Chapter 8

Milk Homogenization

Objective

This chapter gives an overview of milk homogenization, principles and equipments.

Introduction

Homogenization is a mechanical process of disintegration of particles into small size. Milk homogenization is the process of breaking of larger fat globule into smaller size to prevent fat separation and making a permanent emulsion of milk fat and serum. During homogenization, breakup of the fat globules is done to such extent that after 48 hours of quiescent storage no visible cream separation occurs. The average fat globule size is in the range of 2 to 6 µm and few may be of 10 µm. The critical diameter for fat globule agglomeration is 0.7 µm. Fat globule-milk serum emulsion is stable when the size of fat globule is less than 0.7 µm. Advantages of homogenization are:

a. Small fat globule size leading to no cream line formation

b. Homogenized milk is more whiter in colour

c. Prevents fat oxidation

d. Produces better quality powder

e. Better mouth feel, milk has full bodied flavour

f. Improves digestion. Homogenized milk produces a soft curd which is easily digested by infants

Homogenization may be required for dairy products and beverages such as: cream, pasteurized milk, flavoured milk, milk for yogurt and cheese, dressings, ice cream mix, yogurt drinks, and for other products like fruit juice, soya milk etc. Homogenization is required for production of recombined milk to prevent fat separation. A milk homogenizer is shown in fig.8.1.

Fig.8.1. Milk homogenizer

Principle

Homogenization is accomplished by forcing the milk or cream or any product under pressure through narrow gap. Due to high turbulence, shear and compression larger fat

globules are disintegrated into smaller globules. Homogenized milk or cream forms a stable emulsion, if the size of the fat globules is sufficiently reduced. The size of fat globules after homogenization depends upon:

a. Temperature of milk

b. Source of the milk (season of the year)

c. Flow rate of milk

d. Homogenization pressure

e. Geometry of the homogenizing valve

f. Stages of homogenization (single or two)

g. Percent and viscosity of milk fat

Methods

Milk homogenization requires high pressure. Piston type reciprocating pump is used to produce such high pressure. The construction of a single stage piston pump is shown in fig.8.2. Crank transforms the rotating motion of motor shaft into reciprocating motion. When the piston moves back, milk is sucked into the cylinder through the inlet valve. With forward movement of the piston, inlet valve closes and outlet valve opens up. Generally three stage piston pump is used to produce high pressure for milk homogenization. The pressurized milk flows under pressure towards the homogenization valve. Disruption of larger size fat globule takes place in the homogenization valve. The opening for milk flow can be adjusted and maintained using homogenization valve system (Fig.8.3).

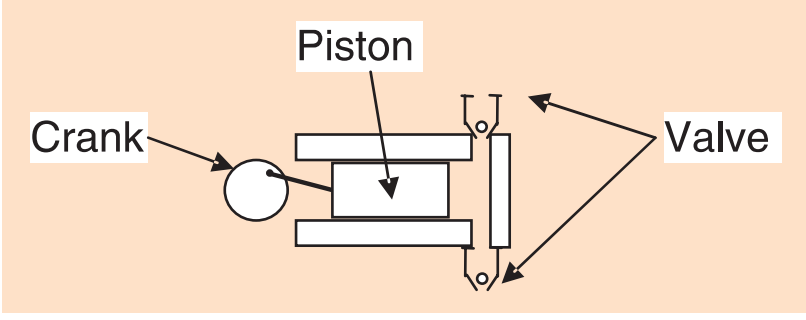

Fig.8.2. Single stage piston pump

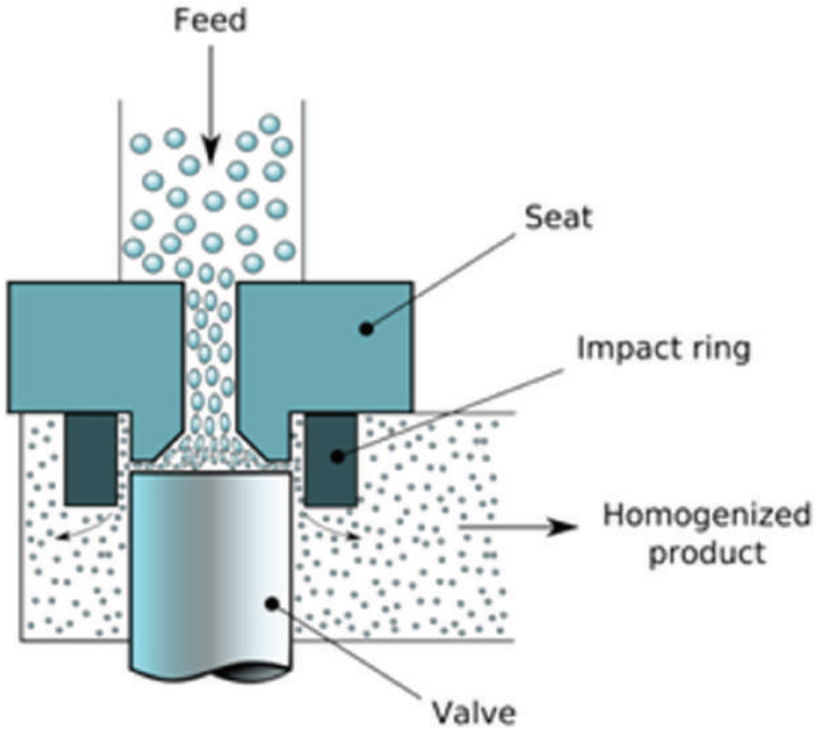

Fig.8.3. Homogenizer valve system

Single and Double Stage Homogenization

Requirement to reduce the fat globule size also depends on the desired shelf life of the milk product. Smaller globule size is needed for longer storage period to prevent creaming. If the fat globules has a tendency to agglomerate after the first homogenizing stage (2100-3000 psi), second stage (300-600 psi) is required to re-disperse them. Ultra high temperature (UHT) milk requires higher pressure for longer shelf life (Table 8.1). When a two-stage homogenizing valve is used, the second-stage pressure should be 10 to 15% of the total homogenizing pressure.

Table 8.1. Homogenizing pressure for UHT milk

	Shelf life			
	10 days	**14 days**	**60 days**	**180 days**
Homogenizing pressure (PSI)	1200-2000	1400-2200	2100-3500	2500-4000
Average fat globule size	0.80 µm	0.75 µm	0.55 µm	0.40 µm

Equipment

The construction of milk homogenizer is shown in fig.8.4. Milk at high pressure is forced through first stage and second stage homogenization value. Pressure gauge 1 and 2 displays the homogenization pressure in the first and second homogenization stage respectively (Fig.8.5).

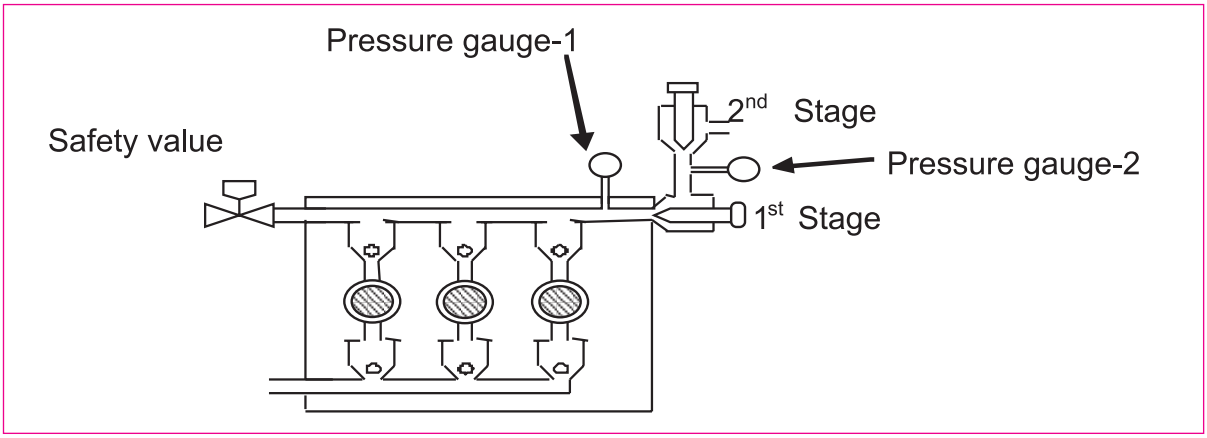

Fig.8.4. Milk homogenizer

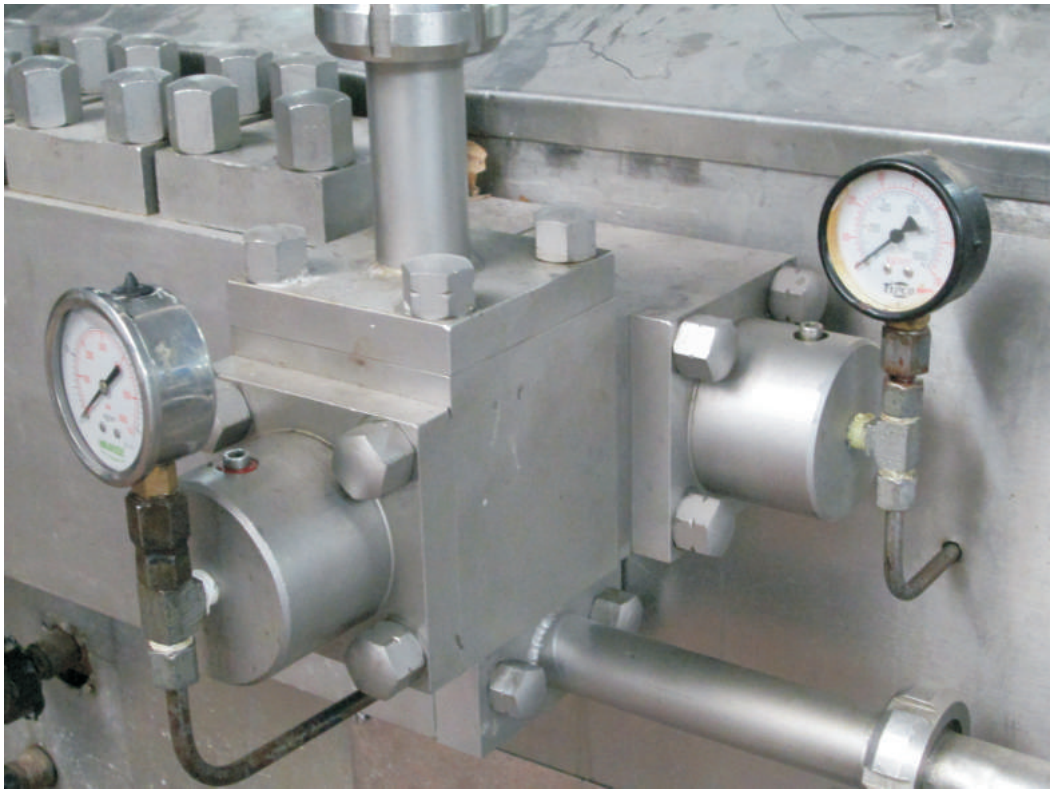

Fig.8.5. Pressure gauge

Homogenization Efficiency

Milk homogenized at 42°C is tested for homogenization efficiency by laser light scattering to determine the fat globule size distribution. Operating parameters which affects the efficiency of high-pressure homogenizers are as follows:

- Pressure
- Temperature
- Valve design
- Flow rate

REVIEW QUESTIONS

1. What is homogenization?
2. What are the advantages of milk homogenization?
3. Differentiate between single and two stage homogenization?
4. List parameters affecting homogenization efficiency.
5. What is the pressure during homogenization at 1st and 2nd stage valve?