

Pasteurization and the HTST Process

Pasteurization ensures the safe consumption of a variety of food products, as well as extending their shelf lives. Today, the HTST (High Temperature/Short Time) pasteurization process is widely used by the food, beverage and dairy industries. It is a continuous process that is energy efficient and effectively destroys the microorganisms in the foodstuffs. An HTST system is ideally fabricated as a modular unit and includes a heat exchanger, tanks, a holding tube, pumps, valves and interconnecting piping. The heat exchanger is an important component in the system and is usually either a shell-and-tube or plate-and-frame unit. High purity and sanitary requirements make stainless steel the preferred material of construction for HTST pasteurization systems. A&B Process Systems is recognized throughout North America for the ability to work with the stainless steel alloys. In addition, having served the food, beverage and dairy industries for over thirty years, the company is presently regarded as “experts” in pasteurization technology and in the design, fabrication and installation of HTST systems.

What is pasteurization?

Pasteurization is a heat treatment that destroys pathogenic organisms (bacteria, viruses, protozoa, molds and yeasts) in foodstuffs to reduce the total bacterial count. The process, introduced in 1862 by the French scientist, Louis Pasteur, is vitally important to the food, beverage and dairy industries, ensuring the safe consumption of such foods as milk, cream, cheese, fruit juices, honey and eggs, as well as extending their shelf lives. Pasteur established that by heating milk to 145° F for 30 minutes, 99.9% of the bacteria present were destroyed. Since then series of time-temperature curves have been developed for all known microorganisms to consistently provide “a 5-log kill,” the industry’s terminology for the destruction of 99.999% of the microorganisms present in a product. Unlike sterilization, pasteurization is not intended to kill all the microorganisms in the food or dairy product and is designed to cause little, if any, degradation of the foodstuff in terms of color, aroma or flavor.

How are food products pasteurized today?

Methods of pasteurization today, are standardized and controlled by the USDA and the standards differ for the different food products. For example, the standard for cheese is designed to preserve a phosphatase enzyme (necessary in the curing process) and is therefore different to the standard for fluid milk. Presently, there are three methods, based on treatment with heat, being used in the food and dairy industries;

- (i) Batch or Vat Pasteurization, which is the oldest method and is no longer favored by food, beverage and dairy industries. This is due, in part, to the fact that with large-scale production the method became impractical in terms of the size and number of tanks required.

- (ii) High Temperature/Short Time (HTST) Pasteurization, which is now, by far, the preferred method of pasteurization and is designed to obtain the expected million-reduction in the number of microorganisms in the particular food product.
- (iii) Ultra-High Temperature (UHT) Pasteurization, in which the foodstuff (particularly milk) is heated to 265° F for 0.5-1.0 seconds. This is considered by some to be a sterilization process, rather than pasteurization, but a significantly longer shelf life is obtained.

The selection of the best method of pasteurization of a particular foodstuff is often complex. For example, there are several factors that must be considered in the design of the heat exchange units to be used --- the type of product, its' viscosity, the flowrate required, the temperature profile needed and any pressure drops that may be involved. The expertise in pasteurization technology at A&B Process Systems represents a valuable resource in making the choices and in designing the process system.

Why is HTST pasteurization the preferred method?

HTST pasteurization, sometimes referred to as “flash pasteurization,” is a continuous process, and that alone would make it attractive to today’s food, beverage and dairy industries. However, the HTST process is also energy efficient, minimizes damage to the foodstuff being treated and is a very effective process with regard to destroying microorganisms. The HTST system utilizes a heat exchange unit to transfer the thermal energy to the milk or other foodstuff. This unit is an important component and may be either a plate-and-frame or shell-and-tube exchanger, though other designs may be considered. For example, the scraped surface heat exchange unit is used in the pasteurization of products containing large particles or where crystallization may occur during processing. In addition to the heat exchange unit, the system requires (i) a balance tank to maintain full flow and to receive the returned foodstuff if the specified temperature is not achieved, (ii) holding tanks to store the raw and pasteurized foodstuff, (iii) a holding tube, which is a length of tubing, installed immediately after the heating zone, sized to provide the correct treatment time, and (iv) a control and monitoring system to both direct flow back to the balance tank and monitor/record the time and the temperature during the process. Ports may be included to allow connections to either a Clean-in-Place (CIP) or a Sterilize-in-Place (SIP) system, often required for high purity and sanitary processes.

The efficiency of the heat exchange process has become important to the food, beverage and dairy industries, in light of (i) the rising costs of energy and (ii) the environmental concerns associated with the production of energy today. The heat exchanger is therefore designed to optimize the energy consumed, by pre-heating the incoming, raw product, using the hot, pasteurized product. The heat regeneration is determined from the ratio of the heat load in the regeneration zone to that of the total system and it is typically expressed as a percentage. Today, 85-90% heat regeneration is expected and well-designed systems can realize over 92%. It can be shown that 1% heat regeneration represents cost savings of tens of thousands of dollars.



The HTST system is ideally fabricated as a modular unit or “skidded system,” allowing the footprint to be designed to meet the floor space available in the particular plant. Furthermore, a modular system is assembled and fully tested prior to delivery, making it “ready to go” immediately after installation.

How different are the heat exchange units?

A plate-and-frame heat exchange unit consists of a series of plates, mounted in a frame and clamped together. The spaces between adjacent plates create flow channels and the unit is arranged to allow hot and cold fluids to enter and exit at the four corners. This design provides a highly efficient, countercurrent flow, yielding heat transfer coefficients significantly higher than other designs. A corrugated chevron or herringbone pattern, pressed into each plate, gives strength and rigidity, as well as increasing turbulence in the flow channels. The net result of this design feature is to further enhance the rate of heat transfer. The plate-and-frame exchanger may be designed to provide wider channels to avoid fouling and blocking with the more viscous food products, e.g., ice cream mixes, yogurt. However, the relatively narrow channels in the plate-and-frame units may be a disadvantage if the products contain particulates or if crystallization can occur during the process.

Shell-and-tube heat exchangers are mechanically simple, yet provide a flexible and reliable approach to control heat transfer in a process. The basic configuration is a bundle of tubes inserted and fixed inside a shell, allowing separated fluid flow through the tubes and through the shell. The unit is designed to provide a high surface area of the metal or alloy, across which the heat transfer occurs. The shell-and-tube exchanger is capable of operating at elevated temperatures and pressures and is tolerant to particulates in the foodstuffs. Double-Tube and Triple-Tube™ heat exchangers have recently found application in pasteurization processes. These units contain removable tubes, facilitating repair or replacement, and realize 85+% heat regeneration. The Triple-Tube™ unit consists of an inner tube, intermediate tube and an outer shell mounted concentrically. The heating or cooling medium flows through the inner tube and between the intermediate tube and outer shell. The product flows countercurrent between the inner and intermediate tubes to increase the efficiency of the heat transfer process.

How does UHT pasteurization compare with the HTST method?

Ultra-High Temperature pasteurization is a rapid process that yields a product with a longer shelf life. It is also a continuous method and, depending upon the method of heating used, the process system may not be significantly different from that used with HTST pasteurization. In the UHT method of pasteurization the foodstuff may be heated directly or indirectly and the latter approach again uses a heat exchange unit. The design of the exchanger will depend upon the thermal requirements of the process. Direct heating is believed to shorten the time necessary to hold the foodstuff at the specified temperature, therefore minimizing damage to heat sensitive products such as milk. An important aspect of the UHT pasteurization process is stated to be that the product is packaged into sterile containers. However, this does require maintaining a sterile environment between processing and packaging, adding complexity to both the equipment and the plant.

What equipment is used in batch pasteurization?

Batch or Vat pasteurization is a simpler process, requiring efficient heating and agitation in a sealed tank, holding the milk at 63° C for at least 30 minutes. Other foodstuffs may require different temperatures and/or different times, but the efficiency of mixing of the food product is critically important in the batch process, since it is necessary to ensure that all of the fluid (or essentially all) is held at the specified temperature for the required length of time.

Why is A&B' interested in pasteurization processes?

As a result of thirty years of service to the food, beverage and dairy industries, A&B Process Systems has acquired considerable expertise with regard to pasteurization technology and the design, fabrication and installation of pasteurization systems, particularly HTST systems. Furthermore, to meet the purity and sanitary requirements in those industries, stainless steel tanks, pumps, valves and piping are widely used. A&B Process Systems is recognized throughout North America for the design, fabrication and installation of stainless steel process equipment and process systems. The company's reputation has been built upon the capability to manufacture high quality products to meet performance specifications in a timely manner. A&B recognized the advantages of modular systems to the processing industries and established the necessary in-house resources to support the design and fabrication of such systems. A&B Process Systems also has an Automation and Controls Group in-house, ensuring the incorporation of user-friendly, reliable instrumentation into a process system.