

The logo of Galgotias University is a stylized circular emblem composed of several overlapping, curved segments in shades of red, yellow, and blue, creating a sense of motion or a globe.

TOPIC:CENTRIFUGATION

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Disclaimer

All the content material provided here is only for teaching purpose

The logo of Galgotias University is a circular emblem with a stylized 'G' shape in the center. The 'G' is composed of three curved segments in shades of yellow, blue, and red. The background of the emblem is a light, textured grey.

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Centrifugation is a process used to separate or concentrate materials suspended in a liquid medium.

- The theoretical basis of this technique is the effect of gravity on particles in suspension.
- Two particles of different masses will settle in a tube at different rates in response to gravity.

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Principle and theory of centrifugation

Centrifugal effect:

Centrifugal force in terms of the ratio to the gravitational force is known as centrifugal effect.

Consider a body of mass m rotating in a circular path of radius r at a velocity v . The force acting on the body in a radial direction is given by:

$$F = \frac{mv^2}{r}$$

r

Here, F = centrifugal force m = mass of the body

v = velocity of body

r = radius of circle of rotation

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The same body will be acted upon by a gravitational force. It can be expressed as:

$$G = mg$$

where, G = gravitational force g = gravitational constant

The centrifugal effect is the ratio of the two forces, so that:

$$\begin{aligned} C &= F / G \\ &= mv^2 / mgr \\ &= v^2 / gr \end{aligned}$$

But, $v = 2\pi rn$ Where, n = speed of rotation. So,

$$\begin{aligned} F / G &= (2\pi rn)^2 / gr \\ &= 4\pi^2 r^2 n^2 / gr \\ &= 2 \pi^2 n^2 d / g \dots\dots\dots(1) \text{ Where, } d = \end{aligned}$$

diameter of rotation.



CLASSIFICATION OF CENTRIFUGE

(1) Filtration centrifuge:

Those using perforated baskets, which perform a filtration type operation (work like a spin dryer).

- ▶ E.g. perforated basket centrifuge, semi-continuous centrifuge

2) Sedimentation centrifuge:

Those with a solid walled vessel, where particles sediment towards the wall under the influence of the centrifugal force.

- ▶ E.g. Tubular bowl centrifuge, Non-perforated basket centrifuge, super centrifuge, conical disc centrifuge

(3) Continuous centrifuge:

Those where a continuous process or very high capacity is required.

E.g. Continuous horizontal centrifuge

Perforated basket centrifuge

Principle:

Perforated basket centrifuge is a filtration centrifuge. The separation is through a perforated wall based on the difference in the densities of solid and liquid phases.

The bowl contains a perforated side-wall. During centrifugation, the liquid phase passes through the perforated wall while solid phase is retained in the bowl.

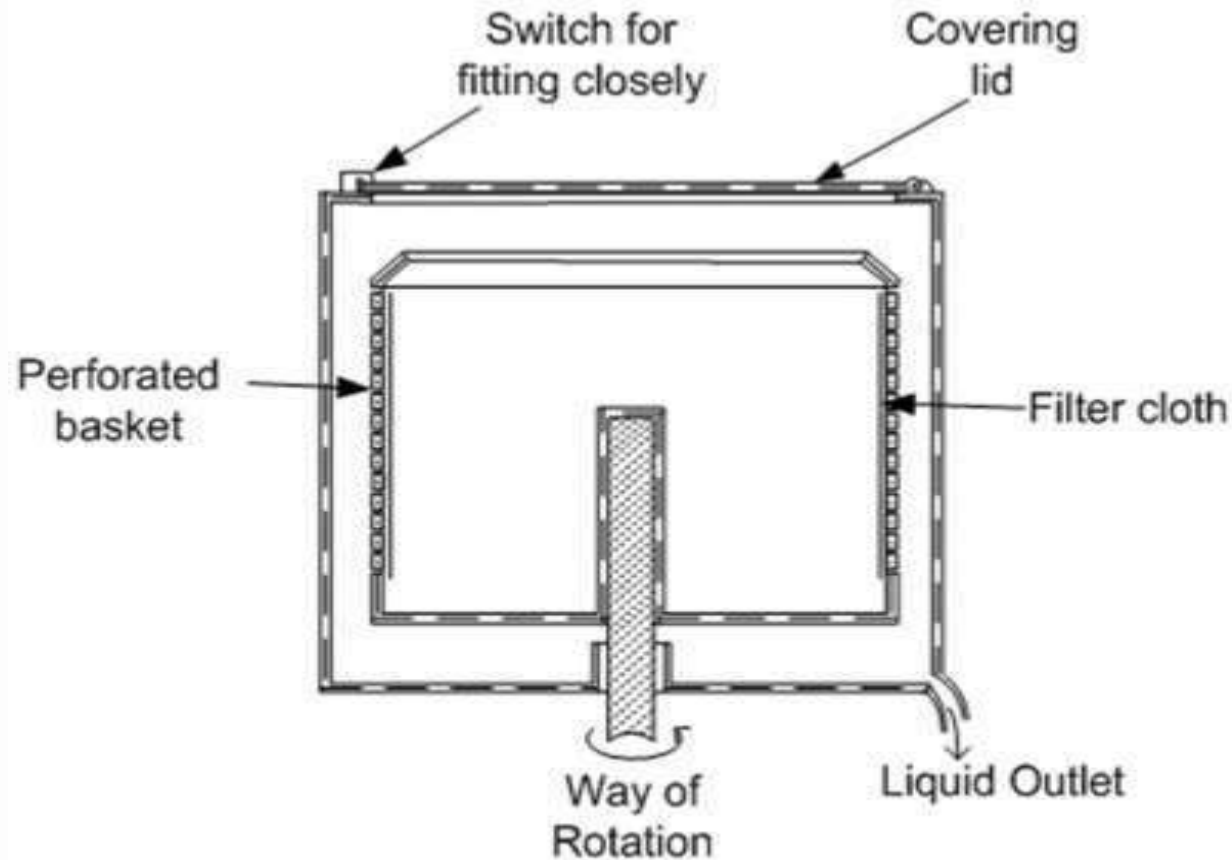
The solid is removed by a blade.

In this centrifuge a basket is mounted above a driving shaft such arrangement is described as

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Model of perforated basket centrifuge

<http://jeepakistan.blogspot.com>

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▶ Working:

- Liquid feed is inserted to the bowl/basket when it is stationary in such a way that it distributes evenly in the basket.
- Power is supplied to start the rotation of basket. The basket should achieve its maximum speed quickly. It rotates at 1000 rpm.
- During the process liquid passes through perforated walls and solid remains inside the wall.
- The solid is collected after drying by spinning and liquid is collected from outlet.

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Uses : (1) Perforated basket centrifuge is extensively used for separating crystalline drugs (such as aspirin) from the mother liquor. Free flowing product can be obtained because mother liquor is removed completely.

(2) It is also used for removing unwanted solids from a liquid. For example, precipitated proteins are removed from insulin.

(3) Sugar crystals are separated using perforated basket centrifuge.

Advantages : (1) The centrifuge is very compact and it occupies very little floor space.

(2) It can handle slurries with a high proportion of solids and even those having paste like consistency.

(3) The final product has very low moisture content.

(4) In this method, the dissolved solids are separated from the cake.

(5) The process is rapid.

Disadvantages : (1) The entire cycle is complicated resulting in considerable labour costs.

(2) It is a batch process.

(3) If the machine is adapted for prolonged operation, there is considerable wear and tear of the equipment. On prolonged operation, the solids may form hard cake, due to the centrifugal force, which is difficult to remove simultaneously.

Semi continuous centrifuge

► It is also known as short cycle automatic batch centrifuge.

Principle:

This centrifuge is a filtration centrifuge. The separation is through a perforated wall based on the difference in the densities of solid and liquid phases.

The bowl contains a perforated side-wall. During centrifugation, the liquid phase passes through the perforated wall while solid phase is retained in the bowl.

The solid is removed by cutting with a blade

Working:

- The perforated basket is allowed to rotate and Liquid feed is inserted to the bowl/basket from side pipe in such a way that it distributes evenly in the basket.
- During the process liquid passes through perforated walls and solid remains inside the wall.
- The cake is washed with water. The wash escapes from
 - the basket through the filtrate outlet.
- The solid is collected after drying by spinning and liquid is collected from outlet.
- In this centrifuge after achieving the desired thickness about 50 to 70 mm the feeler cuts off the air supply to diaphragm valve that automatically cuts of the entry of the slurry.

- Simplest form of filter used for batch process.
- A number of units can be connected in parallel to increase the surface area of filtration.
- Pressure difference can be obtained either with vacuum or using pressure up to the order of 800 kilopascals.
- Labour costs for operating the filter leaf are fairly moderate.
- The efficiency of washing is high.
- The slurry can be filtered from any vessel.
- The cake can be washed simply by immersing the filter in a vessel of Water.

Non-perforated basket centrifuge

Principle:

This is sedimentation type centrifuge so separation takes place on the basis of difference in their densities without presence of perforated/porous medium.

During centrifugation solid remains at side wall of the basket while liquid remains at the top which is collected by skimming tube.

Construction:

- It consist of basket made up of stainless steel. The basket is placed on the vertical shaft.
- Basket contains inlet tube and skimming tube

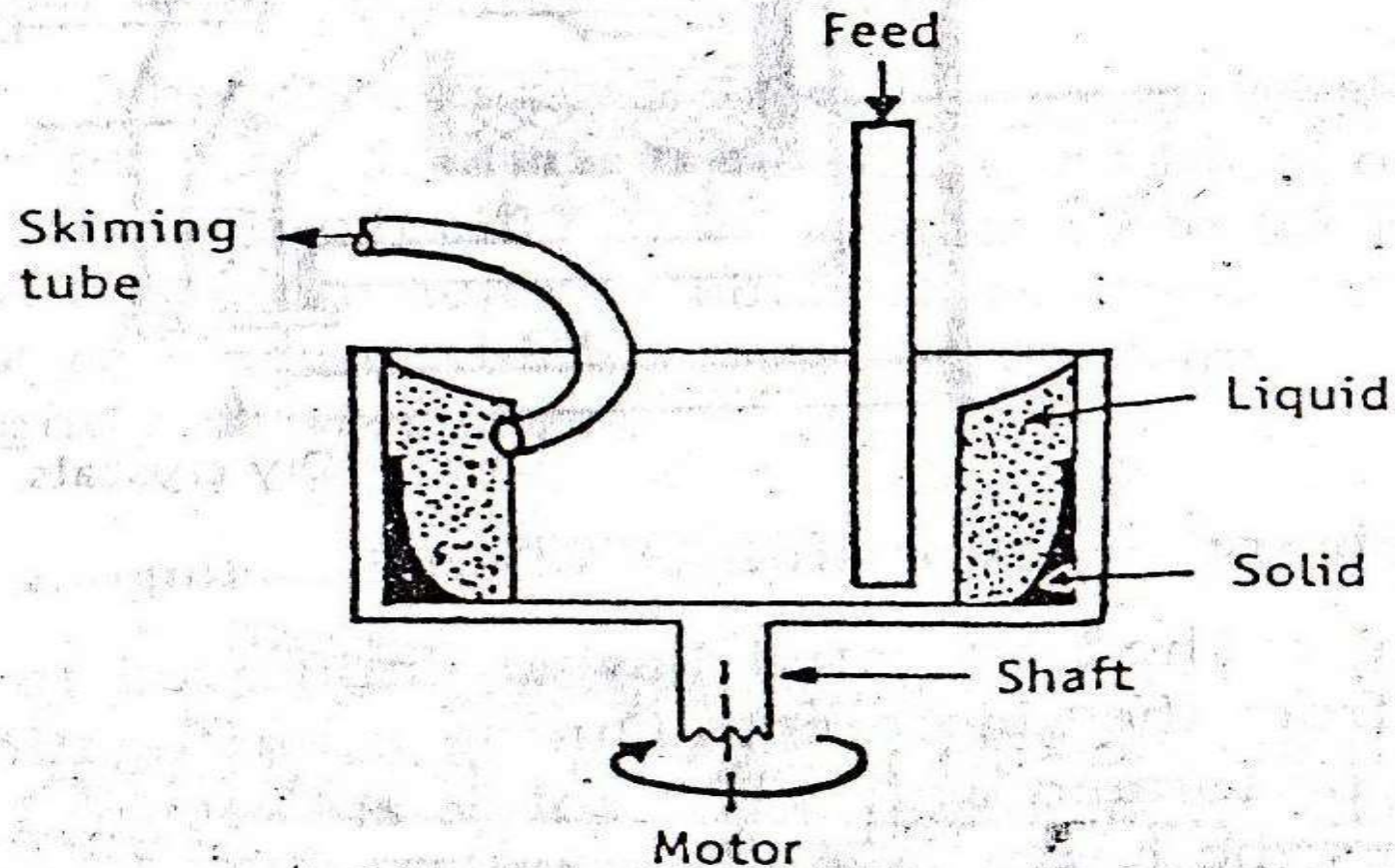


Figure 10-3. Construction of non-perforated basket centrifuge.

- ▶ Working:
- ✓ The suspension is fed continuously into the basket. During centrifugation solid phase is retained on the sides of the wall while liquid remains on the top.
- ✓ The liquid is collected with skimming tube and solids are scraped off by using scraper from the basket.
- ▶ Uses:
- ✓ It is useful when the deposited solids offer high resistance to the flow of liquid.
- ▶ Advantages:
- ✓ Cost is less than other centrifuges
- ▶ Disadvantages:
- ✓ Solid phase is retained on the sides of the basket.

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- Can be used under high pressures, without any danger of bursting the filter medium.
- Running cost are low, as separate filter medium is not used.
- Can be constructed from a material that can provide excellent resistance to corrosion and avoid contamination of sensitive products.
- It is extremely versatile filter because fine as well as large both type of particles can be separated.
- Removal of cake can be carried out by simply back- flushing with water.
- Change over from one batch to another or one product to another is easy.
- Sterile products can be handled.

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Super centrifuge

Principle:

This is sedimentation type centrifuge so separation takes place on the basis of difference in their densities between to immiscible liquids.

Centrifugation is done in the bowl of small centrifuge. During centrifugation the heavier liquid is thrown against the wall, while lighter liquid remains as inner layer.

The two layers are simultaneously separated using modified wiers

Construction : The construction of a supercentrifuge is shown in Figure 10-6. It consists of a long hollow cylindrical bowl of small diameter. It is suspended from a flexible spindle at the top and guided at the bottom by loose-fit bushing. It can be rotated on its longitudinal axis. Provision is made at the bottom for the feed inlet using pressure system. Two liquid outlets are provided at different heights at the top of the bowl, for simultaneous recovery of the separated liquids using modified weirs.

Working : The centrifuge is allowed to rotate on its longitudinal axis at a high frequency usually about 2000 revolutions per minute with the help of drive-assembly. The feed is introduced from the bottom of the centrifuge using a pressure system. During centrifugation, two liquid phases separate based on the difference in their densities. The heavier liquid is thrown against the wall, while the lighter liquid forms an inner layer. Both liquids rise to the top of the vertical bowl.

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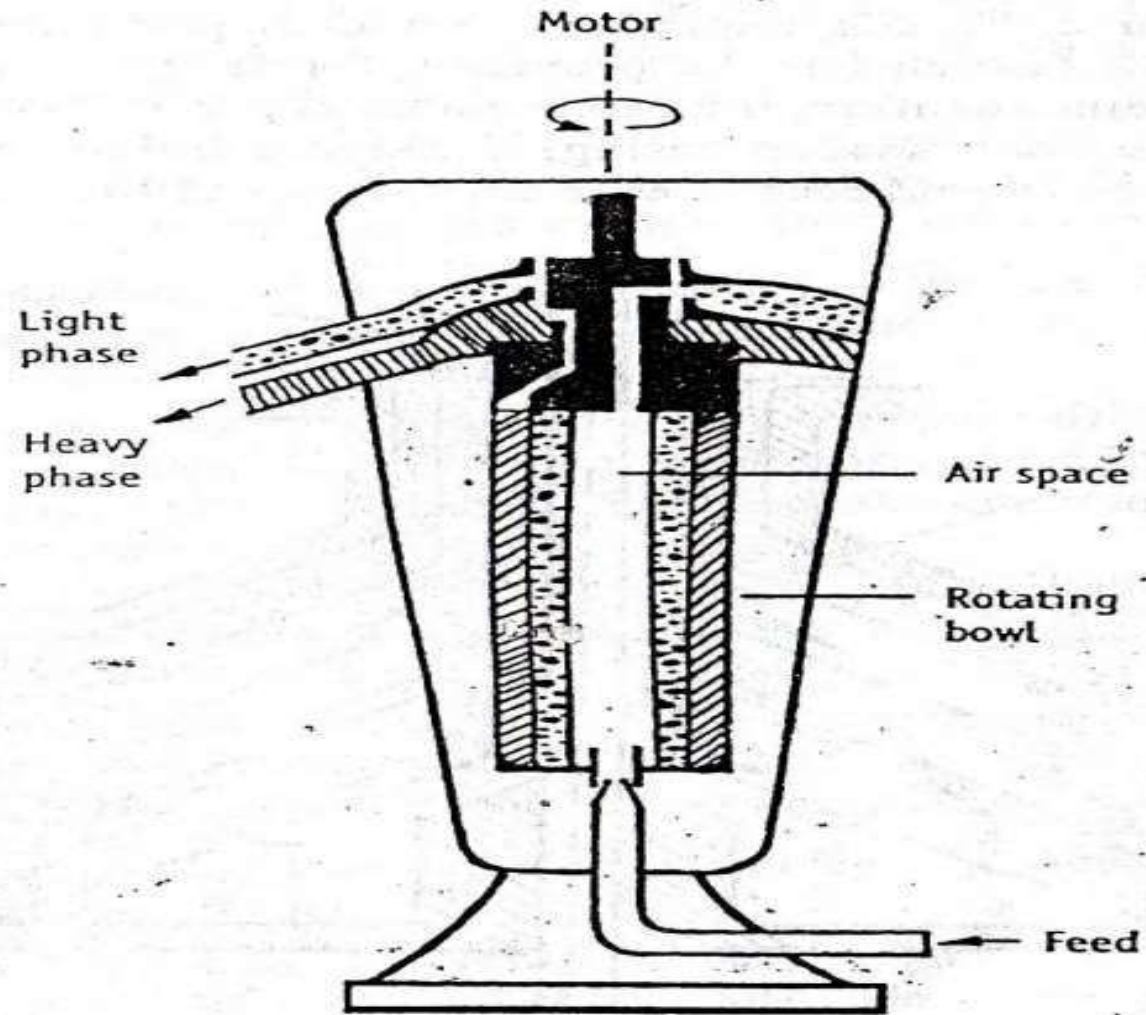


Figure 10-6. Construction of supercentrifuge.

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