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DEPARTMENT OF BIOTECHNOLOGY
FACULTY OF ENGINEERING & TECHNOLOGY

LT26:Types of Centrifuges

Content Outline

1. Types of Centrifuge
2. Ultra centrifuge
3. Industrial centrifuge

TOPIC

Many different types of centrifuges are commercially available including:

- large-capacity low-speed preparative centrifuges;
- refrigerated high-speed preparative centrifuges;
- analytical ultracentrifuges;
- preparative ultracentrifuges;
- large-scale clinical centrifuges; and
- small-scale laboratory microfuges

Bench top centrifuges

Simple bench-top centrifuges vary in design and are mainly used to collect small amounts of biological material, such as blood cells. To prevent denaturation of sensitive protein samples, refrigerated centrifuges should be employed. The maximum speed of this type of centrifuge is between 4,000 to 6,000 r.p.m. with a 'g' of 3,000 to 7,000.

Sometimes the cooling arrangement can also be made in this type of centrifuge. Now some 'Microfuges' are available where maximum speed of 8,000 to 13,000 r.p.m. with 'g' value of about 10,000 can be made using small Eppendorf tubes

High Speed Refrigerated Centrifuge

High-speed refrigerated centrifuges are absolutely essential for the sedimentation of protein precipitates, large intact organelles, cellular debris derived from tissue homogenisation and microorganisms. They operate at maximum centrifugal fields of approximately 100 000 g. Such centrifugal force is not sufficient to sediment smaller microsomal vesicles or ribosomes, but can be employed to differentially separate nuclei, mitochondria or chloroplasts. In addition, bulky protein aggregates can be sedimented using high-speed refrigerated centrifuges.

Continuous Flow Centrifuge:

It is also one type of high speed centrifuge where the rotor is slightly modified or specially designed one. In this type there is a continuous flow of the medium in the centrifuge tube. Here the cells or particles are sedimented against the wall and the excess medium or liquid comes out through the exit tube. Cells can be harvested continuous from a large volume of the culture medium. This approach does not therefore use centrifuge tubes but a continuous flow of medium. As the medium enters the moving rotor, biological particles are sedimented against the rotor periphery and excess liquid removed through a special outlet port.

Ultracentrifuges:

(a) Preparative Ultracentrifuge:

This is a type of instrument where actual isolation, purification of macromolecules or cell organelles can be done. It operates in refriger-ated condition under vacuum to avoid frictional resistance of the rotor caused by the spinning air.

The whole system is sophisticated with continuously monitoring system of the rotor temperature (temperature sensor). There is also one over speed disk system which checks the rotor so that it does not exceed its maximum allowable speed.

It operates through some pho-toelectric devices. For ultra smooth and quiet performance of the rotor, it is attached directly to the motor. Most rotors are fabricated from Titanium or Aluminum alloys. Titanium rotor has one advantage that it is quite resistant to corrosion. This instrument can attain a maximum speed of 80,000 r.p.m. and can produce a centrifugal field of 600,000 g.

(b) Analytical Ultracentrifuge:

This instrument has many applications in the fundamental studies of macromolecules show-ing the molecular weight, purity and shape of the material. It runs at a speed of about 70-80,000 r.p.m. with about 500,000 g and consists of a specially designed rotor in a special rotor chamber which remains under vacuum at low temperature. There is an arrangement of a special optical system to determine the concentration distributions within the sample during centrifugation.

Industrial centrifuge

(a) Disc stack centrifuge

•Disc stack centrifuges are able to apply a force from 4000 to 14,000 times gravitational force. *Typical particle size and feed concentration range*: 0.1–100 μm and 0.05–2% w/w (self-cleaning and manual discharge), 0.5–10% w/w (nozzle discharge).

•The disc stack centrifuge is a versatile device, which may be used for separating solid/liquid mixtures in continuous, semi-continuous and batch configurations. Disc stack centrifuges are ideally suited for separating particles 3–30 μm in concentrations of 0.02%–0.05% of microalgal cells.

•Although several variants exist, the generic type is characterised by an imperforate bowl surrounding an inverted stack of 30–200 thin conical discs separated by 0.3–3 mm spacers. The disc spacing is dependent on the viscosity and solids content in the feed and needs to be fixed accordingly, lower viscosities and solids concentrations favour spacings below 1 mm. As the discs are spun on a common vertical axis the process suspension, which is fed centrally from the top, travels through the annular spaces between the discs.

•Centrifugal forces up to 14000g cause particles to accumulate on the underside of the discs from where they slide down towards the outer periphery of the centrifuge bowl. In batch units the thickened solids remain in the bowl until the solids handling capacity of the centrifuge is reached.

•While disc stack centrifuges are able to accept a wide range of feeds they are both mechanically complex and expensive. Moreover, the close stacking of conical discs means that mechanical cleaning can be difficult, and resort is often made to chemical cleaning.

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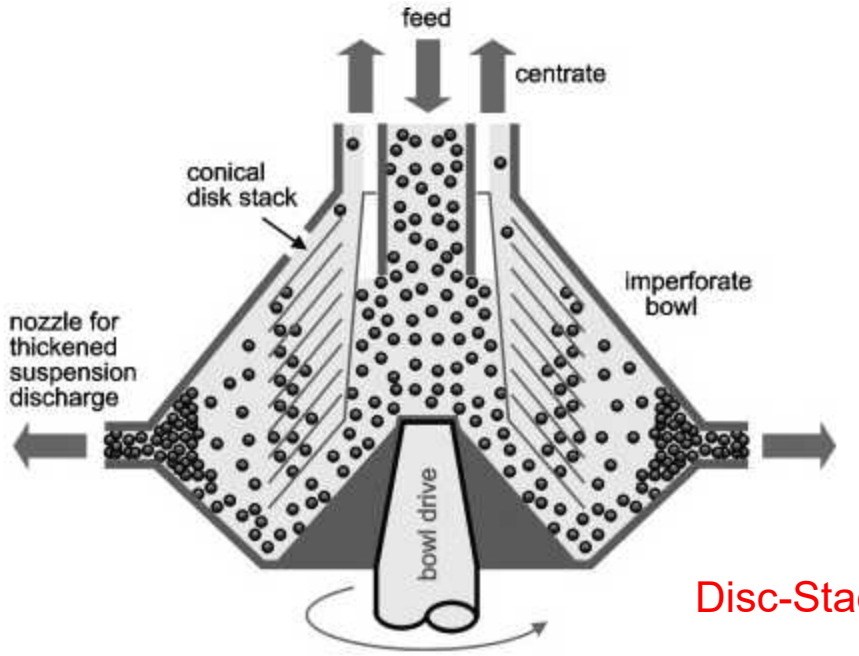
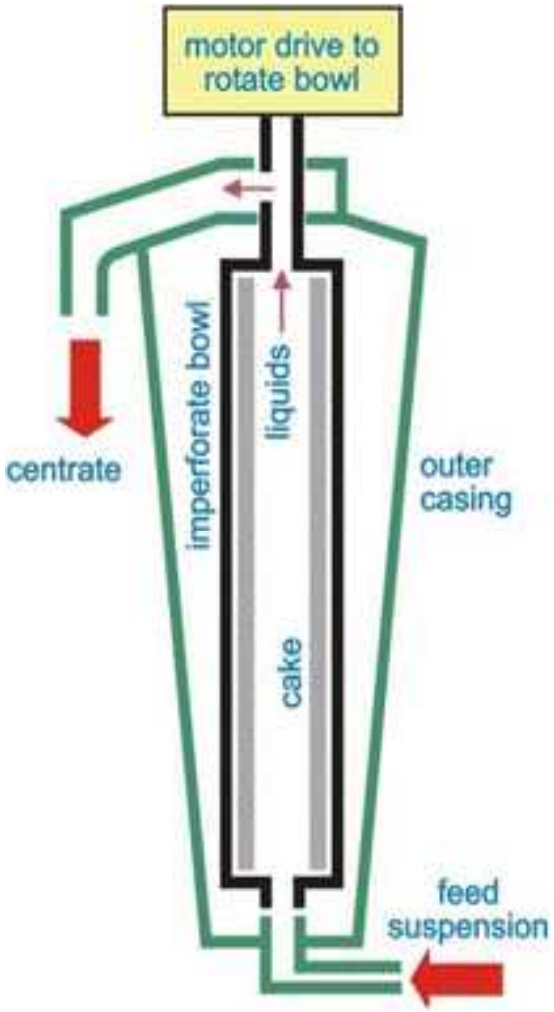


Disc-Stack Centrifuge

(b) Tubular bowl centrifuge

Tubular centrifuges are the simplest type of mechanical centrifuge. The tubular centrifuge consists of a vertical tubular rotor with an inlet for feed and outlets for the light and heavy phases, enclosed in a stationary housing. Tubular centrifuges serve mainly as separators. The two liquid phases are discharged continuously, while small amounts of solid impurities (sludge) are retained in the bowl and removed when the machine is stopped for cleaning. Tubular centrifuges rotate at high speed (typically 15 000 rpm), developing centrifugal accelerations in excess of 10 000 g. They can, therefore, separate liquids of slightly different densities and retain very fine solid particles. On the other hand, they have limited capacity due to their geometry

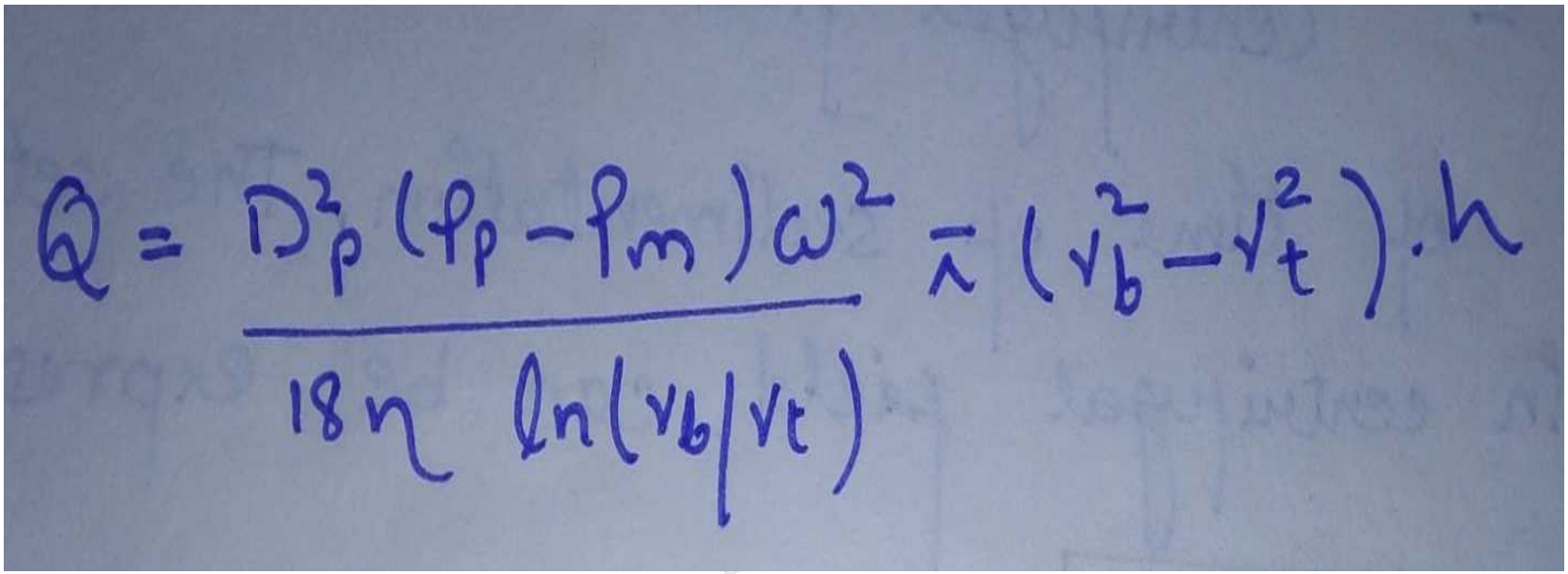


Tubular Bowl centrifuge

Calculation of centrifuge throughput, Q of tubular bowl centrifuge

•Once we know how long a particle should be in the centrifuge, we can calculate a feed flowrate, *Q*. The volume of fluid in the centrifuge is $V = (\pi r^2_b - r^2_t) h$. Calculate the volumetric flow rate $Q = V/t_{s.}$ therefore putting the equation of settling time and volume in this equation we get:

•The unit of Q is m^3s^{-1}



Feed flow rate of tubular bowl centrifuge

References & Further reading

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