Nevada Dairy Commission

Pasteurizer Operator Study Guide

Reference and study guide for the HTST and Vat Pasteurizer Operator

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INTRODUCTION

Pasteurization is the only public health measure which, if properly applied will adequately protect against all infectious milk-borne disease organisms which may have entered the milk prior to pasteurization.

Pasteurization is a heat treatment or thermal process that kills part but not all of the vegetative microorganisms in the food and is consequently used for foods, which are further processed or stored under conditions, which minimize growth. In the case of milk, pasteurization is used to kill pathogenic microorganisms. Since only about 90% deactivation is achieved some spoilage organisms and spores may survive this heat treatment, it is necessary to keep pasteurized milk refrigerated to obtain the desired shelf life. Therefore, in addition to the destruction of pathogens and undesirable bacteria, pasteurization also extends the useful life of the product with minimal alteration of flavor and physical characteristics. Organoleptically speaking, a high temperature short time process (161°F for 15 seconds) for fluid milk is preferred, rather than a low temperature long time treatment (145°F for 30 minutes), since HTST usually results in less nutrient destruction and fewer sensory changes.

The term "thermal process' generally refers to a process during which a food product is subjected to high temperatures with the objective of inactivating undesirable microorganisms or enzymes. Thermal process is necessitated by the fact that plant and animal tissue and fluids are normally and naturally contaminated with microorganisms and/or enzymes, which may cause undesirable changes in the product during storage.

Pasteurization has been described as the principle safeguard between a potentially dangerous milk supply and the consumer. Methods must be dependable and equipment constructed of material of a type that permits easy and effective cleaning. Adequate precautions must be taken to detect and avert faulty operational controls.
The legal definition of pasteurization is the process of heating every particle of milk and milk products to the minimum required temperature (for that specific milk or milk product), and holding it continuously for the minimum required time in equipment that is properly designed and operated. The human factor is possibly the most important in achieving proper pasteurization of milk.

HTST PASTEURIZATION

HTST CRITICAL CONTROL POINTS

1. INDICATING THERMOMETER

Scale: Span not less than 25°F including pasteurization temperature plus or minus 5°F.
Accuracy: 0.5°F, plus or minus throughout scale.

2. RECORDER CONTROLLER

Accuracy: Within 1°F at set temperature plus or minus 5°F.

Diversion set point: Flow diverted before minimum pasteurization temperature is reached.

Sensor location: Within 18 inches of and upstream from FDD
Function/operation: Thermometric response is 5 seconds or less to change 12°F of a 19°F span that includes the cut-in temperature. Electronically operated for continuous flow pasteurizers.
Chart in compliance: Scale not less than 30°F including set diversion temperature and at least +/- 12°F.
Graduated in 1°f divisions at least 1/16 inch apart at diversion temperature and time divisions not more than 15 minutes.
Speed not more than 12 hours for circular charts or 24 hours for strip charts.
Frequency pen records the position of FDD on outer edge and must track in the reference arc inscribed on the STLR case.

3. TIMING/METERING PUMP

Location: Downstream from the raw regenerator.
Seal in place: Set at fastest minimum legal pasteurization time.

4. HOLDING TUBE

Proper slope: 0.25 inch per running foot.
Unchangeable: Permanent supports with no alterable sections

5. FLOW DIVERSION DEVICE

Assembly: Located downstream from the holder, leak escape installed on the forward flow side of valve seat, flow control sensor located upstream within 18 inches of the flow control device.
Function: Assume fully divert position within 1 second, power failure or loss of air pressure automatically moves valve to divert position de-energizes the metering pump if incorrectly assembled or a malfunction occurs.
Divert/leak detect line slope: Leak escape installed on the forward flow side of valve seat, sight glass installed in detect line to constant level tank, both lines self-draining with no restrictions or valves in the leak detect line.
Break at balance tank: Overflow level at least 1 inch below the lowest level of raw milk in the regenerator.

6. VACUUM BREAKER

Proper location: Vertical elevation of at least 12 inches above the highest raw milk in the system.

BASIC HTST SYSTEM COMPONENTS

- Constant Level Supply Tank (balance tank)
- Thermal Exchange System
- Timing (Metering) Pump
- Holding Tube
- Indicating Thermometer
- Flow Diversion Device
- Recorder Controller

AUXILIARY EQUIPMENT

- Booster Pump
- Homogenizer
- Separator
- Stuffer/Feed/Product Pump
- Vacuum chamber

PASTEURIZATION				
PRODUCT	**HTST**		**HHST**	
	TIME	TEMP	TIME	TEMP
WHOLE, LOWFAT SKIM MILK	15 SEC	161°F	1.0 SEC. 0.5 0.1 0.05 0.01	191°F 194°F 201°F 205°F 212°F
MILK PRODUCTS – with increased viscosity, added sweeteners or 10% or more fat content	15 SEC	166°F	15 SEC.	166°F
EGG NOG, FROZEN DESSERT MIXES	25 SEC 15 SEC	175°F 180°F	25 SEC. 15 SEC.	175°F 180°F

HTST BASIC DESIGN AND FLOW PRINCIPLES

1. Cold raw milk enters the constant level tank (approx. 40 F) and is drawn under reduced pressure into the regenerator section of the press.

2. In the regenerator section, the cold raw milk is pre-warmed by the heat given up by the hot pasteurized milk flowing in a counter current direction on the opposite side of the milk to milk regenerator plates.

3. The raw milk, under pressure flows through the heater section where steam heated hot water on opposite sides of the stainless steel plates continues to heat the milk to a temperature exceeding the minimum pasteurization temperature.

4. The hot milk, now at or above legal pasteurization temperature, and under pressure, flows through the holding tube where the transit time ("hold") is at least 15 seconds. The velocity or rate of flow of the milk through the holding tube is totally governed by the speed of the timing (metering) pump. The residence time of the milk in the holding tube is determined by the pumping rate of the timing pump, the length of the holding tube and the surface friction of the milk product.

5. The milk then contacts the sensing bulbs of the indicating thermometer and the recorder-controller. If the milk temperature is not at or above the minimum required set point, then the sub- legal milk is returned to the constant level tank via the diversion port and line of the flow diversion device.

6. If the milk contacts the STLR at or above the minimum set point (161 F), the recorder-controller signals the flow diversion device to assume the forward flow position and the milk flows through the forward flow port of the FDD. The milk from this point continues through the system as legally pasteurized milk.

7. The hot pasteurized milk passes through the milk to milk regenerator (pasteurized side) and gives up heat to the cold raw milk on the opposite side of the plate. In turn, the pasteurized milk is partially cooled.

8. The partially cooled pasteurized milk then passes through the cooling section where re-circulated cooling water is used to reduce the milk temperature to below 45 F.

9. The cold pasteurized milk then exits the cooling section and rises to an elevation of at least 12 inches above any raw milk in the system and is open to the atmosphere at this point, through a sanitary vacuum breaker.

10. From this point the pasteurized milk may travel directly to a storage or surge tank for subsequent packaging or may be returned to the constant level tank.

DEFINITIONS

ATMOSPHERIC PRESSURE – The force exerted on an area by the column of air above that area. Atmospheric pressure at sea level is 14.7 pounds per square inch.

BALANCE TANK – Raw product tank located at the start of a pasteurization system used to maintain a constant supply of product to the pasteurizer.

BOOSTER PUMP – A centrifugal pump placed in a pasteurizing system between the balance tank and the raw regenerator and capable of producing positive pressure in the raw regenerator.

CENTRIFUGAL PUMP – A high speed pump that produces product flow due to the velocity increase of the liquid caused by the rotation of the pump.

CONSTANT LEVEL TANK – See balance tank.

COOLING SECTION – The section of a heat exchanger (press) in which one of several non-toxic coolants flows in a counter current direction on the opposite side of a stainless steel plate from the pasteurized product.

DEFLECTOR PLATE – A stainless steel plate in the regenerator section of the press designed to change the direction of flow.

FLOW DIVERSION DEVICE – Either a single stem (one three-way valve) or a dual stem (two, three-way valves connected by a common yoke), designed to change the direction of product flow when working in conjunction with the recorder-controller.

FREQUENCY PEN – A solenoid actuated recording pen (located on the outer edge of the recording chart) that records the position of the flow diversion device in a continuous flow pasteurizing system.

HEAT EXCHANGER – Equipment designed to effect heat transfer between two or more mediums.

HOLDING TUBE – The section of piping in continuous flow pasteurizers of sufficient length to provide the minimum legal residence time for heated milk.

HOT WATER TEMPERATURE CONTROLLER – A system that controls the temperature of the heating medium by regulating a mixture of steam and water circulating through the heating section of the press.

MARGIN OF SAFETY – The additional temperature and time used for pasteurization above the minimum requirements to kill all disease causing organisms in the milk.

MICROSWITCH – A mechanically actuated electric NO (normally open), NC (normally closed) switch. It is a small level actuated switch used in the control circuit and is sometimes referred to as a limit switch.

PNEUMATIC – Operated by compressed air.

REGENERATOR BYPASS VALVE – A automatic or manually controlled valve used in combination with the booster pump for the purposes of start up of a continuous pasteurizer with a milk to milk regenerator. The valve allows for the bypassing the regenerator in order to provide the proper pressure relationships in the regenerator, thus allowing the booster pump to operate.

SANITIZATION – The application of any effective method or substance to a clean surface for the destruction of pathogens. Such treatment must not adversely affect the equipment, the milk or the health of the consumer. Application of heat or suitable chemical may accomplish this if used in accordance with good manufacturing practices.

SAFETY THERMAL LIMIT CONTROLLER – The term sometimes used interchangeably when referring to the recorder-controller.

SOLENOID – An electronically operated valve used to open or close a valve or a magnetic relay switch.

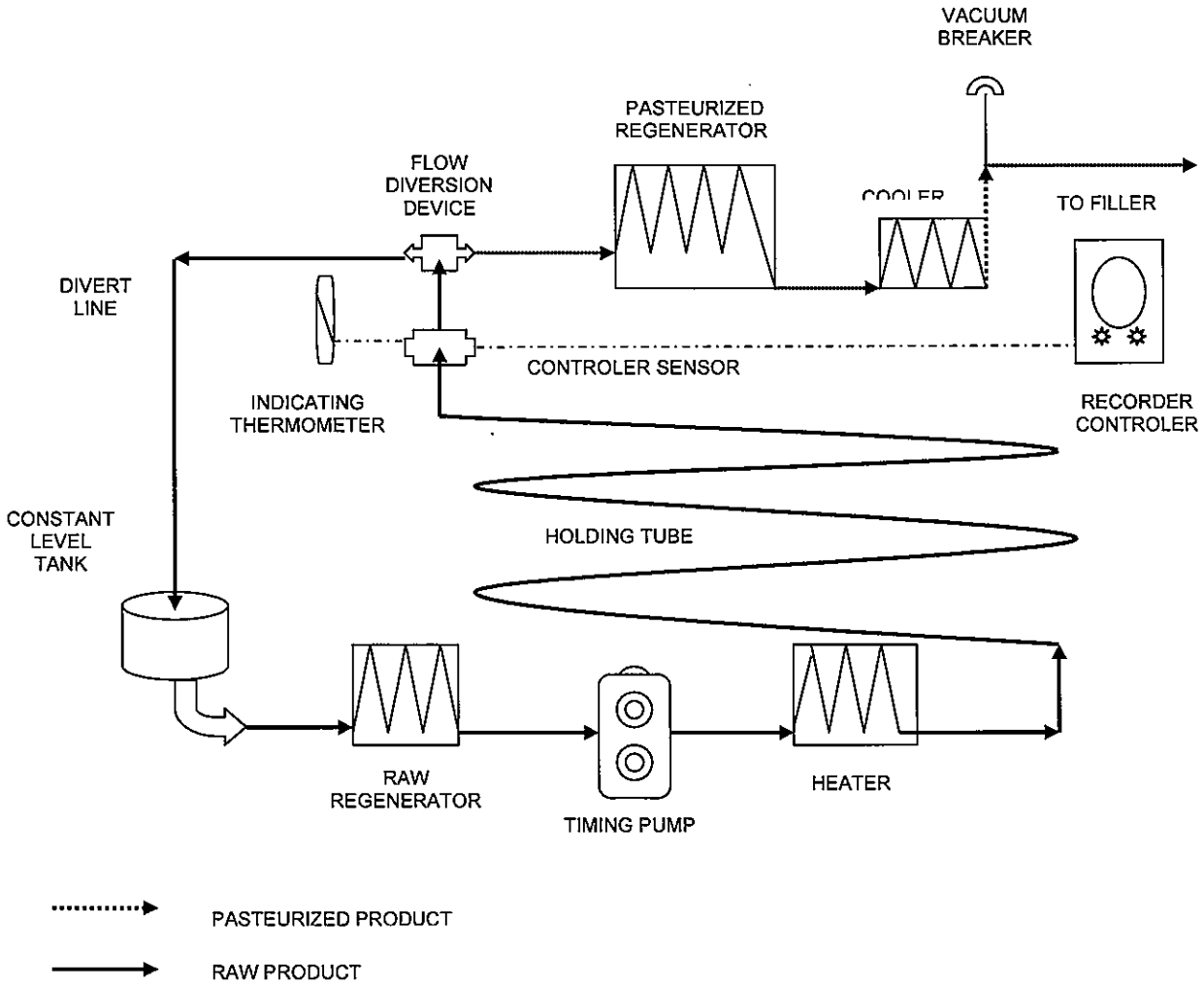
STUFFING PUMP – Any centrifugal pump used in the system for the purposes of enhancing the flow to a component, other than those located between the balance tank and the raw regenerator.

TIME DELAY RELAY (TDR) – An adjustable timer used to maintain a set time period equal to or greater than the required minimum.

TIMING PUMP – Sanitary, positive displacement type pump that provides a constant measured rate of flow to the continuous pasteurization system. Homogenizers may be used as timing pumps since they are piston-type positive displacement pumps. All timing pumps are capable of creating suction and do not slow down under discharge pressure.

VACUUM BREAKER – An air relief valve held in the closed position by the product flow pressures and opens to admit air when the product pressure drops below atmospheric pressure.

BASIC FLOW - HTST



VAT PASTEURIZATION

The heating of milk in a vessel has long been one of the most effective methods of rendering a relatively organism free and hopefully pathogen free milk product. The product is heated in a jacketed stainless steel vat that has been fitted with water and steam to the jacket liner, thermometers to monitor and record product temperatures and some means of agitation to assure uniformity in temperature distribution. Other requirements include properly designed valves, time/temperature requirements and methods of operation.
Generally all vats or batch type pasteurizers should conform to 3-A sanitary Standards for Non-Coil Type Batch Pasteurizers For Milk and Milk Products, #24-01. This standard provides guidelines for the installation, approved materials, finish and fabrication of vat pasteurizers. All vat pasteurizers must comply with Item 16A of the Pasteurized Milk Ordinance (PMO), including all operational and construction requirements.

VAT PASTEURIZATION		
PRODUCT	TIME	TEMPERATURE
WHOLE, LOW FAT, SKIM MILK	30 MINUTES	145°F
MILK PRODUCTS – with increased viscosity, added sweetener, or 10% or more fat content	30 MINUTES	150°F
EGG NOG, FROZEN DESSERT MIXES	30 MINUTES	155°F

VAT PASTEURIZATION – CRITICAL CONTROL POINTS

1. Time and temperature requirements
2. No temperature abuse
3. Covers in place during operation
4. Vat construction within compliance
5. Agitation during operation
6. No ingredients added after pasteurization
7. Product protected after pasteurization

CONSTRUCTION STANDARDS

A. VALVES

1. Valves must be constructed of solid stainless steel and designed to prevent the accumulation of unpasteurized milk in the passages when the valve is closed.
2. Outlet valves must be leak detector -type, which are designed to prevent leakage of raw milk past the valve body.

3. Outlet valves must be fitted with stops that provide the operator with a physical indication of complete valve closing during the entire filling, heating and pasteurization holding period operation.
4. Outlet valves must be of the close-coupled design to prevent the accumulation of unpasteurized milk in the valve when in the closed position.
5. Vats must be fitted with a means of continuous mechanical agitation.
6. The raw milk fill line must be separated from the vat during the holding time phase.
7. Vertically mounted outlet valves must have a leak detector groove arrangement that will allow drainage of product past the plug while in the closed position.

B. COVERS

1. All openings must provided with covers constructed to prevent entrance of surface contamination or foreign material.
2. Openings in the tank or cover must be equipped with raised edges to prevent surface drainage into the milk.
3. Vat covers and any opening into the tank interior must have overlapping or "shoebox box" type edges.
4. All pipes, thermometer and agitator shafts that extend down into the vat must do so only through condensation diverting aprons unless a watertight joint is used.

C. AGITATORS

1. Vats must be equipped with mechanical means of assuring that every particle of milk is heated. Product temperature variances must not exceed 1 F between any two points at any time during the holding period.
2. Agitators must meet construction criteria for milk contact surfaces and designed to easily cleanable.
3. Agitator shafts must be fitted with effective drip deflection shields.
4. Agitator shaft openings shall have a minimum diameter of one inch to allow for the removal and cleaning of the agitator shaft.
5. The annular space around the shaft shall be fitted with an umbrella or drip shield to protect against the entrance of contaminants.

D. INDICATING AND RECORDING THERMOMETERS

VAT PASTEURIZER THERMOMETER CRITERIA

THERM TYPE	SPAN	GRADS	ACCURACY	CHART SPEED
INDICATING	25°F	1°F	0.5°F	N/A
RECORDING	140-160°F	1°F	0.5°F	1 REV/ 12 HRS.
AIR SPACE	25°F	1°F	1°F	

PASTEURIZATION GREATER THAN 160°F

THERM TYPE	SPAN	GRADS	ACCURACY	CHART SPEED
INDICATING	25°F	1°F	0.5°F	N/A
RECORDING	150-170°F	2°F	0.5°F	1 REV/ 24HRS
AIR SPACE	25°F	2°F	1°F	

1. Indicating thermometers shall be mercury actuated, direct reading type, scaled to a minimum of 0.625 of an inch, with a span of not less than 25 F. The span must include the pasteurization temperature (plus or minus 5° F) and be graduated in 1° F and accurate to within 0.5°F.
2. The sensing bulb of the indicating (official) thermometer must be designed to extend fully into the product during pasteurization.
3. An approved air space must be provided that is graduated in 2-degree maximum increments and accurate to pus or minus 1°F. The bottom of the bulb chamber must not be less than 2 inches or more than 3.5 inches below the underside of the top enclosure or cover. The bottom of the bulb must never be less than 1 inch from the top surface of the product during pasteurization.
4. The vat must be equipped with a recording thermometer graduated in 1°F increments between 140° and 155°F. The chart must be graduated in time scale divisions of not more than 10 minutes for a maximum record of twelve hours and designed for the recorder used.
5. On vats used solely for pasteurization at temperatures above 160°F, the recording chart may be graduated in 2°F within a 150° to 170°F range. The chart for this type of vat may be graduated in 15 minutes for a maximum of 24 hours.

Required recorder chart information

a) Name of plant
b) Date
c) Signature or initials of operator
d) ID of recorder if more than one vat used
e) Record of holding time including empty and fill times
f) Reading of air space thermometer at beginning of holding time
g) Reading of indicating thermometer at an indicated point during the holding period
h) Amount and name of product by each batch
i) Record any unusual occurrences

Charts shall be retained 3 months.

E. AIR SPACE HEATER

1. Air space heaters may be necessary to maintain minimum air space temperatures, at least 5°F higher than minimum pasteurization temperature.
2. These devices must be of sanitary design, meet all 3-A Sanitary requirements and. be easily demountable for cleaning.
3. The steam system must be properly trapped and filtered to prevent the contamination of the product. Steam used must be of culinary quality.
4. The air space bulb must at least I inch above the product.
5. This requirement may be waived when 30-minute pasteurization of milk products is done at higher temperatures and the air space thermometer indicates that the air temperature is at least 5°F above pasteurization temperature throughout the holding period.

BATCH PASTEURIZER OPERATING STANDARDS

1. All components must be added to the batch prior to beginning pasteurization. This includes liquid sugar and sweeteners, water, milk powders and all other flavorings, stabilizers and vitamins.

   Certain flavoring ingredients may be added after pasteurization. These include ingredients that have a water activity of 0.85 or less, high acid content, dry sugars, fruits and roasted nuts, safe and suitable bacterial culture organisms and flavorings containing a high alcohol content. Fruits and vegetables may be added to cultured products having a pH of 4.7 or less.
   Such ingredient addition shall be done in a sanitary manner and the ingredients must be of safe and wholesome quality.

2. Pasteurization must be performed in properly designed and operated equipment that ensures that every particle of product will be held continuously for the minimum time and temperature. The product should be heated to pasteurization temperature in as short a time as practicable and in no case should this time exceed 4 hours. Following pasteurization the product must *be cooled to 45°F or less* as soon as possible. The only exception is for cultured product processing.

3. If, for any reason the lid or any cover is lifted or mechanical failure of any kind occurs after beginning pasteurization, the timing process must be restarted and notes to that effect must be made on the recording chart by the operator.

4. The *official thermometer is the indicating thermometer* and the recording thermometer functions only to provide a record of the pasteurization cycle. The operator must verify the accuracy of the recording thermometer, for each batch, with the indicating thermometer.
   No batch of milk shall be pasteurized unless the sensors of both thermometers are covered.

5. The air space thermometer reading must also be recorded on the recording chart during pasteurization. To assure the minimum air space temperatures are being maintained, the air space indicating thermometer shall be *read at the beginning and at the end of the holding period.* The air space temperature must *never be less than 5°F above the minimum legal pasteurization temperature* required for the product in the vat.

6. Recording charts must be used only for the length of time it has been designed for. *Overlapping information on circular charts is never acceptable.* Required information on the chart must be legible and meet all the requirements of the PMO.

7. The outlet valve is *designed to detect and expel any leakage* past the valve seat and is *close coupled* to prevent cold pockets of product from accumulating in the valve or piping.

   At no time during the pasteurization cycle or following may the outlet piping be directly attached to any line or vessel containing raw milk or any other contaminating substance.

ASSURANCE OF HOLDING PERIODS

1. Vats must be operated so that every particle of milk is held for *at least 30 minutes at or above the minimum required temperature* for the specific product processed.
2. When the milk product is heated to pasteurization temperature in the vat and is partially cooled in the vat before opening the outlet valve, the recorder chart must show *at least 30 minutes at or above the minimum pasteurization temperature.*

3. When the milk product is preheated to pasteurization temperature prior to entering the vat, the recorder chart must show a *holding time of 30 minutes plus the filling time of the vat from the level of the recorder bulb sensor to the maximum level* of normal operation.

4. When cooling is begun after the outlet valve is opened or is done entirely outside the vat, the chart must show a *holding time of 30 minutes plus the time necessary to empty the vat to the level of the recording thermometer bulb.*

5. The operator must *indicate filling and/or emptying times on the chart* by inscribing the start and end of the official 30 minute holding time.

6. Vat pasteurization *charts must clearly show the four identifying holes* (marks) which verify the chart has not been rotated or manually turned to give a false time line accuracy.

GENERAL CLEANING AND SANITIZING OF PASTEURIZING EQUIPMENT

Milkstone is a hard deposit or encrustation that is a combination of milk solids and washing powder that may build on milk equipment. The minerals contained in hard water also contribute to its formation. It is a chemical reaction that is accelerated by heat causing more deposits on heating surfaces than elsewhere. Aside from these contributing factors the primary cause of milkstone is improper cleaning.

Phosphatase Test – Is a test used to determine the effectiveness of the pasteurization process. Phosphatase is an enzyme normally present in raw milk that is easily destroyed or inactivated by pasteurization. When milk that is contaminated with raw product or not held at the proper temperature long enough active phosphatase will be present in larger amounts than found in properly pasteurized milk.

A positive coliform test is indicative of post-pasteurization contamination. Coliform organisms are easily killed by pasteurization. The following steps can prevent post-pasteurization contamination: Clean and sanitized equipment and containers. No hand capping or bottling or other handling of milk equipment. Prevent exposure to potential contaminate such as flies, dust, dirt, drip or splash.

Milk spoilage, bacterial breakdown of milk proteins:

Sour - milk held at temperature of 65-75 will allow souring type organisms grow.

Bitter - milk that is held at temperatures below 50 would more often become bitter for the same reason.

Ropy - thermoduric spore-formers that may survive the heat process, traced to stagnant water on the farm.

Sweet curdle - fermentation and coagulation of milk with no acid production by organisms surviving the heat process that may destroy acid producing organisms.

Thermoduric -organisms that survive pasteurization temperatures.
Thermophilic -organisms that grow freely in milk at temperatures above 140°F

Sanitation - mere cleaning of equipment does not remove or destroy all disease causing organisms that may have been present. Even very small numbers remaining may grow to dangerous proportions since many grow rapidly in milk. All milk equipment must be treated with a sanitizing agent just prior to usage. Cleaning must be thorough before sanitation can be effective since the presence of organic material such as, milkstone and soil can inactivate the sanitizer.

The number and type of bacteria present in raw milk, faulty equipment or soiled, unsanitized contact surfaces of equipment may influence efficiency of pasteurization.

SANITIZING METHODS

1. **Steam**
   This method can be used successfully only in confined areas. All parts of equipment must be exposed to a temperature of at least 170°F for at least 5 minutes.
2. **Hot Water**
   This method is difficult to use on assembled equipment, particularly where hot water flows over a surface cooler. The temperature and exposure time is the same as steam.
3. **Chemical**

An approved chemical sanitizing solution, such as chlorine or quaternary ammonia is circulated or pumped through assembled equipment. Equipment may also be dipped in a solution to expose all the surfaces to the sanitizer. The strength of a chlorine solution should be 100 parts per million (ppm) for 30 seconds of contact time or 50 ppm for 2 minutes contact time.