Milk Heating

Before the introduction of heating in milk it was a good source of infection because milk is a perfect medium for microbial growth & diseases like T.B & Typhus were spread by milk. Tuberculosis was caused due to direct use of raw milk.

Around middle of the nineteenth (19^{th}) centaury concept of the pasteurization by Louis Pasteur gave the idea of lethal effect of heat on microorganisms & hint was used as preservation technique. In milk the pasteurization was considered as "any heat treatment of milk destroys the *Tubercle Bacillus* (TB) without major effect on physical & chemical properties of the milk".

Around 1930, detection of Phosphatases should that this enzyme is always present in raw milk & appropriate time – temperature combination can inactivate it. And then the milk will be considered as efficiently pasteurized. So pasteurization is "the heat treatment of milk that inactivates the Phosphatases & kills all the pathogenic microorganisms".

However the most resistant microorganism in milk is TB. It is considered to be killed at 63^0C at 10 minutes.

Temperature – Time Combination:

During heating an appropriate combination of time & temperature is used. For example *Coliform bacteria* if treated at 70^0C for 1 second, these are killed but at 65^0C, 10 seconds are required to kill these.

So temperature & time have inverse relation.

For example TB is killed at 70^0C for 20 seconds & at 63^0C for 2 minutes.

Limiting Factors for Milk Heating:

Limiting factors for milk heating are nutrition value & sensory qualities. So during heating we should care of these two factors from loss.

Various Types of Heat Treatments:

Thermization:

It is mild heat treatment for pre heating of milk. It is heating of milk below pasteurization temperature to temporarily inhibit the bacterial growth & milk is heated about 15 seconds for 60-65^0C. After this, milk is again stored at 4^0C.

Pasteurization:

Heat treatment given to milk to kill all the pathogenic microorganisms as well as to inactivate Phosphatases is called as Pasteurization. There are two main types of pasteurization:

1. LTLT (Low Temperature Long Time) – is done at 63^0C for 30 minutes,
2. HTST (High Temperature Short Time) – is done at 72-75^0C for 15-20 seconds.

For the milk products having fat contents more than 8%, the inactivation of Phosphatases is not enough. It can reactive in very short time. So check point is considered Peroxidase enzyme, these are inactivated at 80^0C for 5 seconds.

UHT Treatment:

This heat treatment destroys all types of microorganisms as well as spore forming bacteria. This is heating of milk at temperature ranging from 137-143^0C for 2-3 seconds.

Sterilization:

This is normally not used for milk but for same products i.e., concentrated milk or skimmed milk powder. This is like the original form of sterilization. Milk heated at 80^0C is packed in containers or glass or plastic bottles & heated at 115-120^0C for 20-30 minutes.

Heat Transfer:

Heat transfer is done during two processes 1/. Heating & 2/. Cooling.

Heat Regeneration: To utilize heat within system again & again so that heat is not lost is called heat regeneration. It is reuse or reutilization to minimize heat transfer loss within system.

Holding: Holding is keeping the milk or any food at a specific temperature for specific time period.

Principals of Heat Transfer:

There are two main principals of heat transfer as:

1. Direct Heating,
2. Indirect Heating.

1/. Direct Heating:

Heating medium comes in direct contact with food commodities. In milk it is only applied by injecting steam in milk or by infusion of milk into steam. Direct method is efficient for rapid heating & heat loss.

2/. Indirect Heating:

During Indirect heating a partition is placed between the product & heating or cooling medium & the heat is transferred through the partition to the product.

Methods of Heat Transfer:

1/. Convection:

It is the transfer of heat by the movement of molecules from high temperature area to low temperature area.

2/. Conduction:

It is the transfer of heat by vibration & touching of high heat molecules to low heat molecules.

3/. Radiation:

It is the transfer of heat through rays i.e., infra red rays etc.

HEAT EXCHANGERS

The equipment used to transfer the heat is called as heat exchangers. There are mainly three types of heat exchangers as;

1. Plate Heat Exchanger (PHE)
2. Tubular Heat Exchanger (THE)
3. Scraped Surface Heat Exchanger (SSHE)

The factors that affect the selection of heat exchangers are following:

- Physical properties of liquid,
- Product flow rate,
- Temperature requirements,
- Pressure management,
- Design of heat exchangers,
- Cleaning requirements of heat exchangers,
- Running time of heat exchangers.

Flow is the running of heat with respect to time. There are mainly two types of flow:

1. Current Flow: When two liquids are flowing in same direction.
2. Counter Current Flow: When two liquids flow in opposite direction. That result in heat regeneration.

Plate Heat Exchangers (PHE):

Mostly heat transfer in dairy industry is performed in PHE. It consists of a pack of stainless steel plates clamped in a frame. One frame may contains one or more than one packs of plates or sections which are meant for different treatments like pre-heating, final heating or cooling.

Hot water is usually used as heating material. While cooling material is used as cold water, Ice or propyl glycol. The plates are corrugated in a pattern for optimum heat transfer. The plates are compressed in frame & the frames hold the plates apart, so that thin channels are formed. The liquid enters & leaves the channel of plate. The liquid moves through holes from 1^{st} – 3^{rd} plate.

Tubular Heat Exchanger (THE):

Tubular heat exchangers are sometimes used for pasteurization & UHT. The tubes are used for flow of hot water. In the outer large diameter tube hot water moves, while in the inner small diameter tube milk is moved.

The diameter of tubes is adjusted according to the requirements. However unlike plate heat exchangers, the channels cannot be expand. As compared to PHE, here the higher flow of velocity is required for efficient heat transfer. 'THE' are available in three types as;

1. Mono Tube: One small diameter tube ion one large tube,
2. Multi Tube: More than one small diameter tube ion one large tube,
3. Concentric Tube: Tubes of varying diameter in between each other.

Scrapped Surface Heat Exchangers (SSHE):

It is used for high viscous products. SSHE is used for heating & cooling of a cylinder, rooter & blades. The product is pumped up to downward. The rooter moves & the blades scrape the sticky products from the walls of the tube. The length of blades & the diameter of the rooters is adjusted according to particle size of the product.