

Objectives, principle & applications of Centrifugation & Perforated basket centrifuge

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Definition

- 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.

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:

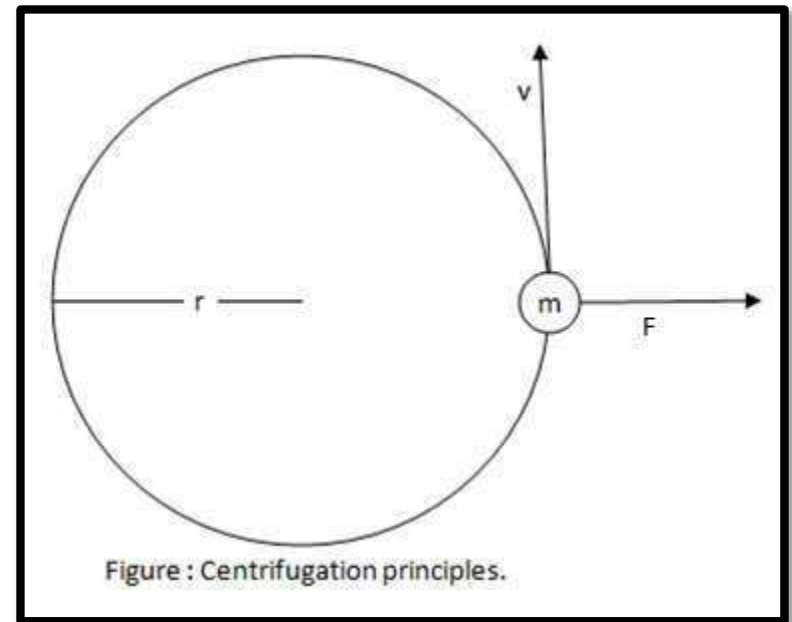
- $$F = \frac{mv^2}{r}$$

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,

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

Where, d = *diameter of rotation.*

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- The gravitational constant has a value of 9.807 m/s^2 , so that equation (1) may be simplified to:
 - Centrifugal effect = $2.013 n^2 d$
 - Provided that , n is expressed in S^{-1} and d is in meter.
 - From the equation, it can be drawn that the centrifugal effect is directly proportional to the diameter, but is proportional to the square of the speed of the rotation.
 - Thus, if it is necessary to increase the centrifugal effect, it is of greater advantages to use a centrifuge of the same size at a higher speed, rather than use a
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- ▶ ⁵ larger centrifuge at the same speed of rotation.

Factors affecting centrifugation process

- Liquid viscosity
- Liquid density
- Solids concentration
- Particle size distribution
- Surface charge of particles
- Type and shape of particles
- Feed rate
- Agitation speed
- Size of centrifuge
- Height of cake
- Mode of operation
- Time at full speed

Classification of centrifuge

Industrial centrifuges can be classified into 3 main types:

(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:

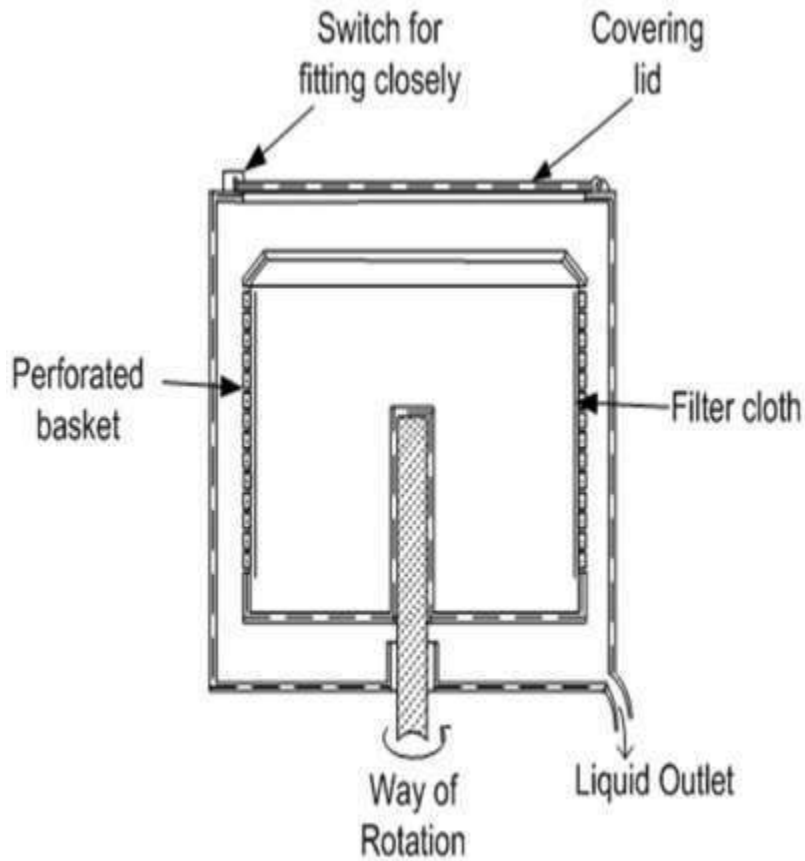
Those where a continuous process or very high capacity is required.

- ▶ E.g. Continuous horizontal centrifuge

Perforated basket centrifuge

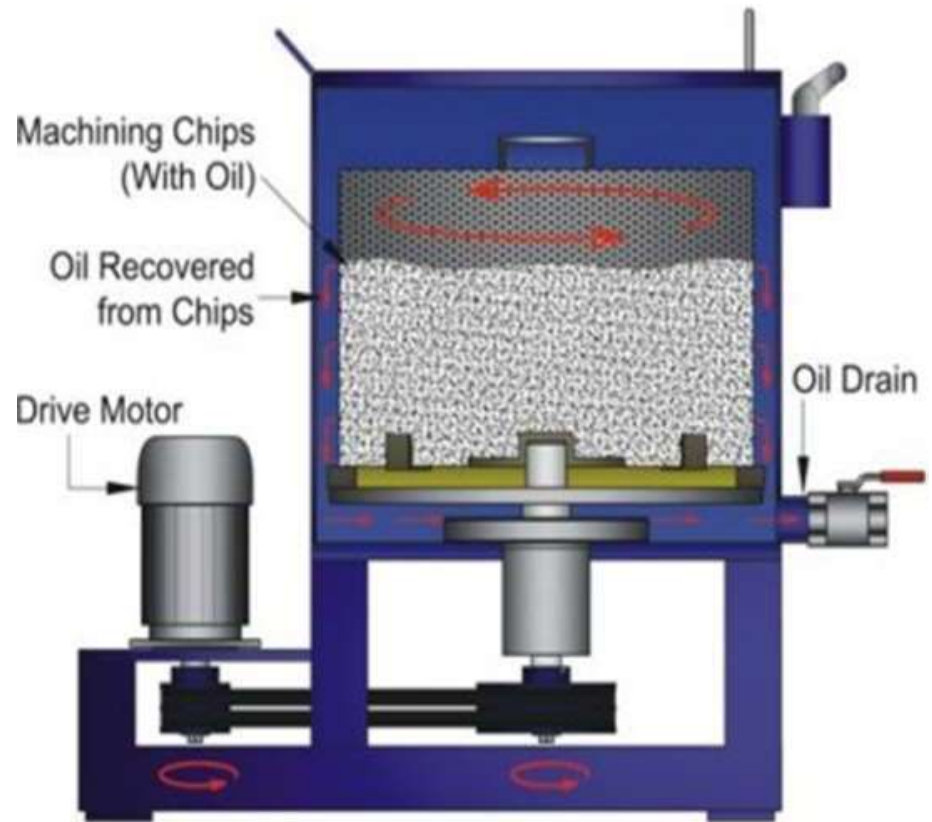
- Principle:
- ✓ Perforated basket centrifuge is a filtration centrifuge. The separation is through a perforated wall based on the difference in the densities of solid and liquid phases.
- ✓ The bowl contains a perforated side-wall. During centrifugation, the liquid phase passes through the perforated 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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- Construction:
 - ✓ It consist of perforated basket which is made up of stainless steel and lined with filter cloth.
 - ✓ The basket is suspended above the shaft and driven by a motor or turbine.
 - ✓ Surrounding the basket casing is provided which collect the filtrate and discharge them to the outlets.



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.

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.

THANK YOU