Class 11: Processing of milk-Cooling-Pasteurization-Definition-Various methods-Low Temperature Long Time, High Temperature Short Time and Ultra High Temperature-advantages and disadvantages.

Thermal processing :

The main purpose of heat treatment of milk is to render it sage for human consumption and to enhance its shelf life. Thermal processing is an integral part of all operations/processes of milk and milk products manufacturing units. The common pathogenic organisms likely to occur in milk are killed by relatively mild heat treatment. The most resistant organism is the Bacillus tuberculosis and hence has been made as index organism to achieve complete safety of milk. Any heat treatment, which may destroy this organism, can be relied upon to destroy all other pathogens in milk. The thermal death of such pathogenic organisms like Tubercle bacilli, Typhus and Coliform bacteria of such pathogenic organisms like Tubercle bacilli, Typhus and Coliform bacteria and **Coxiella burnettie (Q fever organism**) has made the basis for time-temperature combinations is also a matter of optimization where both microbiological effects and quality aspects must be taken into account. Various categories of heat.

Different categories of heat treatment.

Treatments	Process	Temperature (^{o}C)	Time(seconds)
Pasteurization	LTLT	63	1800
-	HTST(milk)	72	15-20
-	HTST(cream)	>80	15
Thermization	-	57-68	15
Sterilization	-	115-121	180-780
Ultra-pasteurization	-	115-130	2-4
UHT	-	135-150	1-6

Pasteurization :

It is the process of heating every particle of milk or milk products, **in properly designed and operated equipment to specified temperature and holding at that temperature for specified period of time followed by immediate cooling and storing at low temperatures**. Pasteurization can be achieved either by holding method (batch process) or continuous process. Under batch process the milk is heated to 63^{o}C for 30 minutes in a double-jacketed vat. Heating and cooling is done by spraying or circulating hot water /steam of chilled water between the inner and outer jacket of the vessel. The milk is kept gently agitated mechanically to ensure uniform heating/cooling. The process is called **low temperature long time (LTLT) method**. This method is suitable for small quantities ranging from 200-1000 litre requiring low initial cost of equipment.

High temperature short time (HTST) treatment for pasteurization of milk refers to heating every particle of milk in a continuous flow to a minimum of 72^{o}C for at least 15 seconds followed by immediate cooling to 4^{o}C. The entire process is automated and is ideal for large scale handling of 5,000 lph or higher. The complete process of preheating, heating, holding, pre-cooling and chilling is completed in a plate type heat exchanger mounted on a compact frame with inter connected sections to make the process continuous. The heat exchanger plates are so designed as to prevent mixing of thin channels of product and heating/cooling medium by separating the plates with rubber gaskets. The complete equipment consisting of four sections is called pasteurizer. Each section consists of varying numbers of plates depending on equipment capacity. The raw cold milk (4-5^{o}C) from balance tank enters the pre-heating/pre-cooling (regeneration) section, where hot pasteurized milk (72^{o}C) flows counter current to the raw cold milk, within adjacent plates, thereby, transferring heat for pre-heating of raw milk and pre-cooling of pasteurized milk resulting in energy saving. The pre-heated milk then enters the heating section where it is heated to a temperature of 72^{o}C, using hot water or steam, passes to holding section where the temperature of milk is maintained for specified period of time (15 seconds) until it leaves the section. A flow diversion value is placed at the outlet of holding section that senses the temperature and accordingly diverts the milk either forward or returns to balance tank if not properly heated. The pasteurized milk thus passes to regeneration section followed by cooling section where it is chilled using chilled water or glycol solution as a coolant.

Thermization

This process consists of heating milk below pasteurization temperature to temporarily inhibit bacterial growth. The process is useful where it is not possible to immediately pasteurization all the milk and some of the milk needs to be stored for hours/days before further processing. The milk is heated to 63-65^{o}C for 15 seconds and rapidly chilled to 4^{o}C or below to prevent aerobic spore forming bacteria from multiplying after thermization. Thermization has favourable effect on spore forming bacteria to revert to vegetative state which are destroyed upon subsequent pasteurization.

Ultra –pasteurization.

Its objective is to enhance or extend the shelf life of the product (milk) by 15 – 30 days. The fundamental principle is to reduce main causes of reinfection of the product during processing and packaging. This is achieved by heating milk to 115-130^{o}C for 2-4 seconds and cooling it to below 4^{o}C. This requires extremely high level of hygienic practices to be followed during production and maintenance of temperature lower than 4^{o}C during distribution of such products. Ultra pasteurized products are packed in pre-sterilized containers aseptically and held refrigerated to achieve extended shelf life.

Ultra-high temperature treatment (UHT)

It is a technique for preserving liquid food products by exposing them for brief intense heating. In short the process is termed as UHT treatment. The heating temperature normally ranges from 135-150^{o}C for 1-6 seconds. The process is continuos which takes place in a closed system that prevent the product from being contaminated by air-borne microorganisms. The product passes through heating and cooling stags in quick succession followed by aseptic filling as an integral part of the process. There exist two methods of UHT treatment indirect heating and cooling in heat exchangers and direct heating by steam injection or infusion of milk with steam and cooling by expansion under vacuum. UHT-treated products are packed asceptically in specially designed multilayer containers, and can be stored at room temperature for extended period of time (2-6 months) without bacterial growth.

Sterilization :

In this process milk or condensed milk packed in clean containers is usually subjected to high temperature (115-120^{o}C) for 20-30 minutes. The containers may be tin cans (200-400 g capacity) for evaporated/sweetened condensed milk or glass bottle for milk. The process of heating and partial cooling is achieved in a rotary autoclave for batch production or hydrostatic tower for continuous production. In container sterilization is the original form of sterilization and is still used.

Microwave heating :

It is a novel method of heating, which greatly reduces the effect of heat penetration lag associate with traditional process of convection or conduction. Microwaves form part of the electromagnetic spectrum (frequency range 915 and 2450 MHz). The heating effect is achieved by transfer of energy to a dipole (in water) within the product. The constant movement of dipole due to oscillation of molecules generate heat. The high temperature produced in are of high water concentration transfer heat to other areas of food not absorbing microwave energy so well. Microwave absorption is inversely proportional to the penetration depth as a function of water content, salt content and temperature. During microwave heating temperatures at the surface, are often lower due to evaporative cooling than at the centre of the product. Conduction effects are only the means of leveling out the temperature imbalance due to microwave heating, Microwave absorption characteristics change with change in physical phase of the product. In frozen state molecules are less free to move and therefore less able to interact with electrical field. As the product melts the areas of water and dissolved salts appear which absorb microwaves rapidly.

Keeping quality of milk – treatment of milk – pasteurization different types – preservation and storage

Keeping quality of milk is influenced mainly by clean milk production and type of milking – mecahnical-high, manual-low.

Bacteriological standard milk raw milk. (standard plat count / ml.)

1. spc - not exceeding 2 lacs. very good

2 .2 – 10 lacs. – good

3. Bet 10-50 lacs fair

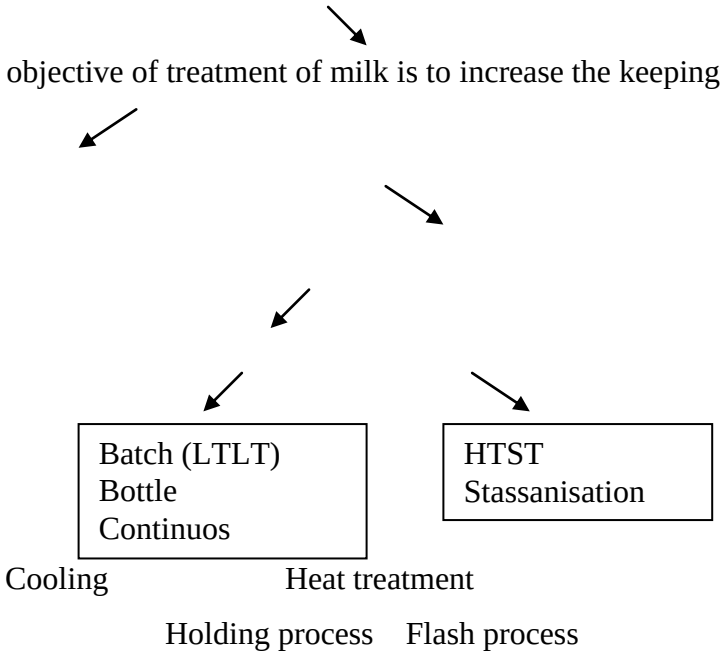
4. > 50 lacs poor

Pasteurized milk – spc should not exceed 30,000

COB (Clot on boiling test) to determine the heat stability.

Treatment of Milk

The main objective of treatment of milk is to increase the keeping quality.



Importance : Milk contains some micro organism when drawn from the udder, that number increases during subsequent handling. The common milk microorganisms grow best between. 20 and 40^0C bacteriological growth is invariably accompanied by deterioration in market quality due to development of off flavour acidity etc. One method of preserving milk is by prompt cooling to a low temperature.

The term pasteurization has been coined after the name of Louis Pasteur of France (1860-4) who demonstrated that heating wine at 122 to 140^{o}F (50 - 60^{o}C) killed the spoilage organism and helped in its preservation. Although Louis Pasteur pioneered studies of heat treatment for preservation, **pasteurization of milk was attributed to Dr.Soxhlet of Germany in 1888.**

EFFECT OF TEMPERATURE ON BACTERIAL MULTIPLICATION

Effect of storage temperature on bacterial growth in milk

Milk held for 18 hrs at Temperature ^{0}C	Bacterial growth Factor *
0	1.00
5	1.05
10	1.80
15	10.00
20	200.00
25	1,20,000.00

* Multiply initial count with this factor to get final count

Pasteurization of Milk

Louis Pasteur found heating the wine to 140^{0}F (60^{o}C) greatly improved keeping quality by destroying most of the bacteria.

Pasteurization is the processing of exposing the milk to a controlled temperature for a specific time with the object of destroying all the pathogenic bacteria and cooling the milk immediately to a temperature low enough to retard the growth of the surviving bacteria 161^{o}F for 15 seconds and rapidly cooling to 50^{o}F sufficient to kill the most common disease producing bacteria .

Advantages :

1. Pasteurization renders milk safe for consumption

2. It destroys all the common disease producing organism eg. TB, Typhoid, Diptheria, etc. which may be present in milk.
3. Pasteurization destroys approximately 99% of all bacteria and most of the yeast and moulds.
4. Keeping quality is improved facilitating easy transport of milk over long distances.
5. Pasteurized milk or cream – desired type of ripening can be obtained more effectively.
6. Pasteurization eliminates undesirable taints from milk.
7. Products prepared from Pasteurization milk are of more uniform quality.
8. Natural flavour of milk is not affected by Pasteurization.
9. Pasteurization destroyes lipase enzyme / which is responsible for rancidity of milk .

Objections to Pasteurization

a) Organisms developing in Pasteurized milk form harmful products. streptococcus theremophilus, S.liquifaciess and M.candidus varian and M.Luteus.
b) Infants do not develop so well on Pasteurized as on raw milk
c) Products of bacterial growth are not destoryed.
d) Pasteurization may be used to mask dirty milk.
e) Pasteurization bring about chemical changes in milk. Cause ppt. of ca and Phosporus
f) Pasteurization - partial destruction of vit.E and K, vit.C is destroyed varying degree dependent on the system.

Holding process: Low temperature long time (LTLT method milk is heated to 150^{o}F and is held at that temperature for 30 minutes then it is cooled to a temperature not more than 50^{o}C.

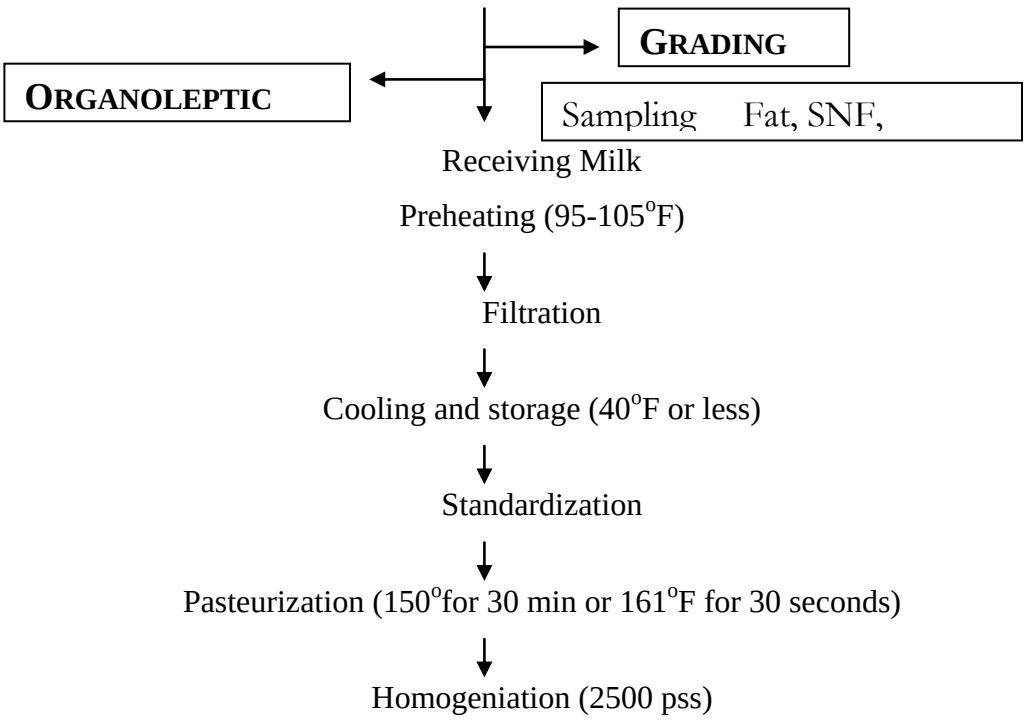
Flash Pasteurization

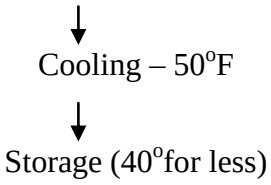
1. Milk is heated to 161^{o}F held for 15 sec.
2. Plate heat exchanger is the most widely used.
3. It includes a section of regenerative heating and cooling followed by final heating and cooling.
4. From the balance tank milk is sucked under slight vaccum through regenative section – 120-130^{o}F by the hot Pasteurization milk flowing in pipeline.

5. The partially heated milk them is pumped thro final heating section under 10 lbs pressure, where it is heated to the required temperature by hot water at temperature 2 to 3^{o}F higher then final
   temperature.
6. Final heating section- the pasteurized milk passes through a holding tube of such capacity that the holding time is not less then 15 sec. and then regenerative section where it is partially cooled and final cooling.

Stassanisation : The milk is heated to about 165^{o}F for 7seconds under slight pressure in a thin layer between two heated surface (in order that all carbonic acid may be returned) the process is carried out in a tubular heat exchanger consisting 3 concentrate tubes by passing milk between two water heated pipes thro narrow space of 0.6 to 0.8 mm. It is claimed that there is practically no milk stone formation, less destruction of vitamins, no evaporation of milk and more economy in steam utilization than in conventional pasteurization. This device was invented on Dr.Henre Stassano. Adv.Easy cleaning.

Flow Diagram





HTST : This was 1st developed by A.P.V. Co., in the U.K. 1922.