

* Definition of Milk :-

According to US Federal Standard milk is fresh, clean, lactial secretion obtained by the complete milking of one or more healthy cows. properly feed and kept excluding that obtain within 15 days before and 10 days after calving containing not less than 8.5 % SNF (solid Not fat) & 3.5 % fat.

• Colustrum - जीक

- Lactial secretion obtain by complex milking of one or more mammalian animals.

* Major Constituents of Milk :-

• Composition of Milk :-

Water $\rightarrow$ 87.1 %

fat $\rightarrow$ 3.9 %

protein $\rightarrow$ 3.4 %

Lactose $\rightarrow$ 4.8 %

Mineral $\rightarrow$ 0.8 %

(1) Water :-

- It is major constituent of milk.
- It contains about 87.1 %.
- Water provide a definite viscosity to the milk.

(2) Fat :-

- The fat in milk is commonly known as butter fat.
- It plays an important role in flavor of dairy products.
- The fat gives yellowish tinge to the milk.

(3) Protein :-

- The protein found in milk is considered as a complete protein. This means that it contains all the necessary amino acid in the sufficient quantities essential for the maintenance of life.
- The two main proteins found in milk are casein & whey.
- Casein is primary protein in milk adding 80%.
- While whey is secondary protein which is regularly used in other food industries.
- The milk protein helps in building and repairing human muscles.

(4) Lactose :- (Lactose = Glucose + Galactose)

- Lactose is a main sugar found in milk.
- Lactose is less sweet than sucrose and hence prolonged heating ($100 - 130^{\circ}\text{C}$) result in ~~is~~ decomposition which is characterised by caramel colour.
- After metabolism of Lactose by bacteria lactic acid is produce.
- Lactic acid is a main thing that gives ^{flavour} ~~flavoured~~ to the fermented milk product like yoghurt, cheese, etc.

(5) Ash :- (Minerals)

- It is also called as salt of milk.
- In milk mineral ash present about 0.8 %
- Mineral matters or salt of a milk present in a small quantities but influence on physico-chemical properties & nutrient value of milk.

- The mineral ash contains sodium (Na), Magnesium (Mg), Sulphur (S), calcium (Ca), phosphate (PO_4) & potassium (K).
- It also contains chloride, citrate, bicarbonate in trace amount.

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Thursday

Minor components in Milk :-

- (1) phospholipid
- (2) Cholesterol
- (3) Pigment
- (4) Enzymes
- (5) Vitamins
- (6) Gases present in milk.

(1) Phospholipid :-

- There are 3 types of phospholipid present in milk :-
 - (i) Lecithin
 - (ii) Cephatin
 - (iii) Spingomyelin
- It contributes to the reachness of a flavour & it is highly sensitive to oxidative change.
- Lecithin is an important constituent of fat glob. globule.

(2) Cholesterol :-

- These appears to present in complex formation with protein in non-fat portion of a milk.

(3) Pigment :-

- There are fat soluble & water soluble pigment present in milk.

- fat soluble pigments :- carotene and xanthophyll
- water soluble pigment : Riboflavin.

(4) Enzymes :-

- The important milk enzymes are as follows:

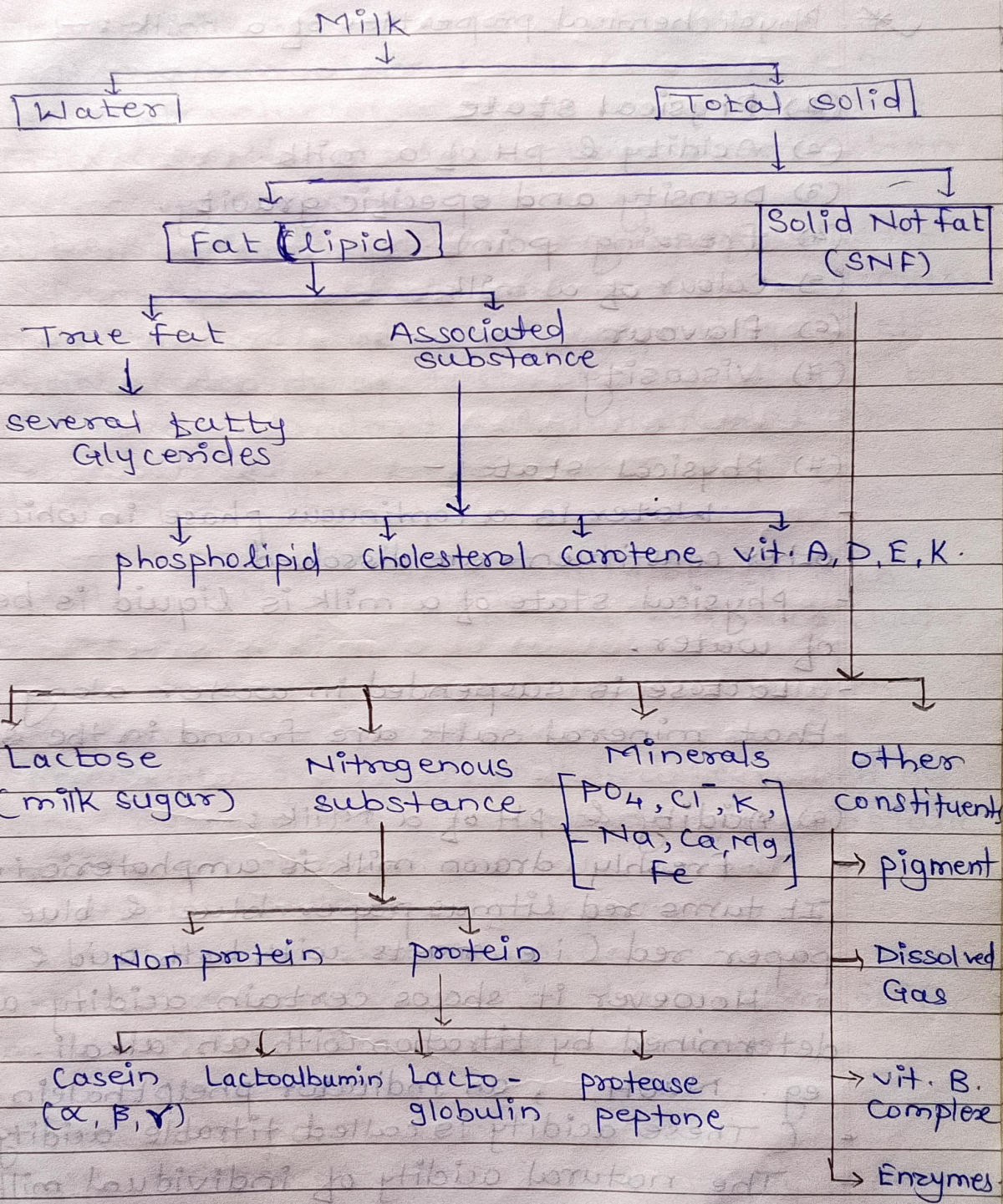
- (i) lipase $\rightarrow$ lipid splitting
- (ii) phosphatase $\rightarrow$ capable of splitting some phosphoric acid.
- (iii) peroxide & catalase $\rightarrow$ decompose hydrogen peroxide (H_2O_2)
- (iv) protease $\rightarrow$ splitting of a protein.
- (v) Galactase $\rightarrow$ Important in ripening of a cheese.

(5) Vitamins :-

- Vitamins found in milk are fat soluble & water soluble vitamins.
 - fat soluble vitamins $\rightarrow$ vit. A, D, E & K
 - Water soluble vitamins $\rightarrow$ vit. B (complex group) folic acid, pantothenic acid, niacin.
- Absence of a vitamins over long period of a diet causes deficiency disease.

(6) Gases present in Milk :-

- Milk contains the gases $\rightarrow$ oxygen, carbon-dioxide & Nitrogen.
- The percentage of a each gas change immediately upon contact with air.



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* Physiochemical properties of a milk :-

(1) Physical state

(2) Acidity & pH of a milk.

(3) Density and specific gravity.

(4) Freezing point.

(5) Colour of a milk.

(6) Flavour.

(7) Viscosity.

(1) Physical state :-

- Water is a continuous phase in which the other constituents are dissolved.
- Physical state of a milk is liquid is because of water.
- Lactose is suspended in water along with that mineral salts are found in the solution.

(2) Acidity & pH of a milk :-

- Freshly drawn milk is amphoteric in nature. It turns red litmus paper blue & blue litmus paper red (i.e. reacts with both acid & base).

However it shows certain acidity as determined by titration with an alkali.

eg. NaOH, an indicator phenolphthalein.

- (This acidity is called titrable acidity)
 - The natural acidity of individual milk varies considerably depending on species, breed, stage of lactation, physiological condition of udder, etc.
- (इन्डे, कास)

• pH of milk :-

- pH of a normal fresh milk is 6.6 — 6.9
- higher pH value of a fresh milk indicates udder infection & value of bacterial action.

(3) Density and specific Gravity of Milk :-

- Density of a substance is ratio of mass upon volume. and specific gravity is the ratio of density of test substance to the density of standard substance (Water).

$$\therefore \text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Specific gravity} = \frac{\text{density of test sub.}}{\text{density of std. sub. (water)}}$$

- The density of a substance varies with temperature.
- The specific gravity of milk is determined by using pycnometer, Lactometer, hydrostatic balance.

• Specific Gravity :-

- Milk is heavier than water.
- The average specific gravity of a milk at 60°F is 1.028 — 1.033 or 1.032.

(4) Freezing point :-

- Milk freezes at temperature slightly lower than water due to presence of soluble constituents such as Lactose & salt.
- factors which lower freezing point are :
 - (i) Water
 - (ii) Increased amount of soluble molecules.
 - (iii) fat & protein content {slightly affect on freezing point}

(5) Colour of a Milk :-

- It is a blend of individual effects produced by :
 - (i) Casein particles and fat globules responsible for colour of milk.
 - (ii) Carotene and xanthophyll impart yellow shed to the milk.
- Milk ranges in colour yellowish creamy white (cow milk) and creamy white (buffalo milk)
- The Intensity of yellow colour depends on breed, feed, etc.

(6) Flavour of Milk :-

- The flavour of a milk is sweet to taste and salty too.
- Sweet flavour is because of lactose sugar & salty taste is because of salt & minerals present in it.
- The flavour of milk changes due to type of feed, stages of lactation, condition of udder and subsequent handling of milk man.
- Abnormal flavour to the milk is because of bacterial growth, chemical changes, processing and handling, etc.

(7) Viscosity :-

- Important in determining the rate of creamy rate of mass & heat transfer, flow of condition in dairy process. and it depends on temperature & pH.

✓* Normal Microflora in milk & its significance : —

- Milk of healthy cow is sterile at the time of secretion but it gets contaminated in udder.
- Microorganism gets entry through the teat opening & grows over there & contaminates milk.
- In addition to being a nutritious food for humans, milk provides a favourable environment for the growth of microorganism.
- Yeast, mold & broad spectrum bacteria can grow in milk particularly at temperature above 16°C .
- Microbes can enter milk via air, feed stuffs, milk handling equipment, milker.
- Once microorganism gets entry into the milk, their numbers increase rapidly.
- It is possible to obtain milk free from bacteria, if proper care is taken.
- As regards the sterility of a milking utensils, hands of milker, proper disinfection of milking area, then the milk may be completely free from bacteria.

• Normal flora of Microorganism : —

- Which is normally present in milk are : —

- (i) Lactobacillus acidophilus
- (ii) Lactobacillus plantarum
- (iii) Lactobacillus bulgaricus
- (iv) Lactobacillus casei
- (v) Lactobacillus delbrueckii
- (vi) Lactobacillus lactis
- (vii) Streptococcus lactis
- (viii) Leuconostoc dextranicum

- (ix) Streptococcus thermophilus

• Lactobacillus (significance) :-

- Lactobacillus is a species of lactic acid bacteria.
- Lactobacillus are abundant in raw milk & are commonly used as probiotics.
- Lactobacillus acidophilus occurs in fermented milk, ice-cream, some cheeses, etc.
- Lactobacillus bulgaricus is convert milk to curd.

• Significance of Streptococcus :-

- Streptococcus is frequently used for culturing cheese & yoghurt as they ferment lactose.
- Streptococcus also produce lactase (helping people with lactose intolerance to digest milk.)
- Its acts as a probiotics that helps improve digestion.

✓ • Sources of contamination of raw milk & relative importance in influencing quality of milk during production, collection, transportation, storage :-

- Microbial contamination of a milk can be from internal & external sources that are described in the following part :-

[A] Interior of Udder :-

- Interior to udder milk drawn from healthy animal usually contains very few no. of microorganisms.
- Under normal circumstances these microorganism do not grow rapidly in the milk.
- The interior microflora varies with respect to environment & surrounding and also with respect to health of animal during progress of milking bacteria are present in the largest numbers at the beginning & then gradually decreases.

[B] Exterior of Udder :-

- The microorganism from these source are usually those which are present on skin in adjacent area of udder hairs.
- If contaminated water is used for washing udder then there might be a contamination in milk.

(a) Coat of animal :-

- The coat serve as vehicle to contribute bacteria directly in milk.
- The hairs around udder & tail contribute the higher bacterial count in milk.

(b) Animal shade & surrounding :-

- Milk produced on farm with pure hygiene may undergo significant spoilage & have a shorter shelf life.
- When compared to milk produced under hygienic conditions.

- The microbe include :- colliforms, staphylococci, streptococci, Gram Negative bacteria & spore formers.

(c) Milking staff :-

- Milking staff plays a vital role in maintaining hygienic & prevent milk contamination.
- The hand contacts & dust particles by milker add varieties of a microbes in milk.
- The risk of a contamination from milker are definitely high.

(d) Milking Equipments (Storage containers & transportation system) :-

* Difference between Colostrum & milk.

Differentiating Character	Colostrum	Milk.
1) Definition	Colostrum is the first form of breast milk produced by female mammals after the birth of child.	Breast milk is the nutritious fluid produced by the mammary glands of mammals in order to feed new-born.
2) Release from the breast	Released before breastmilk	Released after colostrum.
3) Colour	Yellowish	Whitish.
4) Composition	Rich in protein, Immunoglobulin, lactoferrin & growth factors.	Rich in proteins, micronutrients, cholesterol, sugar, stem cells & hormones.
5) Thickness	A thick fluid	Thinner than colostrum
6) Generating volume	Smaller	Larger
7) Sugar	Contains less sugar	contains a high amount of sugar.
8) fat	contains less fat	higher than colostrum
9) Water	present 78%.	present 87%.

* Techniques of Sterilization :-

- 1) Bactobugation
- 2) Thermisation
- 3) Pasteurization
- 4) Boiling and sterilization.

• Pasteurization :- (Types)

- 1) LTLT $\rightarrow$ Low temp. Long time pasteurization
 63°C , 30 min , 7-14 days
 - other name - Batch / vat pasteurization

- 2) HTST $\rightarrow$ High temp. short time pasteurization.

$72^{\circ}\text{C} \rightarrow 15 \text{ sec}$

$89^{\circ}\text{C} \rightarrow 1.0 \text{ sec}$

$90^{\circ}\text{C} \rightarrow 0.5 \text{ sec}$

$94^{\circ}\text{C} \rightarrow 0.4 \text{ sec}$

$96^{\circ}\text{C} \rightarrow 0.05 \text{ sec}$ 20-21 days.

- other name - continuous / flash pasteurization.

Kill all vegetative forms of bacteria & milk can survive for 9 month.

- 3) UHT $\rightarrow$ Ultra high temperature pasteurization.

$130-150^{\circ}\text{C}$ within fraction of second - 9 month
 for 2-4 seconds.

- Extreme heat targets Coxiella burnetii which cause
 Q-fever.
- Stages -

a) Milk chilling = $2^{\circ}\text{C} - 5^{\circ}\text{C}$

b) Pre-heating (Regeneration - 40°C)

c) Calibration stage

d) Standardization stage

e) Homogenization stage

f) Heating section

g) Holding stage

h) cooling / chilling stage.

- 4) UV $\rightarrow$ Kill of bacteria due to UV-light.
 low temperature, for 30 minutes.

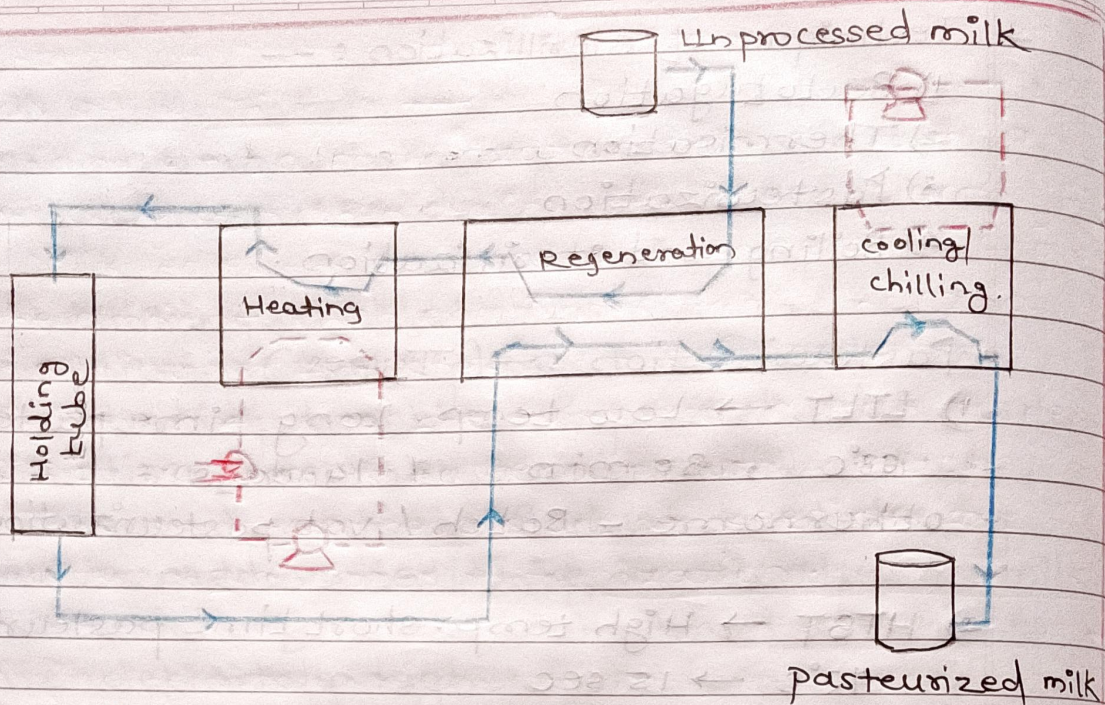


fig. steps in pasteurization

Unprocessed milk $\rightarrow$ chilling $\rightarrow$ preheating



cooling $\leftarrow$ Holding $\leftarrow$ Heating $\leftarrow$ Clarification



standardization



Homogenization

* Pasteurization :-

* Sterilization & Boiling :-

$\triangleright$ LTLT (Low temperature long time) / Batch vat pasteurization :-

- Here the temperature used for pasteurization are reduced to 63°C & held for 30 min.
- The prolonged heating holding period alters the structure of milk protein making them better suited for making yoghurt.

- This method is best for batch pasteurization where the milk is held in jacketed vat for effective pasteurization.

- There are many designs of batch pasteurizers in the market that are suitable for the both domestic & commercial use.

2) HTST (High temperature short time) / flash pasteurization :-

- flash pasteurization involves heating milk to 71.7°C for 15 second to kill Coxiella burnetii which is the most Heat-resistant pathogen in raw milk.
- Since it is technically impossible to bring the milk to that exact temperature, it is always safe to work with a range of temperature.
- To be safe, you can heat the milk to between 72°C - 74°C for 15-20 seconds.
- This will ensure that the milk is heated uniformly to the required temperature.
- This method is most suitable in continuous pasteurization system.
- flash pasteurization milk will keep for between 16 and 21 days.

3) UHT (Ultra-High temperature) :-

- Completely closed pasteurization method.
- The product is never exposed even for a fraction of second during the entire process.
- It involves heating milk or cream to between 135°C - 150°C for 1-2 seconds, then chilling it immediately & aseptically packaging in air tight container.
- UHT remains the most popular milk preservation method for safe & stable milk.

• steps of pasteurization :-

a) Milk chilling —

- chilling is not a pasteurization process but its a necessary step when dealing with large volume of milk.
- Milk leaves the cow's udder at temperature above the ambient, which encourages rapid bacterial multiplication that speeds up spoilage.
- However reducing the temperature to between 2°C to 5°C arrests bacterial growth & metabolism.
- This provides a head start at keeping the quality before proper pasteurization.

b) Pre-heating (regeneration) & 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 is countercurrent flow, cools down the pasteurized milk.
- The purpose of standardization is to obtain a product with uniform content of butter fat.

c) 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 filter.
- A centrifugal clarifier is used to remove all soil & sediment from milk.
- The filters usually fitted in parallel twins permits continuous processing as one can be cleaned while the other is running.

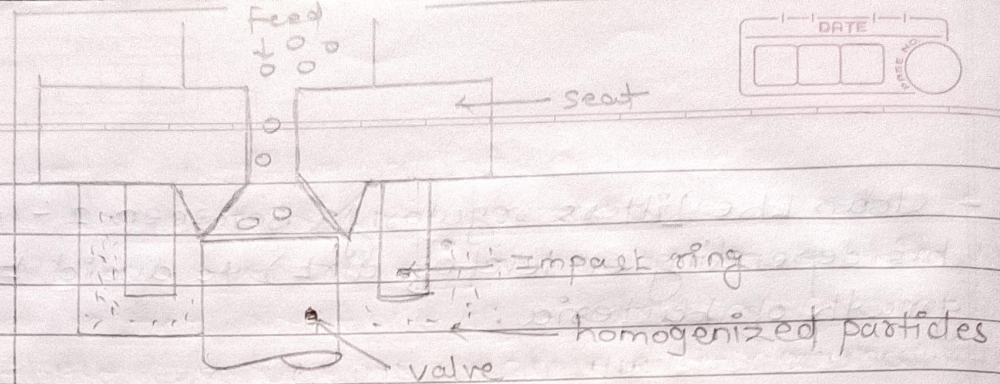


fig. Homogenization process

e) Heating Section :-

- Utilizes heat from steam to raise the temperature of the milk from about 60°C to the required 72°C that is effective to kill the Clostridium botulinum spore.
- The steam exchanges heat with the milk across the PHE (Plate Heat Exchanger) plates in counter current motion.
- In the end, if this section, there is a temperature sensor which control the flow diversion value (FDV).
- any milk that does not attain the required temperature is diverted back to the heating section until it attains the required temperature.

f) Holding Section :-

- After heating, milk flows into the holding tubes whose length have been calibrated with the milk flow rate to ensure that milk takes at least 16 sec in tubes.
- All the milk must maintain required pasteurization temperature at the end of the tube.
- In case of a breach, a sensor will trigger the flow section to bring the milk required temp.
- Once the milk has attained the required temperature at the end of the holding tubes, milk flow back to regeneration section to heat the

incoming chilled milk, while in itself being cooled down to about 30°C .

b) Cooling / chilling Section :-

- 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 packing machines for aseptic packaging & subsequent storage in the cold room.

Balance Tank $\longrightarrow$ Pump $\longrightarrow$ Regeneration heating

$\downarrow$
Regeneration holding

$\downarrow$
Regeneration cooling by cold or chill water.
 $\longleftarrow$ Filter or Homogenizer $\longleftarrow$ Clarifier
may also be connected as per requirement.

* Naturally Occurring preservatives in milk :-

1) LP system (Lactoperoxidase / Thiocyanate / Hydrogen peroxide system)

- Is a chemical method of preserving raw milk where refrigeration is not available.
- This allow the temporary control of milk quality on site storage & transport to a processor.
- Lactoperoxidase is an enzyme which is naturally present in fresh raw milk.
- Bovine / cow contain about 30 mg/l of Lactoperoxidase & the concentration is fairly constant

throughout the lactation.

- LP has no anti-bacterial effect on its own, but has the ability to oxidase the thiocyanate ion in the presence of Hydrogen peroxide (H_2O_2) (these components also exist naturally in tears, saliva & gastric juices)
- Resulting chemical compound has an antibacterial effect in fresh raw milk.
- Against some species of normal gut flora such as Streptococci & Lactobacilli the resulting compound has Bacteriostatic effect (inhibiting bacterial growth), while it has Bacteriocidal effect (killing bacteria) against some Gram-negative bacteria i.e. E. coli, Pseudomonas.

• Working of LP system :-

- LP system consist production of an antibacterial compound from the thiocyanate ion catalysed by Lactoperoxidase in the presence of H_2O_2 .
- This antibacterial system is naturally found in various body fluid including tears, saliva & gastric juices.
- The two essential components for the system (i) Thiocyanate and (ii) Hydrogen peroxide are naturally present in milk in varying concentration depending on the feed given & the species/breed of animal.
- In drawn milk the antibacterial activity is quite weak & lasts for up to 1 hrs., because the milk contains only suboptimal levels of the thiocyanate ion & Hydrogen peroxide.

- 2) Immunoglobulin (Ig) :-

- These factors are responsible for immunological protection of newborns.
- Although in man, parental immunity is conferred primarily through the transmission of immunoglobulin from across the placenta to the foetal circulation.
- Buffalo & cow rely on the transfer of immunoglobulins from colostrum into newborns circulation post-natally when gastro intestinal tract is permeable to intact protein molecules.

- IgA is the chief immunoglobulin of milk & confers passive immunity.
- In human milk the main Ig is called secretory IgA.
- It is present in colostrums in conc. up to 50 mg/ml which drops to a level of mg/ml in mature milk.
- The sites of action of IgA are restricted, since these Ig cannot be absorbed from infant gut in significant quantities.

• Functions of secretory IgA : —

- 1) Neutralizes toxins & viruses.
- 2) Inhibit bacterial adhesion.
- 3) Prevent absorption of food antigen.
- 4) Suppress bacterial growth.
- 5) Aids in phagocytosis by bringing about attachment of bacteria to macrophage.

3) Lysozyme : —

- It is present in different amount in milks of different species.
- The average lysozyme content of human milk (30 mg/100ml) is 3000 times more than that of bovine milk.
- Such significant difference in the lysozyme content may have physiological or nutritional implication on infant feeding.
- Breast feed infants have greater resistance to enteric infection than those fed on artificial food & lysozyme is possibly associated with the mechanism of natural immunity & local resistance.
- Most of the bacteria Gram positive bacteria are very sensitive to the lytic action of lysozyme due to hydrolysis.