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Heat Treatment of Milk in Dairy Industry

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Liquid milk can be delivered to the consumer after various heat treatments: thermization, pasteurization and sterilization etc. The properties of liquid milk that require the most attention is safety to the consumer, shelf life, and flavor. All heat treatment extends the shelf life of foods and beverages. Several methods of heat treatment are used to destroy microorganisms like bacteria, spores, yeast, mould and viruses. These methods are mainly distinguished by differences in time and temperature, which are the most crucial factors during heat treatment. Besides killing microbes, heating inactivates enzymes present in milk that can have a negative impact on taste and appearance during storage. The different techniques used for heat treatment are thermization, pasteurization, sterilization and ultra-high treatment (U.H.T.).

Thermization: Thermization at 57–68 °C for 10–20 s is the generic description for a range of subpasteurization heat treatments of milk. Thermization markedly reduces the number of spoilage bacteria with minimum heat damage to milk components and it does not cause changes in flavor. Thermization at 62–68 °C for 15 s is practiced widely. The treatment can be conveniently performed in a plate heat exchanger designed for the pasteurization of milk using a standard 15 s holding time. This overview focuses on effects of thermization on the quality of milk products. Germination of spores is also addressed including the subsequent inactivation of vegetative bacterial cells by the final heat treatment. Effects of thermization on cheese and liquid-cultured dairy products are also described. The effects of thermization and its positive effects preventing component exchanges in milk, for example, damage of the fat globule membrane caused by the phospholipase of Bacillus cereus, are highlighted.

Pasteurization: Pasteurization is a mild heat treatment that is used on a wide range of different types of food products. The pasteurization process was developed by Louis Pasteur. It has been described as the process of heating milk to such temperature and for such periods of time as are required to destroy any pathogens which may be present, whilst causing minimum changes in the composition, flavour and nutritive value. The two primary aims of pasteurization are to remove pathogenic bacteria from foods, thereby preventing disease, and to remove spoilage bacteria to improve its keeping quality.

Batch/ Holding Pasteurization: This process is also called the Low Temperature Long Time (LTLT) method. This process is not popular in the dairy industry any more after HTST system was introduced. The milk and milk products are heated or cooled in batches in one, two, or three tanks. The process involves heating the milk to a temperature between 62.8 and 65.6 °C, holding it at that temperature for 30 min, and rapidly cooling it to below 10 °C. The heating and cooling of the product is done through a metal wall. The milk is heated in open vats by using steam or hot water. Then the product is heated or cooled, gentle agitation is done for rapid heat transfer.

High temperature short time (HTST) pasteurization: This was first developed by A. P. V. Co. in the United Kingdom in 1922. The HTST pasteurizer gives a continuous flow of milk. The HTST process involves heating milk to 72-75 °C with a 15 second holding time before it is cooled. One of the main advantages of continuous systems over batch systems is that energy can be recovered in terms of regeneration. Although high regeneration efficiencies result in considerable saving in energy, they necessitate the use of larger surface areas because of the lower temperature driving force and there is a slightly higher capital cost for the heat exchanger.

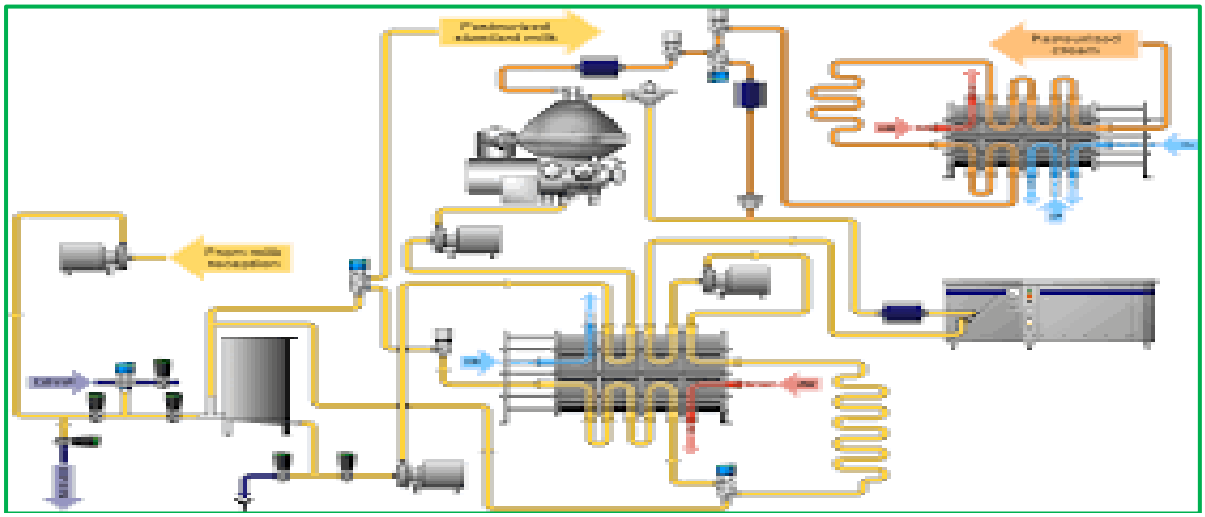

Fig 1: Milk Pasteurizer Flow Diagram

Advantages of HTST pasteurization

- Large volume of milk may be processed continuously.
- Automatic precision controls assure positive pasteurization.
- The equipment requires a relatively small amount of floor and plant space.
- The system adapts itself well to CIP cleaning.
- Filling operations may begin almost simultaneously.
- The HTST method is economical, as it uses regenerator.
- The entire system is simple, requiring little supervisory attention.

UHT – Ultra high temperature treatment: The purpose of UHT (ultra-high temperature) treatment is to destroy all microorganisms that can grow and multiply under storage or shipping at ambient temperatures and destroy the product. UHT treatment sterilizes milk by treating it at a very high temperature for a short time.

UHT treatment normally consists of heating the product to 137-142°C for 2-4 seconds, with a typical example being 137°C for 4 seconds. After cooling, the product is packaged aseptically in an aseptic package, which achieves commercial sterility, meaning it can be stored at ambient temperatures for several months. Both direct and indirect heating are used in UHT treatment, depending on desired quality and production budget. If operating costs are the priority, indirect heating with plate or tubular heat exchangers is used.

Heat treatment in the production of long-life products is called ‘sterilization’. In such processes, the treated product is exposed to such intense heat treatment that the relevant microorganisms and most of the enzymes are inactivated, and the processed product is given excellent keeping qualities and can be stored for several months under ambient conditions. UHT processing uses continuous flow of milk, which renders less chemical change in comparison to retort processing.

Heating the product to the holding temperature and subsequently cooling it before packaging are carried out continuously using heat exchangers. These heat exchangers can be classified into two groups:

a. Direct heat exchangers: where steam is condensed in the product for heating, and later evaporation removes vapor to cool. Direct heating can take place by the following:

Steam injection (steam into product): For homogeneous and high-viscosity products sensitive to shear stress such as creams, desserts, and viscous sauces.

Steam infusion (product into steam): Also, for homogeneous and high-viscosity products sensitive to shear stress such as creams and desserts.

b. Indirect heat exchangers: where the product and the heat exchanging fluid are separated by the heating surface. Indirect heating can be done by the following: Plate heat exchangers: For homogeneous and low-viscosity products. Plate heat exchangers are frequently used for energy regeneration to reduce the cost of heating and cooling.

Advantages of UHT Milk

- UHT treated milk has definite advantage when the distance between producer and consumer is wide
- UHT treated milk can be kept for several months without refrigeration, advantageous in warm consumer is wide
- Temporary surpluses due to seasonal variations can be covered by subjecting milk to UHT treatment
- Milk can be stored at home all the time. It can be readily available at distant locations and at all odd hours.

Conclusion

The positive effects of pasteurization are the destruction of pathogenic microorganisms to increase the safety of market milk for human consumption, improved keeping quality and inactivation of certain naturally occurring enzymes. The negative effects are: certain preformed products of microbial origin are not inactivated during pasteurization, e.g., Staphylococcal toxins and aflatoxins. In case of milk, it destroys the natural microbicidal property of milk by inactivating different natural occurring antimicrobial substances and the rennet coagulation time also increases. UHT treated milk can be kept for several months without refrigeration at atmospheric condition. Nutritive value is much diminished as compared to pasteurized milk in UHT Milk.