**Pasteurized Milk**

**Introduction**

The milk which is heated up to the pasteurization temperature (72-75 °C for 15 – 20 seconds) is called pasteurized milk. It is of various types, mainly including

whole milk,

skim milk,

standardized milk and

 flavored milk etc.

In most countries, clarification, pasteurization and chilling are compulsory stages in the processing of consumer milk. In many countries, the fat is routinely homogenized, while in others homogenization is omitted because a good “cream-line” is regarded as evidence of quality.

De-aeration is practiced in certain cases when the milk has high air content, and also when highly volatile off-flavor substances are present in the product. This may occur, for example, if cattle feed contains plants of the onion family.

To attain a high quality product, **first class raw material** and **correctly designed process line** is required. **Gentle handling should** also be ensured so that the valuable constituents are not adversely affected.

To ensure milk quality, there are **microbiological standards are set by the** Council of the European Union (EU) to safeguard human and animal health which is shown in table 1.1. Somatic cells count is also used to measure the quantity of raw milk and it must not contain more than **400 000 somatic cells per ml** according to the EU directive.

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| ***Table 1.1*** *EU standards for maximal bacteria count in milk* |
| **Plate Count (CFU/ml)** | **Product** |
| 100 000 | Raw milk |
| 300 000 | Raw milk stored in silo (6 °C) at the dairy for more than 36 hours |
| 50 000 | Pasteurized milk after incubation for 5 days at 6 °C  |
| 10/0,1 ml | UHT and sterilized milk after incubation for 15 days at 30 °C |
| CFU = Colony Forming Units |

**Processing of pasteurized milk**

Depending on legislation and regulations, the design of process lines for pasteurized market milk varies a great deal from country to country and even from dairy to dairy. For instance, fat standardization (if applied) may be pre-standardization, post-standardization or direct standardization.

The simplest process is just to pasteurize the whole milk. Here, the process line consists of a pasteurizer, a buffer tank and a filling machine. The process becomes more complicated if it has to produce several types of market milk products, i.e. whole milk, skim milk and standardized milk of various fat contents, as well as cream of various fat contents.

The following assumptions apply to the plant described below:

* Raw milk
	+ Fat content 3.8 %
	+ Temperature +4 °C
* Standardized milk
	+ Fat content 3.0 %
	+ Temperature +4 °C
* Plant capacity
	+ 20 000 l per hour
	+ 7 hours per day

Figure 1.1 shows a typical process flow in a market milk line. The milk enters the plant via balance tank (1) and is pumped to plate heat exchanger (16), where it is pre-heated before it continues to separator (5), which produces skim milk and cream.

The standardization of market milk takes place in an in-line system. The fat content of the cream from the separator is set to the required level and is then maintained at that level, regardless of moderate variations in the fat content and in the flow rate of the incoming milk.

The working principle of the system will be: After passage of the standardization device, the flow of cream is divided into two streams. One, with the adequate hourly volume to give the market milk the required final fat content, is routed to the homogenizer and the other, the surplus



*Fig. 1.1 Production line for pasturized milk with partial homogenization.*

1. Balance tank
2. Product feed pump
3. Flow controller
4. Deaerator
5. Separator
6. Constant pressure valve
7. Density transmitter
8. Flow transmitter
9. Regulating valve
10. Shut-off valve
11. Check valve
12. Homogenizer
13. Booster pump
14. Holding tube
15. Flow diversion valve
16. Plate heat exchanger
17. Process control

cream, is passed to the cream treatment plant. The capacity of the homogenizer is carefully calculated and fixed at a certain flow rate.

In a partial homogenization arrangement, the homogenizer is also connected with the skim milk line so that it always has enough products for proper operation. In that way, the relatively low flow of cream is compensated with skim milk up to the rated capacity. Following homogenization, the 18 % cream is eventually mixed in-line with the surplus volume of skim milk to achieve 3 % before pasteurization. The milk, now with standardized fat content, is pumped to the heating section of the milk heat exchanger where it is pasteurized. The necessary holding time is provided by a separate holding tube (14). The pasteurization temperature is recorded continuously.

A booster pump (13) which increases the pressure of the product to a level at which the pasteurized product cannot be contaminated by untreated milk or by the cooling medium if a leak should occur in the plate heat exchanger.

If the pasteurization temperature should drop, this is sensed by a temperature transmitter. A signal activates the flow diversion valve (15) and the milk flows back to the balance tank.

After pasteurization, the milk continues to a cooling section in the heat exchanger, where it is regeneratively cooled by the incoming untreated milk, and then to the cooling section where it is cooled with ice-water. The cold milk is then pumped to the filling machines.

**Standardization**

The purpose of standardization is to give the milk a defined, guaranteed fat content. The level varies considerably from one country to another. Common values are 1.5 % for low-fat milk and 3 % for regular-grade milk, but fat contents as low as 0.1 and 0.5 % also occur. The fat is a very important economic factor. Consequently, the standardization of milk and cream must be carried out with great accuracy.

**Pasteurization**

Along with correct cooling, pasteurization is one of the most important processes in the treatment of milk. If carried out correctly, these processes will supply milk with longer shelf life. Temperature and pasteurization time are very important factors which must be specified precisely in relation to the quality of the milk and its shelf life requirements, etc. The pasteurization temperature for homogenized, HTST pasteurized, regular-grade milk is usually 72-75 °C for 15 – 20 seconds.

The pasteurization process may vary from one country to another, according to national legislation. A common requirement in all countries is that the heat treatment must guarantee the destruction of unwanted microorganisms and of all pathogenic bacteria, without the product being damaged.

**Homogenization**

The purpose of homogenization is to disintegrate or finely distribute the fat globules in the milk, in order to reduce creaming. Homogenization may be total or partial. Partial homogenization is a more economical solution, because a smaller homogenizer can be used.

***Efficiency of homogenization***

Homogenization must always be sufficiently efficient to prevent creaming. The result can be checked by determining the homogenization index, which can be found in the manner described in the following example:

A sample of milk is stored in a graduated measuring glass for 48 hours at a temperature of 4-7 °C. The top layer (1/10 of the volume) is siphoned off, the remaining volume (9/10) is thoroughly mixed, and the fat content of each fraction is then determined. The difference in fat content between the top and bottom layers, expressed as a percentage of the top layer, is referred to as the homogenization index. An example: If the fat content is 3.15 % in the top layer and 2.9 % in the bottom layer, the homogenization index will be (3.15 – 2.9)/3.15 x 100 = 7.9. The index for homogenized milk should be in the range of 1 to 10.

**Quality maintenance of pasteurized milk**

 Due to its composition, milk is highly susceptible to bacterial and chemical (copper, iron, etc.) contamination as well as to the effects of exposure to light, particularly when it is homogenized. It is therefore most important to provide good cleaning (CIP) facilities for the plant and to use detergents, sanitizers and water of high quality. Once packed, the product must be protected from light – both daylight and artificial light. Light has a detrimental effect on many nutrients, and it can also affect the taste.

**Shelf life of pasteurized milk**

The shelf life of pasteurized milk is always dependent on the quality of the raw milk. Naturally, it is also most important that production conditions are technically and hygienically optimized, and that the plant is properly managed. When produced from raw milk of sufficiently high quality and under good technical and hygienic conditions, ordinary pasteurized milk should have a shelf life of 8 – 10 days at 5 – 7 °C in an unopened package. The shelf life can however be drastically shortened if the raw milk is contaminated with micro-organisms such as species of Pseudomonas that form heat-resistant enzyme systems (lipases and proteases), and/or with heat-resistant bacilli such as Bacillus cereus and Bacillus subtilis which survive pasteurization in the spore state. To improve the bacteriological status of pasteurized milk and thereby safeguard or even prolong its shelf life, the pasteurization plant can be supplemented with a bactofugation or a microfiltration plant. The bactofugation process is based on centrifugal separation of microorganisms; although the reduction effect of two-stage centrifugation on bacteria spores is up to >99 %, this is not considered good enough for pasteurized market milk if extended shelf life at up to 7 °C is required. Reduction effects of up to 99.5 – 99.99 % on bacteria and spores can be achieved with micro filter membranes of pore sizes of 1.4 µm or less.

Since the small pore sizes needed for effective retention of bacteria and spores also trap milk fat globules, the MF module is fed with skim milk. In addition to the MF unit, the plant contains a high temperature treatment unit for the mixture of the cream phase and bacteria concentrate (retentate), which after heat treatment is remixed with the permeate, the processed skim milk phase. The cream and retentate phase are sterilized at about 130 °C for a couple of seconds. After re-mixing with the micro filtered skim milk phase, the product is homogenized and finally pasteurized at 72 °C for 15 – 20 seconds and cooled to +4 °C.

If strictly hygienic conditions are maintained in the plant, from reception of the raw milk up to and including the packaging and filling system, the foundation of a long shelf life is laid. If the milk is kept at a temperature of not more than 7 °C during the whole chain from the dairy via the retailer to the consumer, it is possible to attain a shelf life of up to 40 – 45 days in an unopened package.

**ESL milk**

The term “Extended Shelf Life”, ESL, is frequently applied in Canada and the USA to fresh liquid products of good keeping quality at +7 °C and below. There is no single definition of ESL, as it is a concept involving many factors. It means the ability to extend the shelf life of a product beyond its traditional life by reducing the major sources of reinfection and maintaining the quality of the product all the way to the consumer. A typical temperature/time is 125 – 130 °C for 2 – 4 seconds. This type of heat treatment is also called ultra pasteurization.

 **Packaging**

Glass bottles for milk were introduced back at the beginning of the 20th century. As a package, glass has some disadvantages. It is heavy and fragile, and must be cleaned before re-use, which causes some problems for dairies. Since 1960, other packages have entered the milk market, mainly paperboard packages but also plastic bottles and plastic pouches. A package should protect the product and preserve its food value and vitamins on the way to the consumer. Liquid foods tend to be perishable, so a clean, non-tainting package is absolutely essential. The package should also protect the product from mechanical shock, light and oxygen. Milk is a sensitive product; exposure to daylight or artificial light destroys some essential vitamins and has a deleterious effect on the taste. Other products, such as flavored milk, contain flavoring matter or vitamins that are oxygen-sensitive. The package must therefore exclude oxygen. A milk carton usually consists of paperboard and plastic (polyethylene). Paperboard comes from wood, which is a renewable resource. The paperboard gives stiffness to the packages as well as making them resistant to mechanical stress. The paperboard also serves to some extent as a light barrier. A thin layer of food-grade polyethylene on either side of the paperboard makes the cartons leak proof. On the outside, the plastic also protects the cartons from condensation when chilled products are taken out of storage. Because of its purity, this polyethylene produces minimal environmental impact when incinerated or deposited in landfills. For products with a long non-refrigerated shelf life and very sensitive products, a thin layer of aluminum foil is sandwiched between layers of polyethylene plastic. This gives almost complete protection of the product against light and atmospheric oxygen.

Main functions of packaging are to:

• Enable efficient food distribution

• Maintain product hygiene

• Protect nutrients and flavor

• Reduce food spoilage and waste

• Increase food availability

• Convey product information