHT plants

Steam injection/infusion systems

B. Indirect UHT plants

In the **indirect systems** the heat is transferred from the heating media by condution

Aseptic packaging

Aseptic packaging has been defined as a procedure consisting of sterilisation of the packaging material or container, filling with a commercially sterile product in an aseptic environment, and producing containers that are tight enough to prevent recontamination, *i.e.* that are hermetically sealed.

The term “aseptic” implies the absence or exclusion of any unwanted organisms from the product, package or other specific areas

End of Session