

Chapter 8

CREAM SEPARATION

(Cream separation, Centrifugation, Tubular bowl centrifuge, Disc bowl centrifuge, Domestic cream separator)

The cream separation is a very important unit operation in dairy industry. The cream or fat is taken out of milk for standardisation purpose. Besides, cream is also required to prepare some value added products as ghee, butter, etc. Cream is usually separated from milk by the centrifugation process.

Centrifugation

Sometimes gravity separation may be too slow because of the closeness of densities of the particle and the fluid, or because of the association forces holding components together, as in emulsions like whole milk. In that case centrifugation helps in separation of the components on the basis of differences in their densities.

- The centrifuge increases the forces on particles many fold.
- Thus the particles that do not settle readily or at all in gravity settlers can often be separated from fluids by centrifugal force.
- The relative settling velocities of small particles are not changed, but the disturbing effects of Brownian motion and free convection currents are overcome.

The equipment using this principle of separation is known as a centrifuge. The centrifuges are used for:

- separation of immiscible liquids,
- clarification of liquids by removal of small amounts of solids, and
- for removal of solids from liquids

Centrifuges are also used for *centrifugal filtration*, where the centrifugal force is used (not the pressure difference) to separate the solids through a filter medium. The major applications of the centrifuges are shown in Fig. 8.1.

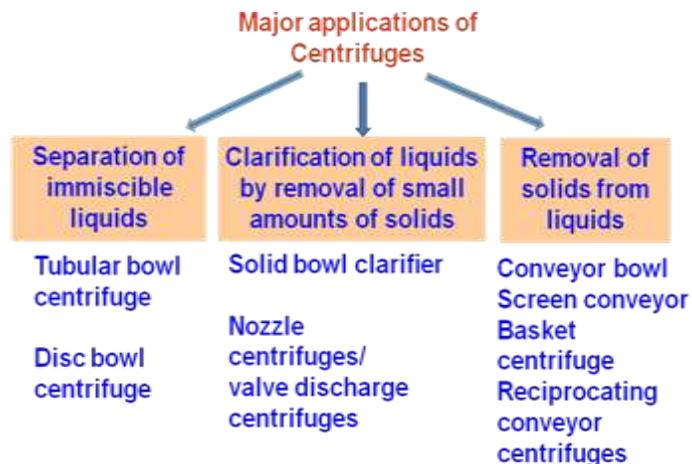


Fig. 8.1 Major applications of the centrifuges

As can be observed from Fig. 8.1, for cream separation, two types of centrifuges are used, namely, the tubular bowl centrifuge, and the disc bowl centrifuge.

Tubular bowl centrifuge

The basic characteristic features of a tubular bowl centrifuge are as follows.

- It consists of a vertical cylinder (or bowl), typically 0.1-0.15 m in diameter and 0.75 m long.
- Rotates inside a stationary casing (15000-50000 rev/min depending on the diameter).
- Tubular bowl centrifuges, which develop about 13000xg force, are also known as super centrifuges.
- Feed liquor is introduced continuously at the base of the bowl and the two liquids are separated and discharged through a circular weir system into stationary outlets.
- Some narrow centrifuges known as ultra centrifuges have a diameter of 75 mm and very high speeds of about 60000 rev/min.



Fig. 8.2 A tubular bowl centrifuge

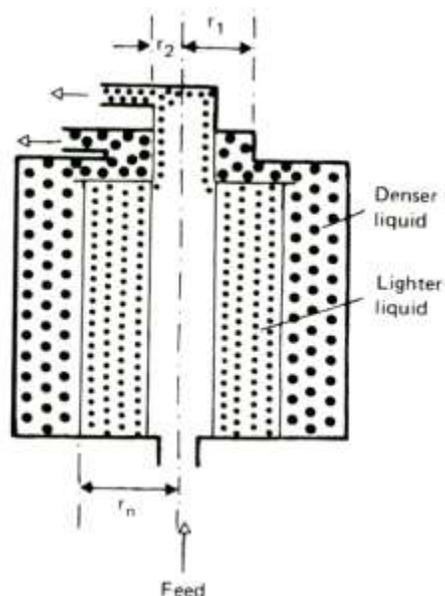


Fig. 8.3 Working principle of a tubular bowl centrifuge

Disc bowl centrifuge

The characteristic features of a disc bowl centrifuge are as follows.

- It consists of a conical bowl (0.2-1.2 m diameter), which contains a stack of inverted metal cones.
- The cones rotate at 2000-7000 rev/min.
- There is a fixed clearance between cones: 0.5-1.27 mm; and they have matching holes which form flow channels for liquid movement.

- Feed is introduced at the base of the disc stack.
- Due to the centrifugal force, the denser fraction moves towards the wall of the bowl, along the underside of the discs. The lighter fraction moves towards the centre along the upper surfaces.
- Both liquid streams are removed continuously by a weir system at the top in a similar way to the tubular bowl system.



Fig. 8.4 A disc bowl centrifuge

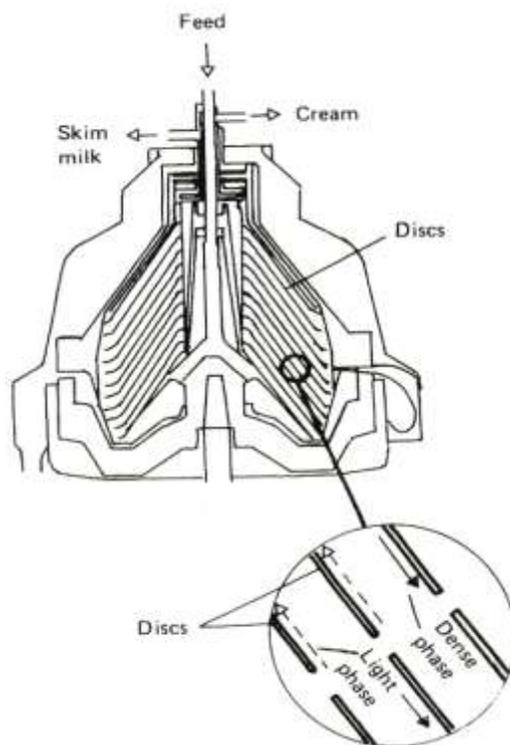


Fig. 8.5 Working principle of a disc bowl centrifuge

- Disc bowl and tubular centrifuges can have capacities even up to 150000 l/h.
- Better separation is obtained by the disc bowl centrifuge due to the formation of thinner layers of liquid.

- Periodic cleaning of deposited solids is required.
- The disc bowl centrifuge, in addition to being widely used for separation of cream from whole milk, is also used for clarification of oils, coffee extracts and juices, and separation of starch-gluten.

Domestic cream separator

Small capacity domestic cream separators working on the principle of disc bowl centrifuges are also available. Fig. 8.6 shows such a domestic cream separator with its basic component parts. The separator is operated by hand with the help of a handle fixed to it.

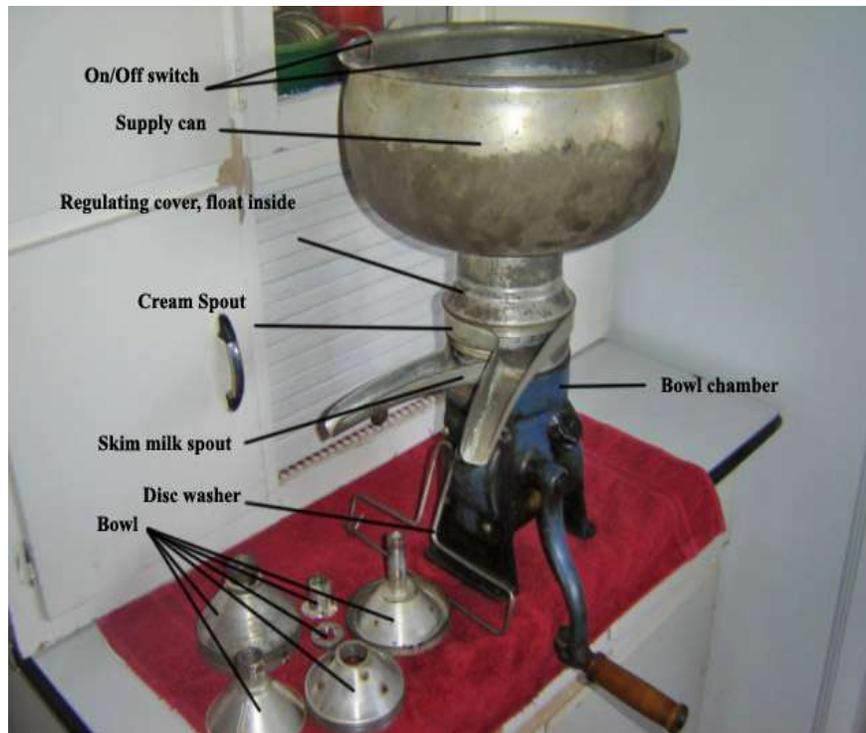


Fig. 8.6 Domestic cream separator

CHECK YOUR PROGRESS

1. What is a centrifuge? What are its main applications?
2. Explain the working principle of a tubular bowl centrifuge with a neat sketch.
3. Explain the working principle of a disc bowl centrifuge with a neat sketch.
4. Explain the different parts of a domestic cream separator.