**UHT milk processing**

In a modern UHT plant the milk is pumped through a closed system. On the  
way it is preheated, highly heat treated, homogenised, cooled and packed  
aseptically. Low-acid (pH above 4.5 – for milk more than pH 6.5) liquid  
products are usually treated at 135 – 150°C for a few seconds, by either  
indirect heating, direct steam injection or infusion. High-acid (pH below 4.5)  
products such as juice are normally heated at 90 – 95°C for 15 – 30 seconds. All parts of the system downstream of the actual highly heating section are of aseptic design to eliminate the risk ofreinfection.  
Compared with traditional sterilisation in hydrostatic towers, UHT treatment of milk saves

* time
* labor
* energy and space.

UHT is a high speed process and has much less effect on the flavour of the milk. However, regular of autoclave-sterilised milk are accustomed to its “cooked”  
or caramel flavour and may find the UHT-treated product “tasteless”.

**UHT milk processing**

**Definition**

UHT milk can be defined as a product obtained by heating milk in a continuous flow to a temperature in excess of 135oC for not less than two seconds and immediately packaging in sterile packages under aseptic conditions.

**Unit operations involved in UHT processing of milk**

1. **Raw milk reception/Raw milk quality:**

Milk exposed to high heat treatment must be of *very good quality*. It is particularly important that the proteins in the raw milk do not cause thermal  
instability. The heat stability of the proteins can be quickly determined by an  
alcohol test. When samples of the milk are mixed with equal volumes of an  
ethyl alcohol solution the proteins are instable and the milk flocculates at a  
certain concentration. The higher the concentration of ethyl alcohol solution  
is without flocculation, the better the heat stability of the milk. Production  
and shelf life problems can usually be avoided if the milk remains stable at  
an alcohol concentration of 75%.  
The alcohol test is typically used to reject all milk which is unsuitable for  
UHT treatment because:  
• it is sour, due to high bacterial count of acid producing micro-organisms  
• it has the wrong salt balance,  
• it contains too much serum proteins – typical of colostrum.  
Raw milk of bad quality has an adverse effect on both processing conditions and on the final product quality. Sour milk has poor thermal stability  
and causes both processing problem and sedimentation, e.g. burning-on  
on the heating surfaces resulting in short running times and difficulties with  
cleaning as well as sedimentation of proteins on the bottom of the packages during storage.  
Milk stored for long time at low temperature may contain high numbers  
of *Psychrotrophic bacteria* which can produce *heat-resistant enzymes*  
which are not completely inactivated by sterilisation. During storage they  
can cause taste changes such as rancidity, bitterness or even gelation  
problems (age-thickening or sweet curdling).  
The bacteriological quality of the milk must be high. This applies not only  
to the total bacteria count but also, and even more important, to the spore  
count of spore-forming bacteria which influence the rate of unsterility

**Milk Reception:**

Milk is collected in milk churns at farm house. These churns are send to milk collection center. From collection centers to industry it is transferred in tanks. Milk is received at industry either by weight or by volume. Before reception deairation is done to remove air, for this purpose deareator is used. After receiving it is stored in silos.

**2. Filtration**The milk filter consists of a nylon filter-bag or a filter-pad supported on a perforated stainless steel, objective is to remove any impurity.

**3. Centrifugation**The milk received comes from variable sources and have variable composition so, in order to set fat and SNF at standard level centrifugation is done to separate cream from milk. The milk obtained after centrifugation is called skim milk.

**4. Standardization** Milk standardization means adjustment of fat and SNF level. The standard fat level is 3.5% and SNF level is 8.9%. Milk standardization is normally done by following Pearson’s square method.

**5. Homogenization**The fat globules in milk are non-uniform size, ranging from 0.1 to 20 µm. the fat globules in raw unhomogenized milk are between **1-10 µm**, while in homogenized milk the size range is **0.2-2 µm**. The non-uniform size of the globules causes them to float, or cream, to the top of the container. To avoid this homogenization is done to disrupt the fat globule into smaller ones and uniformly distribute them. The equipment use for homogenization is called homogenizer. Homogenization is always done at optimum temperature, normally at 60-65 degree Celsius and 10-15MPa.

**6. Pasteurization**

Pasteurization is done by using pasteurizers (Plate, tubular pasteurizer). Milk pasteurization is done at about 70-72 degree Celsius at 10-15MPa for 15-20 seconds.

**7. UHT Treatment**

**Types of Sterilization Plants**

There are two types of UHT plants:

1. Direct type
2. Indirect type

**Direct Heating Plant**

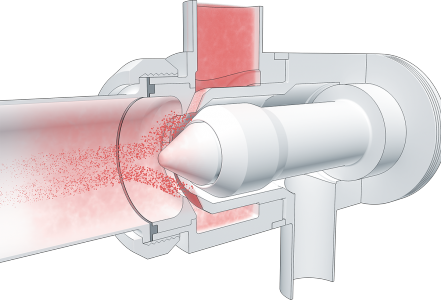
In direct type plants, heating is done by mixing product and steam. In indirect type plant, product is heated by steam or hot water without the two coming in direct contact. Heating in direct type plant is very rapid particularly between 80-140oC and total heat load is less. Changes in the product quality are therefore minimum.

There are two types of direct heating plants

1. Injection type
2. Infusion type

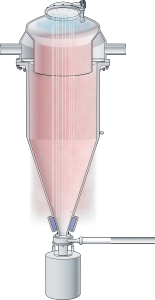
**Injection type**

Processing is through steam-into-milk arrangement. Steam injector is the heart of this plant. Preheated milk at 80-90C enters the injector nozzles from one side. Steam at slightly higher pressure enters the injector from the other side. As the steam mixes with milk, steam condenses and the product is rapidly heated. Rapid condensation of steam prevents entry of air in holding tube. Air in holding tubes results in improper heating. Backpressure is maintained on the discharge side. Backpressure ensures that product does not boil in holding tube. Boiling may result in fouling and improper heating of milk.

**Injection nozzle**

**Infusion type**

In this system, milk is heated by milk-into-steam arrangement. The processing unit consists of a chamber filled with pressurized steam. Milk enters the chamber from the top. There are two alternative arrangements for distribution of milk. In the first type, milk flows to a hemispherical bowl with loose circular disc closing the top. When the bowl is full, milk overflows and falls in droplets through the steam environment. In an alternative arrangement, milk flows through a series of parallel and horizontal distribution tubes. These tubes have slits along the bottom and milk flows like a thin film through the chamber. As milk reaches the bottom of the chamber, it is heated to desired temperature. This system is particularly suitable for thicker liquids and for liquids suspended with smaller chunks.

**Infusion vessel**

**Indirect Type Heating System**

In indirect plant, rise in temperature is very gradual. Therefore, heat load on the product is more. Changes in chemical quality are comparatively more in indirect type than direct.  
There are three types of indirect heating systems

1. Plate heat exchangers
2. Tubular heat exchanger
3. scraped surface heat exchanger

**8. Cooling**

After UHT treatment milk is cooled down to 80-85 degree Celsius.

**9. Packaging**

Packaging material for UHT treatment is tetra pack. Packaging is carried out under aseptic conditions.

**10. Cooling and storage**

After packaging milk is cool down to room temperature, where it is stored for a longer time even up to 6 months.

**Changes in UHT milk during storage**

1. Physical changes
2. Microbial changes
3. Enzymatic changes

**Physical changes**

Physical changes in UHT milk are almost negligible.

**Microbial changes**

Deterioration and spoilage of UHT milk depend upon the quality of raw milk. If raw milk has high microbial load then it can be deteriorate within few days or weeks even after sterilization. There are certain conditions regarding deterioration. If spores of bacillus spp. are present in raw milk they can survive during UHT treatment and regenerate to spoil the milk during storage.

If there is any recontamination during processing or packaging the micro organisms can spoil the milk but it depends on the type of micro organisms. If any bacteria belonging to bacillus genera are present it can deteriorate the milk but these are not health hazardous. However bacteria other than these genera can spoil as well as produce health hazards.

**Enzymatic changes**

Most enzymes from protease group especially plasmine can survive to some extent during UHT. They reactivate during storage after few weeks and break the protein and peptides resulting in gel formation. This activity is known as age gelation. Some lipase enzyme can also survive that can break lipids resulting in rancid smell and flavor.

**Flow line for direct and indirect UHT milk processing:**