Processing by application of heat

There are two main temperature categories employed in thermal processing: Pasteurization and Sterilisation. The basic purpose for the thermal processing of foods is to reduce or destroy microbial activity, reduce or destroy enzyme activity and to produce physical or chemical changes to make the food meet a certain quality standard. e.g. gelatenization of starch & denaturation of proteins to produce edible food.

Blanching:

The word blanch refers to a cooking technique in which food is briefly immersed in steam or boiling water or fat, usually followed by shocking, which is rapidly cooling the food in an ice bath or with cold air. Blanching is used both in cooking and in preparing vegetables and fruits for preservation. When you blanch a food for the right amount of time you help maintain flavor, color, texture, and nutritional value before canning or freezing. It also helps soften the food items and loosens skin to assist in peeling. Blanching is used both by home cooks and in industrial food processing**.**

The primary purpose of blanching is to destroy enzyme activity in fruit and vegetables. It is not intended as a sole method of preservation, but as a pre-treatment prior to freezing, drying and canning. Other functions of blanching include:

- ✓ Reducing surface microbial contamination
- ✓ Softening vegetable tissues to facilitate filling into containers
- ✓ Removing air from intercellular spaces prior to canning

Blanching and enzyme inactivation

Freezing and dehydration are insufficient to inactivate enzymes and therefore blanching can be employed. Canning conditions may allow sufficient time for enzyme activity. Enzymes are proteins which are denatured at high temperatures and lose their activity. Enzymes which cause loss of quality include *Lipoxygenase, Polyphenoloxidase, Polygaacturonase* and *Chlorophyllase.* Heat resistant enzymes include Catalase and Peroxidase.

Testing of the Effectiveness of Blanching

Over blanching causes quality loss due to overheating while under blanching causes quality loss due to increased enzyme activity because enzymes activated and substrates released by heat. The Peroxidase test in vegetables is used to detect enzyme inactivation. This enzyme is not in itself implicated in degradation, but is relatively heat resistant and easily detected. It consists of adding guaiacol solution and hydrogen peroxide solution and observing the development of a brown colour indicating peroxidase activity.

Complete inactivation is not always essential – green beans, peas and carrots with some residual peroxidase activity have shown adequate storage quality at -20°C through with other vegetable (e.g. Brussels sprouts) zero peroxidase activity is essential.

Methods of Blanching

Blanching is carried out at up to 100°C using hot water or steam at or near atmospheric pressure.

Some use of fluidised bed blanchers, utilising a mixture of air and steam, has been reported. Advantages include faster, more uniform heating, good mixing of the product, reduction in effluent, shorter processing time and hence reduced loss of soluble and heat sensitive components.

There is also some use of microwaves for blanching. Advantages include rapid heating and less loss of water soluble components. Disadvantages include high capital costs and potential difficulties in uniformity of heating.

Steam Blanchers

This is the preferred method for foods with large cut surface areas as lower leaching losses. Normally food material carried on a mesh belt or rotatory cylinder through a steam atmosphere, residence time controlled by speed of the conveyor or rotation. Often poor uniformity of heating in the multiple layers of food, so attaining the required time-temperature at the centre results in overheating of outside layers.

Individual Quick Blanching (IQB) involves a first stage in which a single layer of the food is heated to suffcient temperature to inactivate enzymes and a second stage in which a deep bed of the product is held for suffcient time to allow the temperature at the centre of each piece to increase to that needed for inactivation.

The reduced heating time (e.g. for 10 mm diced carrot, 25 s heating and 50 s holding compared with 3 minutes conventional blanching) results in higher energy efficiencies For small products eggs peas, sliced or diced carrots), mass of produce blanched per kg steam increases from 0.5kg for conventional steam blanchers to 6-7kg for IQB.

Hot Water Blanchers

Includes various designs which hold the food in hot water (70 to 100°C) for a specified time, and then moves it to a dewatering/cooling section. In blanchers of this type the food enters a slowly rotating drum, partially submerged in the hot water. It is carried along by internal flights, residence time being controlled by the speed of rotation.

Pipe blanchers consist of insulated tubes through which hot water is circulated. Food is metered into the stream, residence time being controlled by the length of the pipe and velocity of the water.

The blancher-cooker has three sections, a preheating stage, a blanching stage, and a cooling stage. As the food remains on a single belt throughout the process, it is less likely to be physically damaged. With the heat recovery incorporated in the system, 16 to 20 kg of product can be blanched for every kg of steam, compared with 0.25 to 0.5kg per kg stream in the conventional hot water blanchers.

Pasteurization

Pasteurization, heat-treatment process that destroys pathogenic microorganisms in certain foods and beverages. It is named for the French scientist Louis Pasteur, who in the 1860s demonstrated that abnormal fermentation of wine and beer could be prevented by heating the beverages to about 57° C (135° F) for a few minutes. Pasteurization of milk, widely practiced in several countries, notably the United States, requires temperatures of about 63° C (145° F) maintained for 30 minutes or, alternatively, heating to a higher temperature, 72° C (162° F), and holding for 15 seconds (and yet higher temperatures for shorter periods of time). The times and temperatures are those determined to be necessary to destroy the *Mycobacterium tuberculosis* and other more heat-resistant of the non-spore-forming, disease-causing microorganisms found in milk. The treatment also destroys most of the microorganisms that cause spoilage and so prolongs the storage time of food.

Objectives of pasteurization

• To make the product safe for human consumption by destroying the pathogenic organism, which may be present.

• Improves preservation quality by destroying almost all spoilage organisms.

• Helps to retain good flavor over a longer period of time.

Methods of pasteurization

Methods	Treatment
Long hold batch type / Vat pasteurization	63°C-30 min
High temperature short time (HTST) pasteurization	72°C-15 s
Ultra high temperature (UHT) pasteurization	88°C-3 s

However, the time and temperature combination maintained in a dairy plant may vary from the above Table values depending on the initial microbial load and other considerations.

1. Long hold batch or vat pasteurization

The long hold or vat pasteurization is a batch type method where the pasteurization is carried out at 63°C for 30 min. The basic operations involved in a vat pasteurizer are given in Fig.

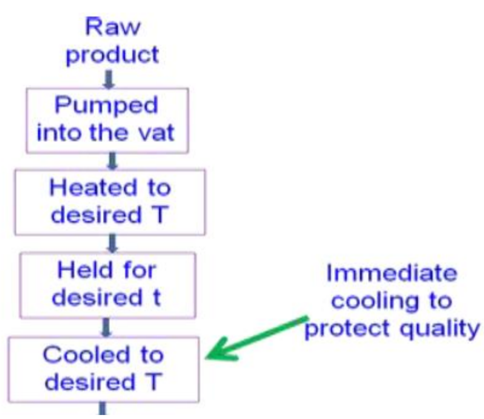

Figure: Basic operations in a vat pasteurizer

General requirements

The following are the requirements for a successful batch pasteurization process.

• Rapid heating: Generally the circulation of heating medium is started as soon as filling of the vat is begun, thus shortening the heating time.

• Immediate cooling: In some designs the cold water is circulated over the outside of the inner lines as soon as the holding period is completed, so a part of cooling can be done in the vat itself.

• Heating medium should be only a few degrees warmer than milk to prevent formation of milk stones on heating surfaces and cause minimum injury to cream line or flavour.

• ***Agitation*****.** Agitation of milk within a certain degree helps in improving the heat transfer.

- ✓ Agitation is easier in case of hot fluid than cold ones.
- ✓ Agitation should not develop foam and it should not injure the cream line.
- ✓ Viscosity of the fluid greatly affects the type of agitator.

Advantages

• Well suited for small plants, low volume products

• Variety of products can be handled.

• Well suited for cultured products such as bottle milk, sour cream, etc.

• Simple controls

• Low installation cost

Disadvantages

• Batch type

• Slow process

• As the controls are mostly manual, it requires constant attention.

• Both heating and cooling are relatively expensive (as we do not have heat regeneration).

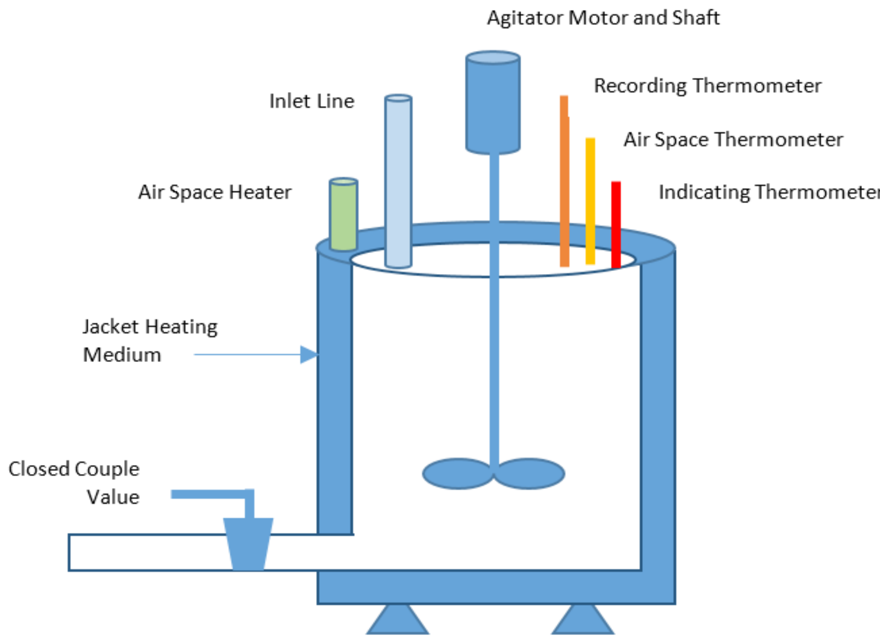

Fig: Batch Pasteurization

2. HTST pasteurization

High temperature short time pasteurisers are usually continuous flow systems using heat exchangers. Generally plate type heat exchangers with regenerative heating, heating and cooling systems are used.

Basic components of HTST pasteurization system

The HTST pasteurization process and its basic components are shown in Fig. First from a constant level tank, milk is pumped by a booster pump into a heat exchanger to heat it with the help of pasteurized milk to about 60°C. As the pasteurized milk is used for heating the raw milk and there is no external heating source, we call that a regenerative heater. The regenerator reduces the actual heat requirement for pasteurization and hence is very important for the overall cost effectiveness of the system. Then the milk enters into the heater where the temperature of milk is raised to the actual pasteurization temperature. The milk then passes through the holder, where the milk temperature is maintained for the specific time so that pasteurization is completed. Then the pasteurized milk goes to the regenerator so that it gives away some heat to the raw milk. It is also simultaneously cooled so that the refrigeration requirement is reduced.

After the regenerator, the pasteurized milk goes to a chiller, where the milk temperature is reduced to about 4-5°C.

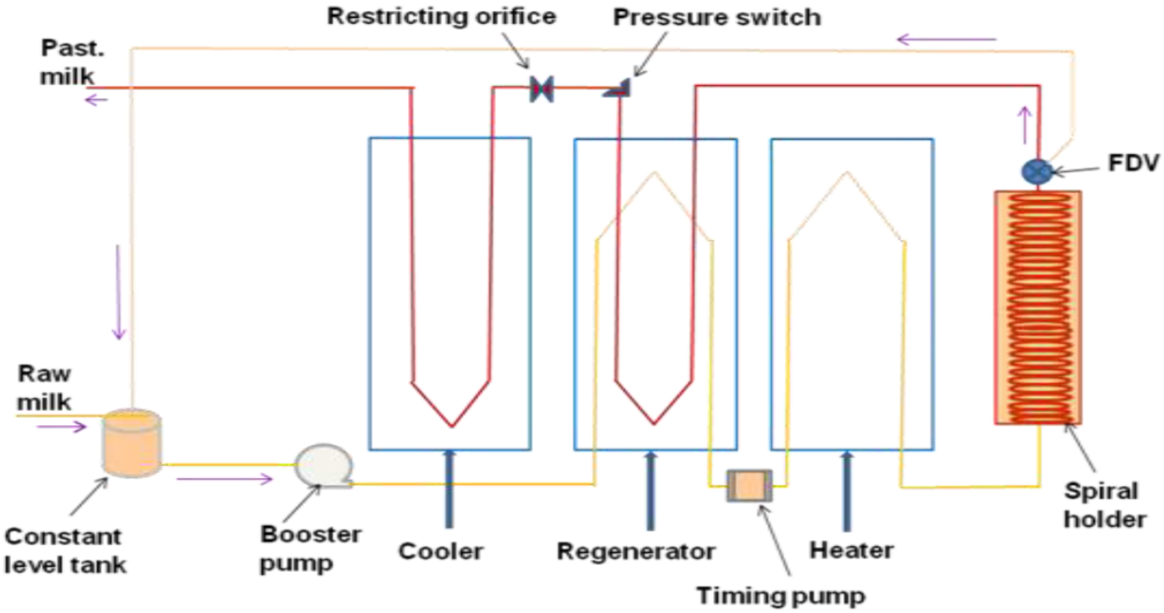

Figure: HTST pasteurization process

Advantages of HTST pasteurization

• Uniform treatment.

• Temperature is regulated at close limits and overheating is prevented.

• Economical than batch systems (due to regenerative heating).

Disadvantages

• The system is complicated.

• Not portable.

• Installation cost is more.

3. Ultra high temperature (UHT) pasteurization

As we have discussed previously, the UHT pasteurization process involves heating the milk at a temperature of 88°C for 3 sec. The equipment is much the same as the HTST units and the controls are also similar, but the operating temperature is higher. The holder is much smaller for smaller pasteurizing time.

Advantages

• Better texture of milk due to short holding time

• Greater bacterial destruction is possible.

When UHT treatment is needed for greater bacterial destruction or its beneficial effect on the body and texture of ice cream, then the treatment may be given following regular pasteurization.

Sterilisation

Unlike pasteurized products where the survival of heat resistant microorganisms is accepted, the aim of sterilization is the destruction of all bacteria including their spores. Heat treatment of such products must be severe enough to inactivate/kill the most heat resistant bacterial microorganisms, which are the spores of *Bacillus* and *Clostridium*.

"Commercial sterility" implies less than absolute destruction of all micro-organisms and spores, but any remaining would be incapable of growth in the food under existing conditions. Time-temperature combination required to inactivate most heat resistant pathogens and spoilage organisms.

Two typical forms of sterilised product are:

• In package sterilised, in which product is packed into containers and the container of product is then sterilised e.g. canning, some bottled products, retort pouches

• UHT or Aseptically processed products in which the product and the package is sterilised separately then the package is filled with the sterile product and sealed under specific conditions e.g. long life milk, tetrapack or combibloc fruit juices and soups etc.

Sterilisation Process and Equipment

The sterilization process in the canned product can be subdivided into three phases. By means of a heating medium (water or steam) the product temperature is increased from ambient to the required sterilization temperature (phase 1 = heating phase). This temperature is maintained for a defined time phase 2 = holding phase). In (phase 3 = cooling phase) the temperature in the can is decreased by introduction of cold water into the autoclave.

Autoclaves or retorts

In order to reach temperatures above 100°C ("sterilization"), the thermal treatment has to be performed under pressure in pressure cookers, also called autoclaves or retorts.

In autoclaves or retorts, high temperatures are generated either by direct steam injection, by heating water up to temperatures over 100°C or by combined steam and water heating. The autoclave must be fitted with a thermometer, pressure gauge, pressure relief valve, vent to manually release pressure, safety relief valve where steam is released when reaching a certain pressure, water supply valve and a steam supply valve. The steam supply valve is applicable when the autoclave is run with steam as the sterilization medium or when steam is used for heating up the sterilization medium water.

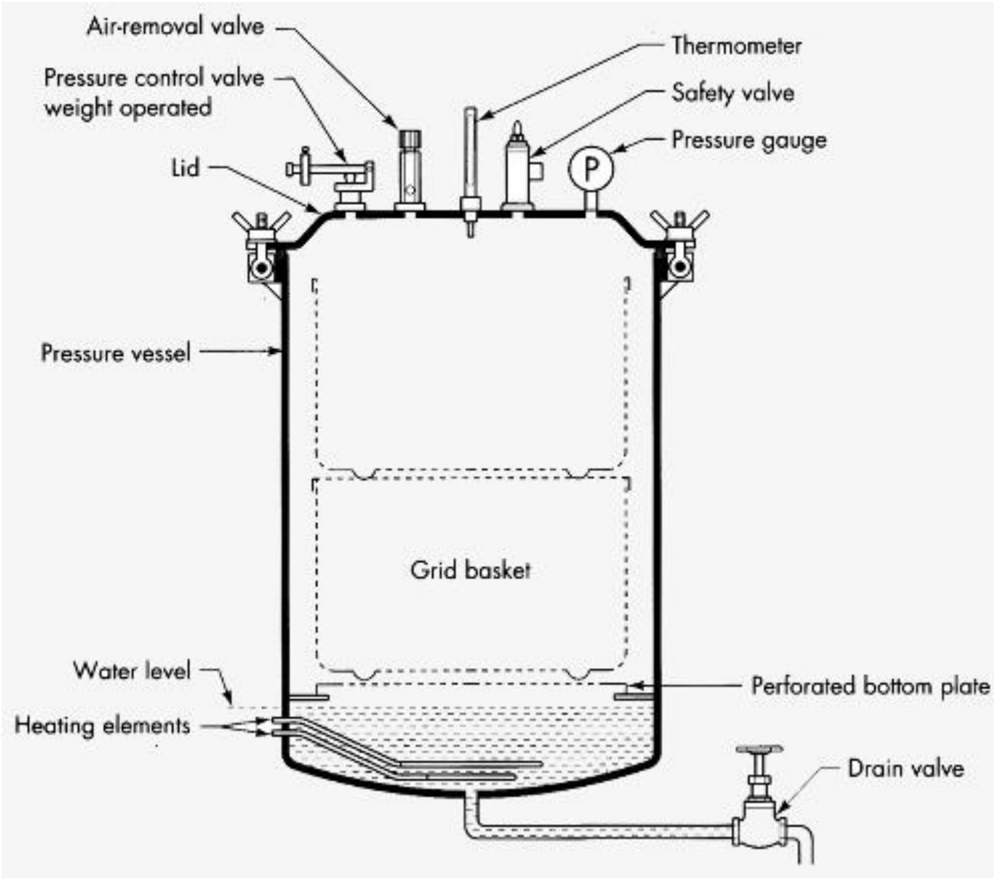

Figure: Autoclave