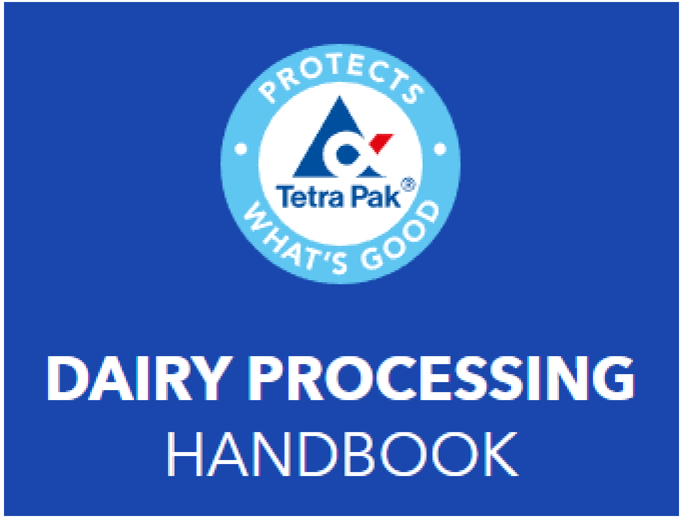
Βιομηχανικές Χημικές Τεχνολογίες

Παρουσίαση εργοστασίου ΝΟΥΝΟΥ

Δ. Κουζιώκας – Performance Excellence Manager


Solar panels
R & P material Warehouse
Utilities
Waste water treatment
60.000 m2
Parking area
Main gate
Processing area
Filling & Packaging area
Cool Warehouse



https://dairyprocessinghandbook.tetrapak.com/

COMPOSITION OF COWS' MILK

The quantities of the various main constituents of milk can vary considerably between cows of different breeds and between individual cows of the same breed. Therefore only limit values can be stated for the variations. The numbers in Table 2.3 are simply examples.

Besides total solids, the term solids-non-fat (SNF) is used in discussing the composition of milk. SNF is the total solids content less the fat content. The mean SNF content according to Table 2:3 is consequently 13.0 - 3.9 = 9.1 %. The pH of normal milk generally lies between 6.6 - 6.8 with average of 6.7 as the most common value. This value is true for pH measurement of milk of approximately 25 °C

Table 2.3
Quantitative composition of milk

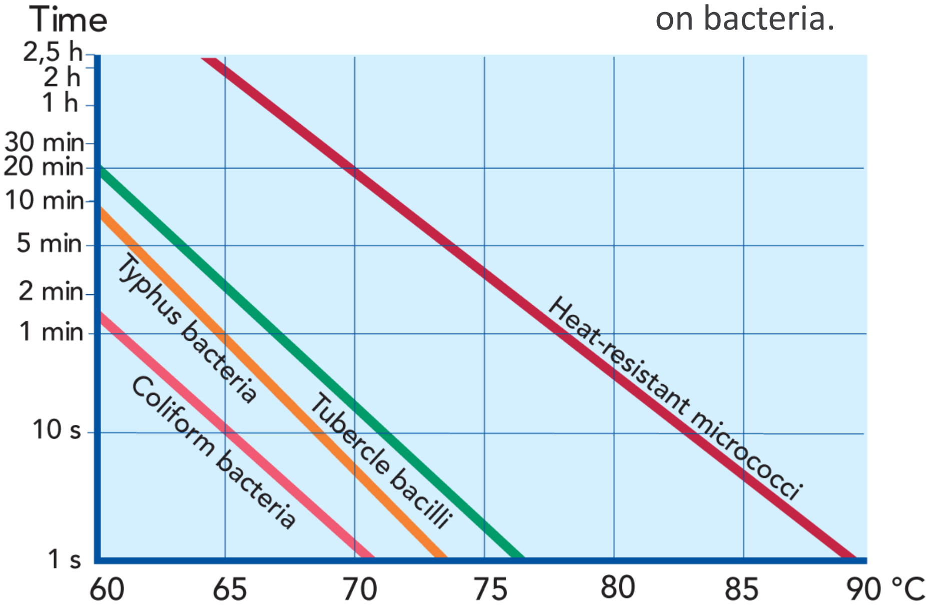
Main constituent	Limits of variation	Mean value
Water	85.5 - 89.5	87.5
Total solids	10.5 - 14.5	13.0
Fat	2.5 - 6.0	3.9
Proteins	2.9 - 5.0	3.4
Lactose	3.6 - 5.5	4.8
Minerals	0.6 - 0.9	0.8

TIME/TEMPERATURE COMBINATION

The combination of temperature and holding time is very important, as it determines the intensity of the heat treatment. Figure 6.1.1 shows lethal effect curves for Coliform bacteria, Typhus bacteria and Tubercle bacilli. According to these curves, coliform bacteria are killed if the milk is heated to 70 °C and held at that temperature for about one second. At a temperature of 65 °C it takes a holding time of 10 seconds to kill coliform bacteria. These two combinations, 70 °C/1 s and 65 °C/10 s, consequently have the same lethal effect.

Tubercle bacilli are more resistant to heat treatment than coliform bacteria. A holding time of 20 seconds at 70 °C or about 2 minutes at 65 °C is required to ensure that they are all destroyed. There might also be heat-resistant micrococci in milk, but as a rule, they are completely harmless.

Fig. 6.1.1
Lethal effect on bacteria.



LIMITING FACTORS FOR HEAT TREATMENT

Intense heat treatment of milk is desirable from the microbiological point of view. But such treatment also involves a risk of adverse effects on the appearance, taste and nutritional value of the milk. Proteins in milk are denatured at high temperatures. This means that the cheesemaking properties of milk are drastically impaired by intense heat treatment. Intense heating produces changes in taste; first cooked flavour and then burnt flavour. The choice of time/temperature combination is therefore a matter of optimization, in which both microbiological effects and quality aspects must be taken into account.
Since heat treatment has become the most important part of milk processing, and knowledge of its influence on milk better understood, various categories of heat treatment have been initiated, as shown in Table 6.1.1.

Table 6.1.1
The main categories of heat treatment in the dairy industry

Process	Temperature, °C	Time
Thermization		
LTLT pasteurization of milk	63	30 min
HTST pasteurization of milk	72 - 75	15 - 20 s
HTST pasteurization of cream, etc.	> 80	1 - 5 s
Ultra pasteurization	125 - 138	2 - 4 s
UHT (flow sterilization) normally	135 - 140	a few seconds
Sterilization in container	115 - 120	20 - 30 min

HOLDING

Correct heat treatment requires that the milk is held for a specified time at pasteurization temperature. This is done in an external holding cell.
A holding cell usually consists of a pipe arranged in a spiral or zig-zag pattern and is often covered by a metal shroud to prevent people from being burned if they touch it. The shroud will also reduce the heat losses to the surrounding air. The length of the pipe and flow rate are calculated so that the time in the holding cell is equal to the required holding time.
Accurate control of the flow rate is essential because the holding equipment is dimensioned for a specified holding time at a given flow rate. The holding time changes in inverse proportion to the flow rate in the holding cell.
Holding sections built into the plate heat exchanger were used earlier, but external holding cells are used almost exclusively nowadays.

Fig. 6.1.12

Shrouded, spiral holdingtube for long holding time.

CALCULATION OF HOLDING TIME

The appropriate tube length for the required holding time can be calculated when the hourly capacity and the inner diameter of the holding tube are known. As the velocity profile in the holding tube is not uniform, some milk molecules will move faster than the average. To ensure that even the fastest molecule is sufficiently pasteurized, an efficiency factor must be used. This factor depends on the design of the holding tube, but is often in the range of 0.8 - 0.9 if the flow is turbulent. For more viscous fluids, the flow might be laminar and then the efficiency factor is lower.

Data required for calculation:
Q = flow rate at pasteurization, l/h
HT = holding time in seconds
L = length of holding tube in dm, corresponding to Q and HT
D = inner diameter of holding tube in dm, to be known or adapted to the other pipework
V = volume of milk in l or dm3 corresponding to Q and HT
η = efficiency factor

Example: A holding time (HT) of 15 sec is required in a pasteurization plant with a capacity (Q) of 10 000 l/h. The inner diameter (D) of the pipe to be used is 48.5 mm = 0.485 dm. Calculate the length (L) of the holding tube, with the efficiency factor of 0.85.

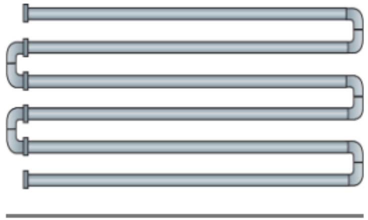


Fig. 6.1.13

Zig-zag holding tube.

Formula

1. $$V = \frac{Q \times HT}{3\,600 \times \eta} \text{ dm}^3$$

2. $$L = \frac{V \times 4}{\pi \times D^2} \text{ dm}$$

The length of the holding tube should be about 26.5 m.

quality

THE HEAT EXCHANGER

A heat exchanger is used to transfer heat by the indirect method.
Several different types will be described later. It is possible to simplify heat transfer by representing the heat exchanger symbolically as two channels separated by a tubular partition.
Hot water (red) flows through one channel and milk (blue) through the other. Heat is transferred through the partition. The hot water enters the channel at a temperature of t_{i2} and is cooled to a temperature of t_{o2} at the outlet. Milk enters the heat exchanger at a temperature of ti1 and is heated by the hot water to an exit temperature of t_{o1}. The temperature changes during passage through the heat exchanger are shown by the curves in Figure 6.1.7.

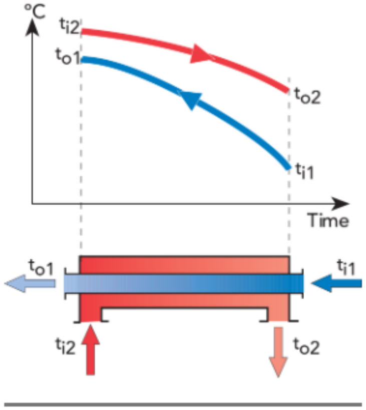


Fig. 6.1.7

Temperature profiles for heat transfer in a heat exchanger.

DIMENSIONING DATA FOR A HEAT EXCHANGER

The necessary size and configuration of a heat exchanger depend on many factors. The calculation is very intricate and is nowadays normally done with the aid of a computer.

The factors that must be considered are:

- Product flow rate
- Physical properties of the liquids
- Temperature programme
- Permitted pressure drops
- Heat exchanger design
- Cleanability requirements
- Required running times

$$A = \frac{V \times \rho \times c_p \times \Delta t}{\Delta t_m \times k}$$

A = Required heat transfer area
V = Product flow rate
ρ = Density of the product
c_p = Specific heat of the product
Δ = Temperature change of the product
Δt_m = Logarithmic mean temperature difference (LMTD)
k = Overall heat transfer coefficient

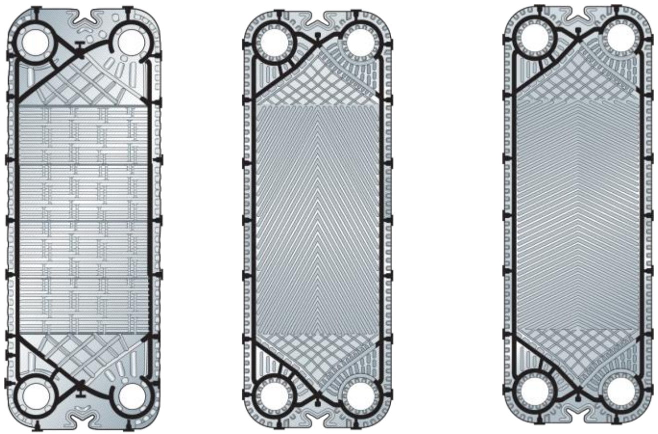
Flow rate, l/h	=	20,000
Density, kg/m^3	=	1 020
Specific heat, kJ/kg, K	=	3.95
Temperature change, °C	=	30
Temperature difference, °C	=	20.8
Heat transfer coefficient, W /m^2, K	=	5,000

The necessary heat transfer surface can be calculated as:

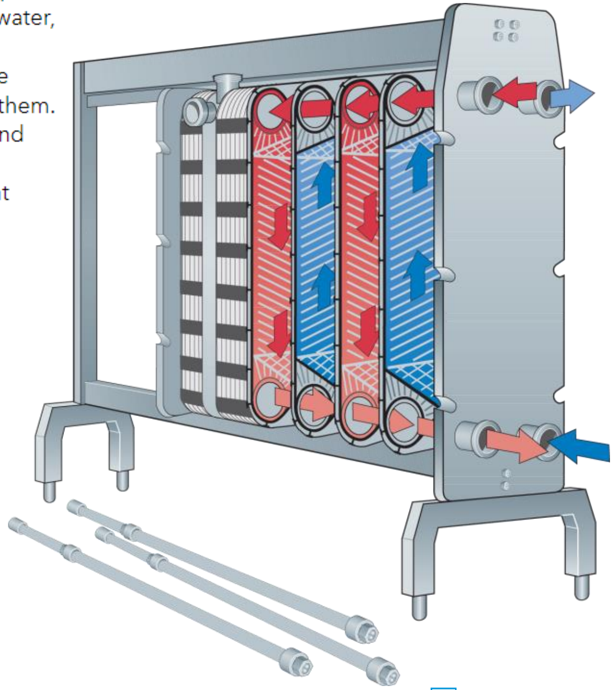
$$A = \frac{20\,000 \times 1\,020 \times 3{,}95 \times 30}{3\,600 \times 20{,}8 \times 5\,000} = 6{,}5 \text{ m}^2$$

PLATE HEAT EXCHANGERS

Most heat treatment of dairy products is carried out in plate heat exchangers. The plate heat exchanger (often abbreviated PHE) consists of a pack of stainless steel plates clamped in a frame.
The frame may contain several separate plate packs – sections – in which different stages of treatment, such as pre-heating, final heating and cooling take place. The heating medium is hot water, and the cooling medium cold water, ice-water or propyl glycol, depending on the required product outlet temperature.
The plates are corrugated in a pattern designed for optimum heat transfer. The plate pack is compressed in the frame. Supporting points on the corrugations hold the plates apart, so that thin channels are formed between them. The liquids enter and leave the channels through holes in the corners of the plates. Varying patterns of open and blind holes route the liquids from one channel to the next.
Gaskets around the edges of the plates and around the holes form the boundaries of the channels and prevent external leakage and internal mixing.



A B C



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TUBULAR HEAT EXCHANGERS

Tubular heat exchangers (THE) are in some cases used for pasteurization and UHT treatment of dairy products. The tubular heat exchanger (Figure 6.1.18), unlike plate heat exchangers, has no contact points in the product channel and can thus handle products with particles up to a certain size. The maximum particle size depends on the diameter of the tube. The tubular heat exchanger can also run longer between cleanings than the plate heat exchanger in UHT treatment.

Compared to a plate heat exchanger, a higher flow velocity is needed to create efficient heat transfer in a tubular heat exchanger.

Tubular heat exchangers are available in two fundamentally different types; multi/mono tube and concentric tube.

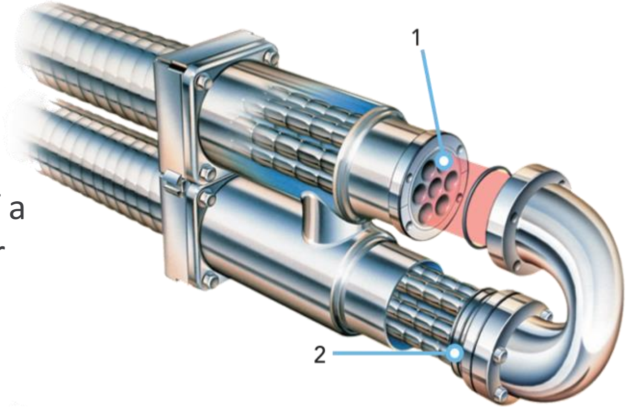
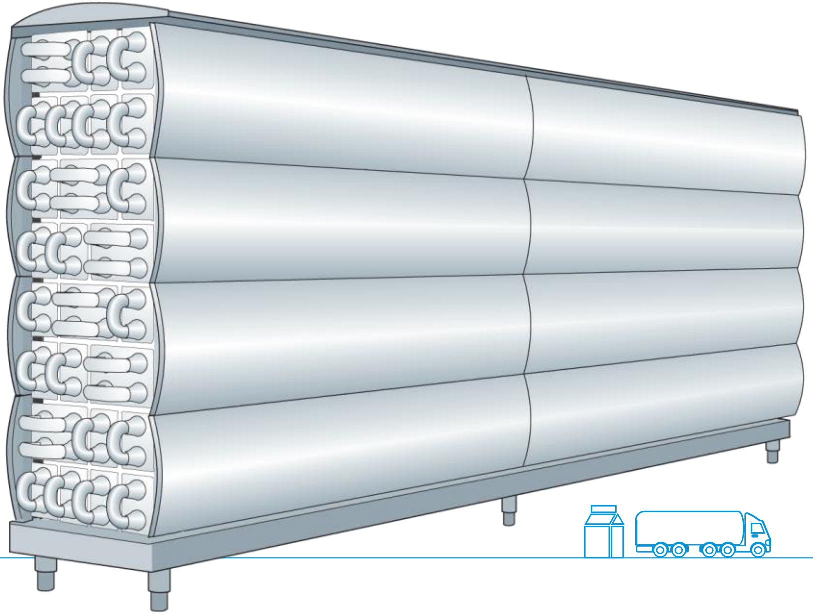


Fig. 6.1.19 End of a multitube tubular heat exchanger.
1.Product tubes surrounded by cooling medium
2.Double O-ring seal



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PROCESS DESIGN CONSIDERATIONS

There are many aspects to be considered when a process line is designed. They can vary and be extremely complex, which places considerable demands on those responsible for the preliminary planning. Project engineering always involves a compromise between different requirements such as:

- Product-related – concerning the raw material, its treatment and the quality of the end product
- Process-related – concerning plant capacity, selection of components and their compatibility, degree of process control, availability of heating and cooling media, cleaning of processing equipment, etc.
- Economic – that the total cost of production to meet the stipulated quality standards is as low as possible
- Legal – legislation stipulating process parameters as well as choice of components and system solutions

The process illustrated in Figure 7.1 deals with heat treatment – pasteurization – of whole milk, e.g. market milk for sale to consumers.

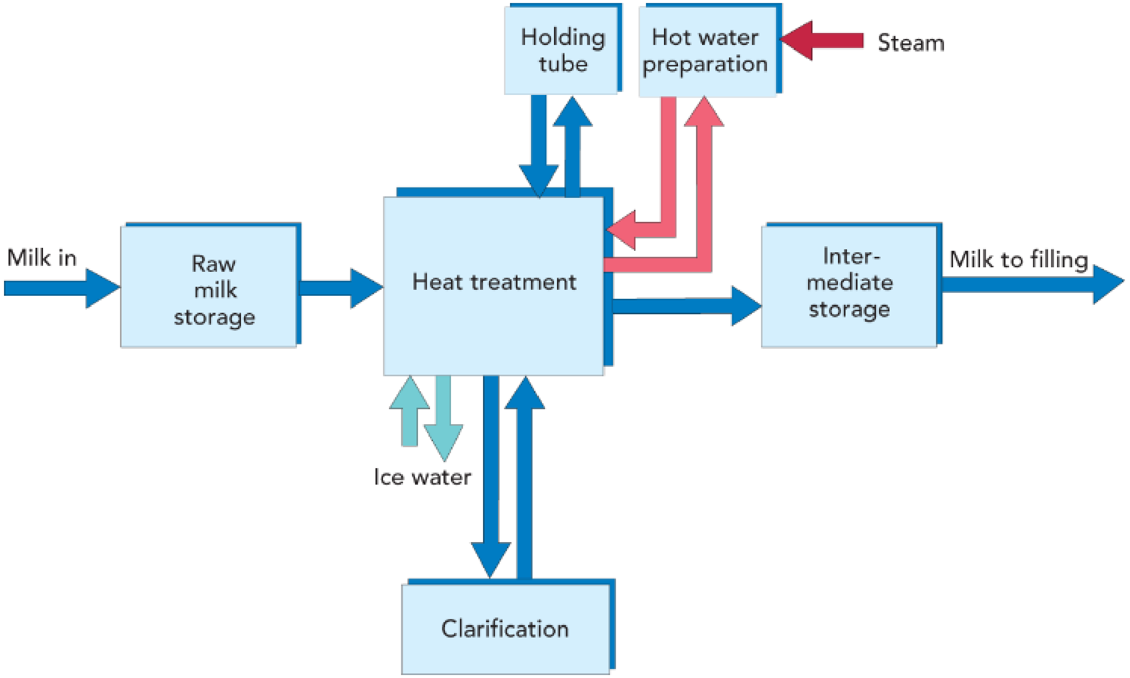

Fig. 7.1

Generalized block chart of the milk pasteurization process.

EQUIPMENT REQUIRED

The following equipment is required for a remote controlled process:

- Silo tanks for storing the raw milk.
- Plate heat exchanger for heating and cooling, a holding tube and a hot water unit.
- Centrifugal clarifier (as only whole milk is to be treated, a centrifugal separator is not needed in this example).
- Intermediate storage tank for temporary storage of processed milk.
- Pipes and fittings for connecting main components and pneumatically operated valves for controlling and distributing the product flow and cleaning fluids.
- Pumps for transportation of milk through the entire milk treatment plant.
- Control equipment for control of capacity, pasteurization temperature and valve positions.
- Various service systems:
  - Water supply
  - Steam production
  - Refrigeration for coolant
  - Compressed air for pneumatically operated units
  - Electric power
  - Drain and waste water.

DESIGN OF PIPING SYSTEM

In the example in this chapter, 20 000 litres of milk per hour have to pass through pipes, fittings and processing equipment during production. The product velocity through the pipes is determined by the size of the passage, i.e. the inside diameter of the pipe. The larger the diameter, the lower the product velocity.
For a flow rate of 20 000 litres per hour, the product velocity in a 76 mm (3") pipe will be 1.25 m/s. The velocity will be 2.75 m/s if a 51 mm (2") pipe is selected.
Higher velocities result in greater friction in the liquid itself and between the liquid and the pipe wall. Consequently, there is more mechanical treatment of the product. For each product, there is an upper velocity limit that should not be exceeded if quality demands are to be met. For milk, this velocity is about 3 m/s.

It might then seem reasonable to choose a larger pipe size than the minimum required by velocity considerations. But larger pipes mean larger components and greatly increased costs. The diameter nearest the limit is therefore chosen. In our case, this is 2.5" (63.5 mm), which corresponds to a velocity of 1.75 m/s, as shown in Figure 7.7.

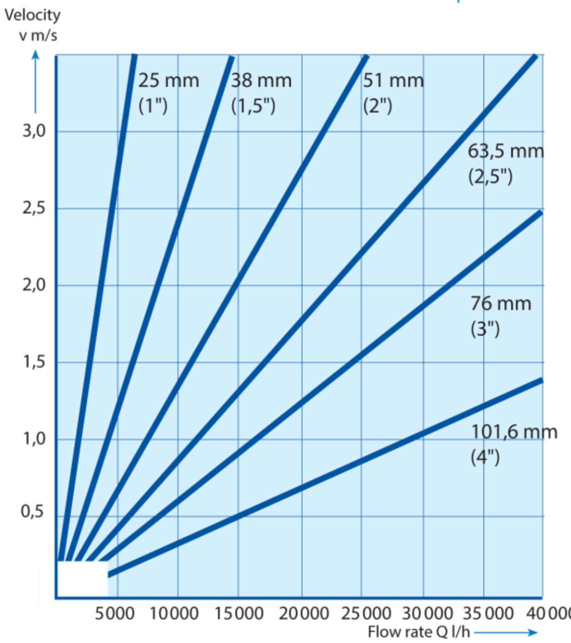

Fig. 7.7 Product velocity and flow rate graph.

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HEAT EXCHANGER

The main aim of pasteurizing milk is to destroy pathogenic microorganisms. To achieve this, the milk is normally heated to not less than 72 °C for at least 15 seconds and then cooled rapidly. These parameters are stipulated by law in many countries. The plate heat exchanger is most common for market milk pasteurization purposes. Tubular heat exchangers can be used when long running times are essential. Scraped-surface heat exchangers are used for viscous products.
When the relevant parameters are known, the size (dimensioning) of the heat exchanger can be calculated. In the present example, the parameters are:

- Plant capacity, l/h 20 000
- Temperature programme, °C 4 - 72 - 4
- Regenerative effect, % 90 - 94
- Temperature of the heating medium, °C 74 - 75
- Temperature of the coolant, °C +2

The demand for service media (steam, water and ice water) is also calculated, as this substantially influences the choice of valves for steam regulation and ice water feed.
In plate heat exchangers, the connection plates between the sections are provided with inlets and outlets for product and service media. The inlet and outlet connections can be oriented either vertically or horizontally. The ends of the plate heat exchanger (frame and pressure plate) can likewise be fitted with inlets and outlets.
When long running time is essential the tubular heat exchanger is an alternative to the plate heat exchanger.
Dimensioning data for the heat exchanger are given in Chapter 6.1.

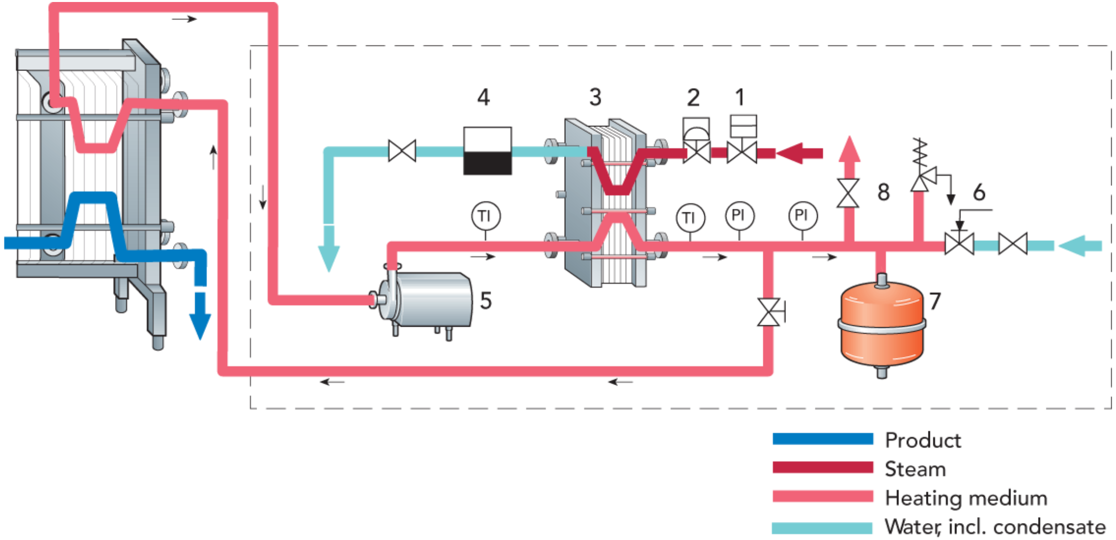


Fig. 7.2 Principle of the hot water system connected to a pasteurizer.

1.Steam shut-off valve
2.Steam regulating valve
3.Heat exchanger
4.Steam trap
5.Centrifugal pump
6.Water regulating valve
7.Expansion vessel
8.Safety and ventilation valves

- **TI** Temperature indicator
- **PI** Pressure indicator

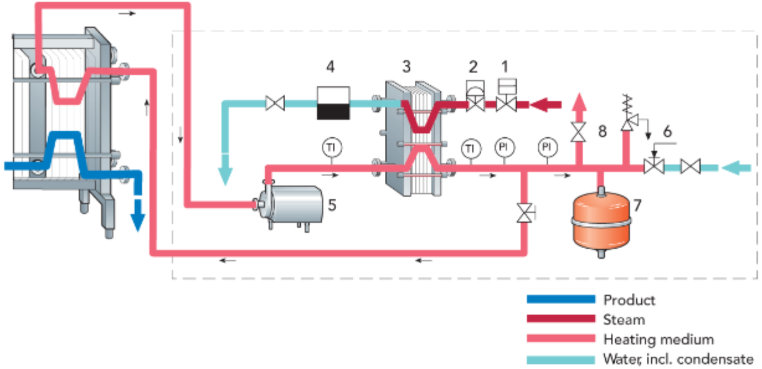
HOT WATER HEATING SYSTEMS

Hot water or saturated steam at atmospheric pressure can be used as the heating medium in pasteurizers. Hot steam, however, is not used because of the high differential temperature. The most commonly used heating medium is therefore hot water, typically about 2 – 3 °C higher than the required temperature of the product.
Steam is delivered from the steam boiler at a pressure of 600 – 700 kPa (6 – 7 bar). This steam is used to heat water, which in turn heats the product to pasteurization temperature.
The water heater in Figure 7.2 is a closed system consisting of a specially designed, compact and simple cassette-type plate heat exchanger (3) equipped with a steam regulating valve (2) and a steam trap (4).
The service water is circulated by the centrifugal pump (5) via the heater (3) and the heating section of the pasteurizer.
The function of the expansion vessel (7) is to compensate for the increase in the volume of the water that takes place when it is heated. The system also includes pressure and temperature indicators as well as safety and ventilation valves (8).

Fig. 7.2

Principle of the hot water system connected to a pasteurizer.

1. Steam shut-off valve
2. Steam regulating valve
3. Heat exchanger
4. Steam trap
5. Centrifugal pump
6. Water regulating valve
7. Expansion vessel
8. Safety and ventilation valves



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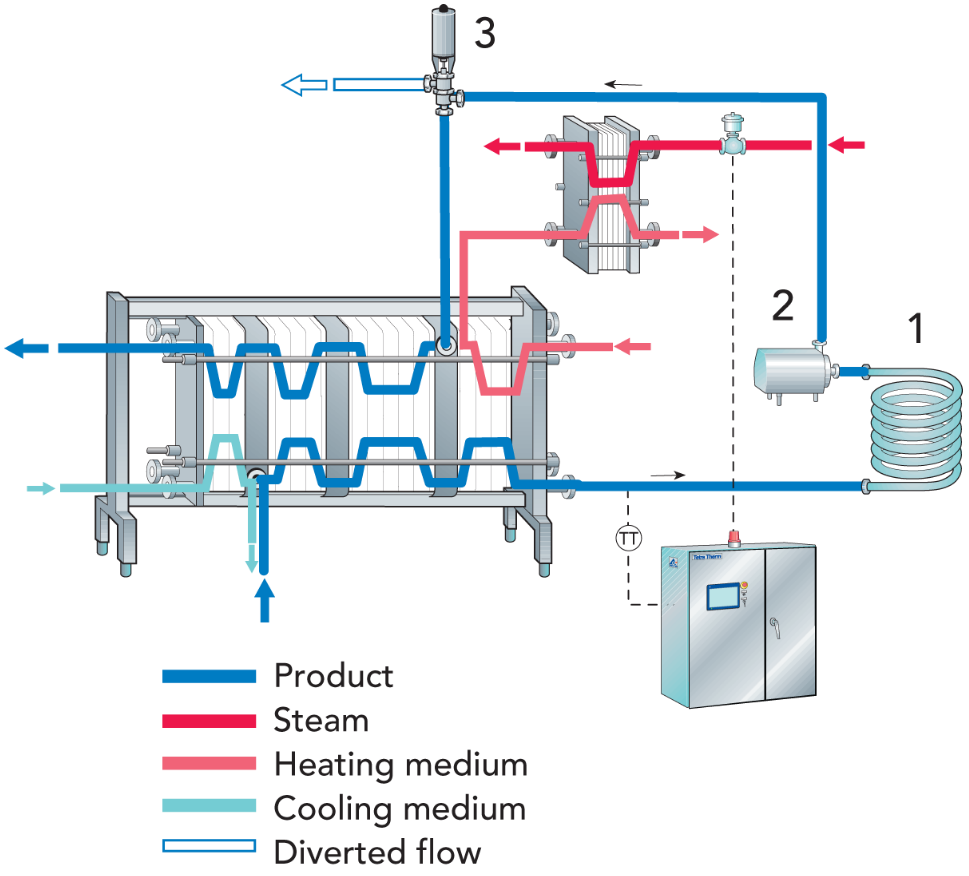


Fig. 7.3 Automatic temperature control loop.

•**TT** Temperature transmitter

1.Holding tube

2.Booster pump

3.Diversion valve

TEMPERATURE CONTROL

A constant pasteurization temperature is maintained by a temperature controller acting on the steam regulating valve (2) in Figure 7.2. Any tendency for the product temperature to drop is immediately detected by a sensor in the product line before the holding tube. The sensor then changes the signal to the controller, which opens the steam-regulating valve to supply more steam to the water. This increases the temperature of the circulating water and stops the temperature drop in the product.

HOLDING

The length and size of the externally located holding tube are calculated according to the known holding time and hourly capacity of the plant and the pipe dimension, typically the same as for the pipes feeding the pasteurization plant. Dimensioning data for the holding tube are given in Chapter 6.1. Typically, the holding tube is covered by a stainless steel hood to prevent people from being burnt when touching it and from radiation as well.

PASTEURIZATION CONTROL

It is essential that the milk has been properly pasteurized before it leaves the plate heat exchanger. If the temperature drops below 72 °C, the unpasteurized milk must be kept apart from the already pasteurized product. To accomplish this, a temperature transmitter and flow diversion valve are fitted in the pipe downstream of the holding tube. Valve (3) in Figure 7.3 returns unpasteurized milk to the balance tank if the temperature transmitter detects that the milk passing it has not been sufficiently heated.

BOOSTER PUMP TO PREVENT REINFECTION

Care must be taken to avoid any risk of contamination of the pasteurized product by unpasteurized product or cooling medium. If any leakage should occur in the pasteurizer, it must be in the direction from pasteurized product to unpasteurized product or cooling medium.

This means that the pasteurized product must be under higher pressure than the medium on the other side of the heat exchanger plates. In Figure 7.3, a booster pump (2) is therefore installed in the product line, either after the holding section or before the heating section. The latter position minimizes the operating temperature of the pump and prolongs its life. The pump increases the pressure and maintains a positive differential pressure on the pasteurized product side, throughout the regenerative and cooling sections of the pasteurizer.
Installation of a booster pump is specified in the legal requirements for pasteurization in some countries.

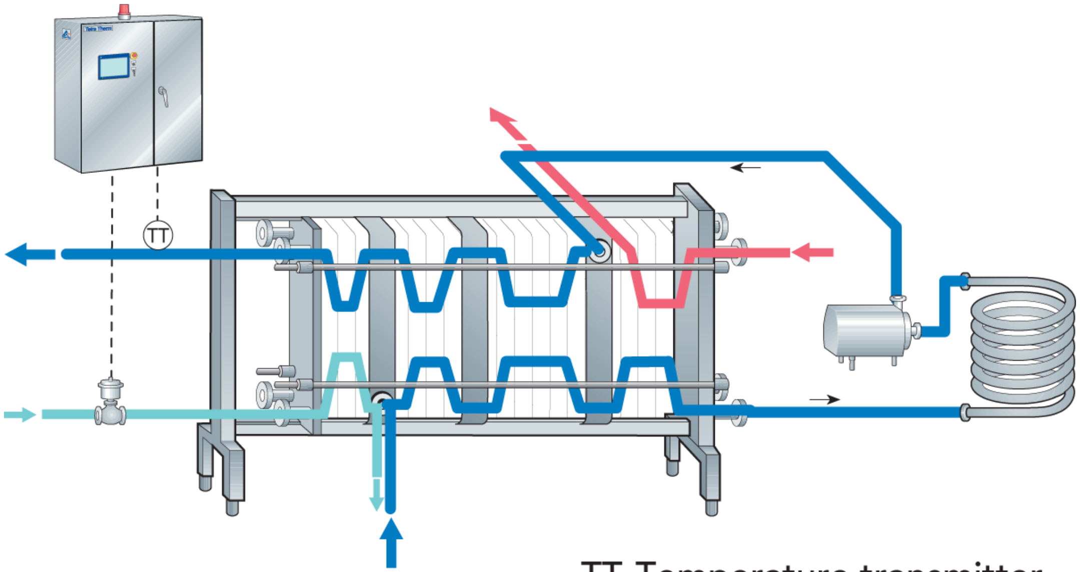


Fig. 7.4 Cooling system for pasteurizer.

PASTEURIZER COOLING SYSTEM

As already noted, the product is cooled mainly by regenerative heat exchange. The maximum practical efficiency of regeneration is about
94 - 95%, which means that the lowest temperature obtained by regenerative cooling is about 8 - 9 °C. Chilling the milk to 4 °C for storage therefore requires a cooling medium with a temperature of about 2 °C. Ice water can only be used if the final temperature is above 3 - 4 °C. For lower temperatures, it is necessary to use brine or alcohol solutions, to avoid the risk of freezing cooling media.

The coolant is circulated from the dairy refrigeration plant to the point of use, as shown in Figure 7.4. The flow of coolant to the pasteurizer cooling section is controlled to maintain a constant product outlet temperature. This is done by a regulating circuit consisting of a temperature transmitter in the outgoing product line, a temperature controller in the control panel and a regulating valve in the coolant supply line. The position of the regulating valve is altered by the controller in response to signals from the transmitter.

The signal from the transmitter is directly proportional to the temperature of the product leaving the pasteurizer. This signal is often connected to a temperature recorder in the control panel and recorded on a graph, together with the pasteurization temperature and the position of the flow diversion valve.

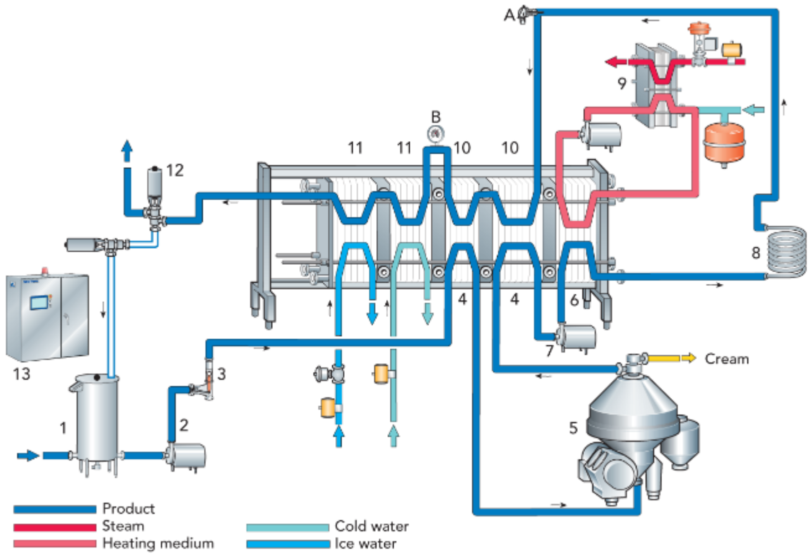
THE COMPLETE PASTEURIZER

A modern milk pasteurizer, complete with equipment for operation, supervision and control of the process, is made using matching components, forming a sophisticated process unit, as in Figure 7.5.

Fig. 7.5

The complete pasteurizer plant consists of:

1. Balance tank
2. Feed pump
3. Flow controller
4. Regenerative preheating sections
5. Centrifugal clarifier
6. Heating section
7. Booster pump
8. Holding tube
9. Hot water heating system
10. Regenerative cooling sections
11. Cooling sections
12. Flow diversion valve
13. Control panel



BALANCE TANK

The float-controlled inlet valve regulates the flow of milk and maintains a constant level in the balance tank. If the supply of milk is interrupted, the level will begin to drop.
As the pasteurizer must be full at all times during operation to prevent the product from burning on to the plates, the balance tank is often fitted with a low-level electrode which transmits a signal as soon as the level reaches the minimum point. This signal actuates the flow diversion valve, which returns the product to the balance tank.
The milk is replaced by water and the pasteurizer shuts down when circulation has continued for a pre-determined time.

FEED PUMP

The feed pump supplies the pasteurizer with milk from the balance tank, which provides a constant head.

FLOW CONTROLLER

The flow controller maintains the flow through the pasteurizer at the correct value. This guarantees stable temperature control and a constant length of the holding time for the required pasteurization effect. Often the flow controller is located after the first regenerative section.

REGENERATIVE PRE-HEATING

The cold untreated milk is pumped through the first section in the pasteurizer, the pre-heating section. Here, it is regeneratively heated with pasteurized milk, which is cooled at the same time.
If the milk is to be treated at a temperature between the inlet and outlet temperatures of the regenerative section, for example clarification at 55 °C, the regenerative section is divided into two sections. The first section is dimensioned so that the milk leaves at the required temperature of 55 °C. After being clarified, the milk returns to the pasteurizer, which completes the regenerative pre-heating in the second section.

The regenerative energy-saving effect in a milk pasteurizer is typically between 90 and 94 %

PASTEURIZATION

Final heating to pasteurization temperature with hot water, normally of a temperature 2 - 3 °C higher than the pasteurization temperature
(Δ_t = 2 - 3 °C), takes place in the heating section. The hot milk continues to an external tubular holding cell. After the holding cell, the temperature of the milk is checked by a sensor in the line. It transmits a continuous signal to the temperature controller in the control panel. The same signal is also transmitted to a recording instrument which records the pasteurization temperature.

FLOW DIVERSION

A sensor after the holding cell transmits a signal to the temperature monitor. As soon as this signal falls below a pre-set value, corresponding to a specified minimum temperature, the monitor switches the flow diversion valve to divert the flow. In many plants, the position of the flow diversion valve is recorded together with the pasteurization temperature.

COOLING

After the holding section, the milk is returned to the regenerative section(s) for cooling. Here the pasteurized milk transfers its heat to the cold incoming milk. The outgoing pasteurized milk is then chilled with cold water, ice water, a glycol solution or some other refrigerant, depending on the required temperature. The temperature of the chilled milk is normally recorded, together with the pasteurization temperature and the position of the flow diversion valve. The graph consequently shows three curves.

CENTRIFUGAL CLARIFIER

As the milk in the present example is not going to be separated into skim milk and cream, a centrifugal clarifier is shown in Figure 7.6.
Some dairies specify centrifugal clarification of cold (<6 °C) raw milk immediately after arrival at the dairy, especially when the milk is going to be stored until the next day. However, clarification at about 55 °C is much more efficient, because the viscosity of the milk is lower at that temperature.
The milk feeding the clarifier is therefore taken from the first regenerative heating section at 55 °C.

DIRECT UHT PLANTS

UHT processing means commercial sterility to ensure food safety and long shelf life at ambient temperature. It entails heating the product to a specific temperature for a specific length of time. The higher the temperature, the shorter the time required to destroy microorganisms. The more rapidly the product can be heated and then subsequently cooled down again, the less impact the process has on the chemical changes in the product, such as changes in taste, colour and even to some extent, nutritional value. The most effective way of achieving rapid heating is to mix high temperature steam directly with the product, followed by flash cooling in a vacuum vessel. This is called a direct system.

Flash cooling is an operation, which as well as cooling, also involves deaeration and deodorisation of the treated product. In addition, deaeration secures higher homogenization efficiency and the deaeration will also positively influence the storage stability of the processed product in terms of preventing oxidation during storage.

The rapid heating and cooling explains why direct systems deliver superior product quality and are often chosen to manufacture heat-sensitive products, such as premium quality market milk, enriched milk, cream, formulated dairy products, soy milk and soft ice mix, as well as dairy desserts and baby food.

Processing of starch-based products in a direct system has a positive effect on texture and smoothness, thus enhancing the mouthfeel.

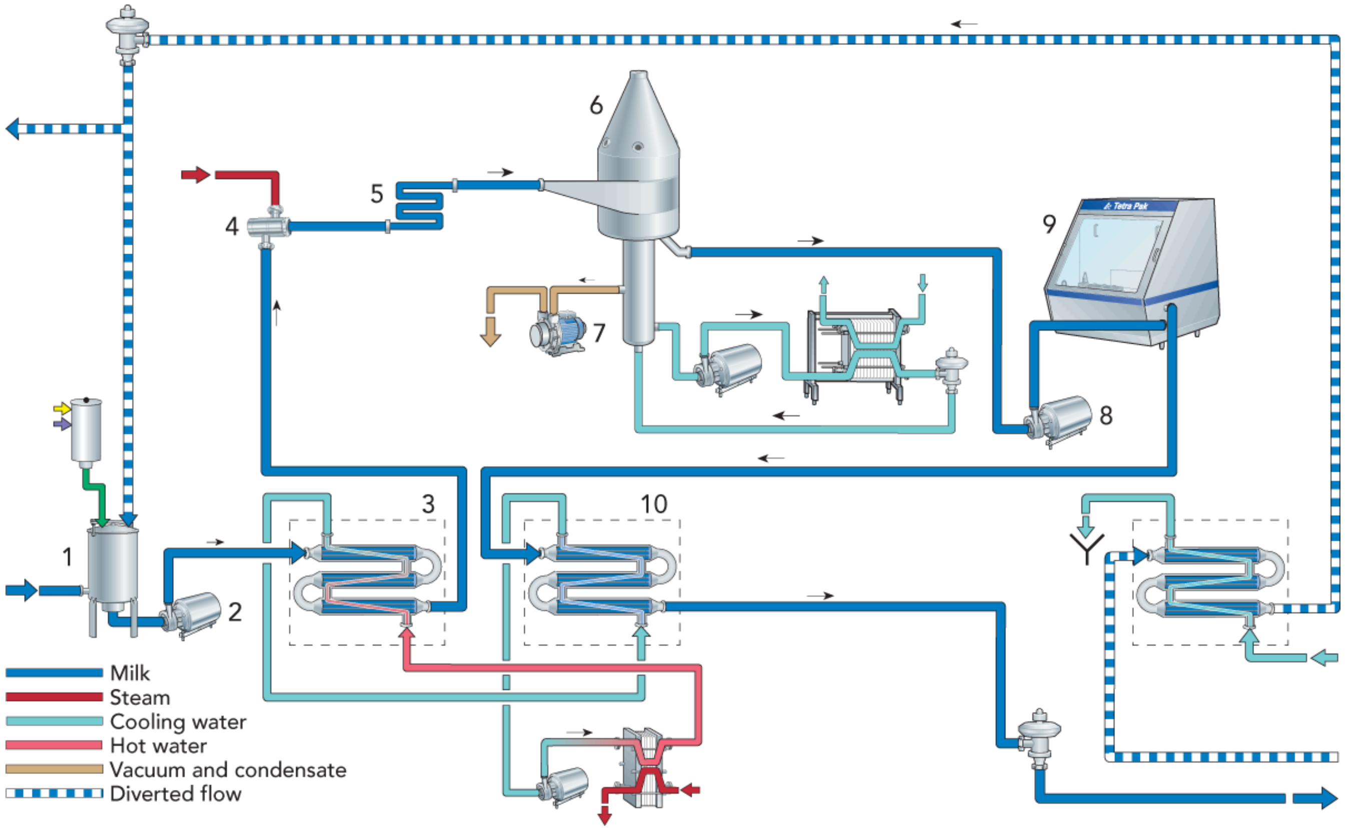


Fig. 9.16 UHT process with heating by direct steam injection combined with tubular heat exchanger.

1.Balance tank

2.Feed pump

3.Tubular heat exchanger, preheater

4.Steam injection head

5.Holding tube

6.Vacuum vessel

7.Vacuum pump

8.Centrifugal pump

9.Aseptic homogenizer

10.Tubular heat exchanger, cooler

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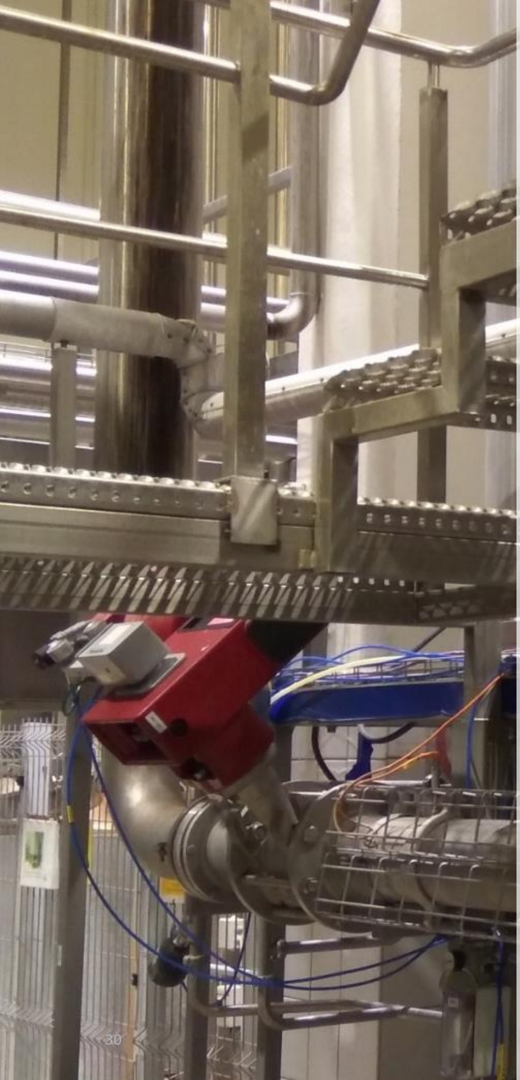
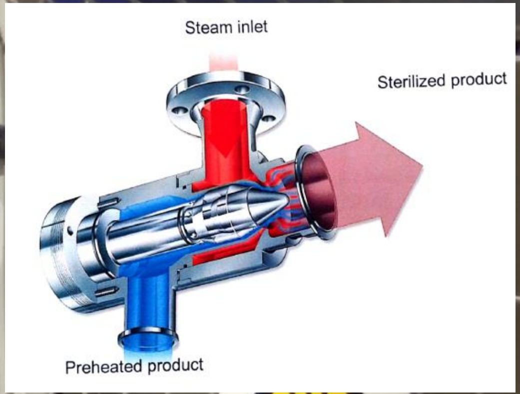


Direct steam injection

- The final heat treatment step is performed by injecting steam inside the milk product.
- The temperature rises instantly to the pasteurization setpoint and steam is converted to water.
- After xx seconds the product is routed to the flash vessel. The low pressure turns the product to unstable superheated liquid. Water is then removed from the product as steam.
- This type of processing contributes to many functional properties of the final product.



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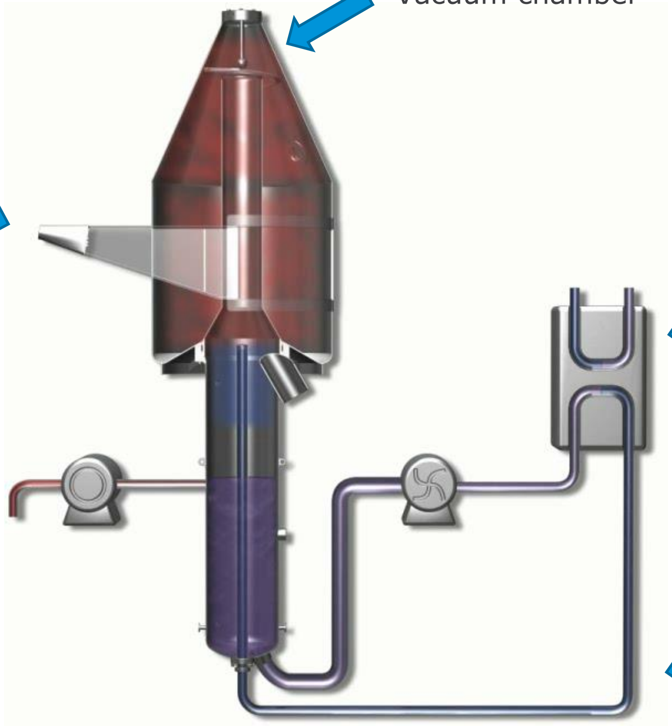
VTIS Flash Vessel

Steam leaves the Vacuum chamber

Product high temperature gets inside the Vacuum Chamber



Cooling water tower cools down the condensate circuit

Condensed steam is removed through the Vacuum pump

Cooling water circulates inside a closed circuit to cool down the condensate circuit

DIRECT UHT PLANT BASED ON STEAM INJECTION AND TUBULAR HEAT EXCHANGER

As an alternative to the above design, the plate heat exchanger in Figure 9.15 (3) can be exchanged for tubular heat exchangers, as shown in Figure 9.16, when products of low or medium viscosity are to be treated.
Following pre-sterilization of the plant and cooling down to about 25 °C, the milk at approx. 4 °C is routed into a tubular heat exchanger (3) for pre-heating to approx. 80 °C.
Steam injection (4) instantly raises the temperature to 140 – 150 °C. The milk is held at this temperature for a few seconds (5) before being cooled down. The injected steam is flashed off as vapour in a vacuum vessel (6), whereupon the temperature of the milk drops to 80 °C.
After aseptic homogenization (9), the milk is cooled (10) to packaging temperature, approximately 25 °C.
If the temperature drops during production, the product is diverted into a reject tank and the plant is flushed by water. The plant must be cleaned and sterilized before restart.

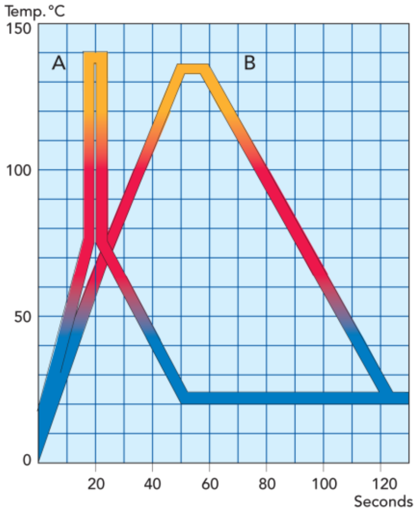


Fig. 9.6 Time-Temperature curve for UHT treatment in direct,A, and indirect, B system.

quality

GENERAL UHT OPERATING PHASES

These operating phases are common to all UHT systems and are therefore not described under each system.

PRE-STERILIZATION

Before start of production the plant must be pre-sterilized in order to avoid re-infection of the treated product.

The pre-sterilization involves:

- Hot water sterilization so that the minimum temperature necessary (normally 125 °C) will be reached at the last point in the line that must be sterile. Minimum time for the hot water sterilization is 30 minutes from the moment the relevant temperature has been reached in the whole aseptic part of the plant.
- Adjustment of the plant to conditions required for production.

PRODUCTION

The production phases vary according to the different processes and are described below.

ASEPTIC INTERMEDIATE CLEANING

Aseptic Intermediate Cleaning (AIC) is a useful tool in cases where a plant is used for very long production runs. A 30-minute AIC can be carried out whenever it is necessary to remove fouling in the production line without losing aseptic conditions. The plant does not have to be resterilized after AIC. This method saves downtime and permits longer production runs.

CIP

The full CIP cycle takes 70 to 90 minutes and is normally carried out immediately after production.
The CIP cycle for direct or indirect UHT plants may comprise sequences for pre-rinsing, caustic cleaning, hot-water rinsing, acid cleaning and final rinsing, all automatically controlled according to a pre-set time/temperature programme. The CIP programme must be optimised for different operating conditions in different plants.

150 years


I WISH I
WOULD'VE FOLLOWED
MY DREAMS
AND BECAME
AN ENGINEER
–SAID NO ONE EVER