

Principle, Applications and Types of Centrifugation

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INTRODUCTION

Centrifugation is a process for separating or concentrating materials suspended in a liquid medium. The theoretical basis for this technique is the effect of gravity on particles in suspension. Gravity causes two particles of different masses to settle at different rates in a tube. The centrifugal force is proportional to the rotation rate of the rotor. The centrifuge is made up of a rotor and a refrigerated chamber powered by an electric motor.

Definition

Centrifugation is a mechanical process that uses centrifugal force to separate particles from a solution based on their size, shape, density, medium viscosity, and rotor speed. The denser components of the mixture migrate away from the centrifuge's axis, while the less dense components migrate towards it.

PRINCIPLE OF CENTRIFUGATION

- The centrifuge uses the sedimentation principle.
- The centrifugation technique works on the principle of separating particles suspended in liquid media using a centrifugal field. These are placed in tubes or bottles in the centrifuge's rotor [1].
- Sedimentation is the process by which suspended material settles out of fluids due to gravity. The suspended material could be clay or powder particles. As an example, consider tea leaves falling to the bottom of a teacup.
- Particles larger than 5 micrometers are separated by a simple filtration process, whereas particles smaller than 5 micrometers do not sediment under gravity. The central force can be used to separate those particles [2].

Objective

- Separation of immiscible liquids.
- Remove impurities from the supernatant liquid to purify the component.
- Crystalline drugs are separated from mother liquor.
- Accelerated creaming and sedimentation testing of the emulsion and suspensions.

APPLICATIONS OF CENTRIFUGATION

- Bulk drug production.
- Manufacturing of biological products.
- Suspension and emulsion evaluation.
- Determination of collide molecular weight.
- Separation of chalk powder and water.
- Skimming milk is made by removing the fat from milk.
- The wine's clarification and stabilisation.
- Drug biopharmaceutical analysis.
- Application in water treatment.
- Draining lettuce after washing it in a salad spinner.
- Using cyclonic separation to separate particles from an airflow.

Process of centrifugation

- The centrifuge is made up of a container that holds a mixture of solid and liquid or two liquids [3-4]. The container is then rapidly rotated. The action of centrifugal force on the density of the mixture separates it into its constituent parts when this container is rotated at high speed.
- A solid or liquid with a higher specific gravity is thrown with greater force [5].

Types of centrifugation techniques

The below mentioned are the following centrifugation techniques-

Density gradient centrifugation: It allows for the separation of many or all components in a mixture as well as measurement. Density gradient centrifugation can be classified into two types: rate zonal centrifugation and isopycnic or sedimentation equilibrium centrifugation.

Rate zonal centrifugation: The solution has a density gradient in rate zonal centrifugation. As a result, the sample has a higher density than all of the solution's layers. On a density gradient, the sample is applied in a thin zone at the top of the centrifuge tube. The particles will begin segmenting through the gradient due to centrifugal force. The particles will begin segmenting into distinct zones based on their size, shape, and density.

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Isopycnic or sedimentation equilibrium centrifugation: The solution contains a wider range of densities in this type of centrifugation. The density gradient contains the entire range of particle densities in the sample pool. Sediment each particle only to the position in the centrifuge tube where the gradient density equals the particle density. Centrifugation separates particles into zones in sedimentation based on their density difference, regardless of time.

Differential centrifugation: It is a common procedure in microbiology and cytology that is used to separate specific organelles for further analysis of specific cell parts. A tissue sample is first homogenised in order to break the cell membranes and mix up the cell contents. The homogenate is then centrifuged repeatedly, each time removing in the pellet and increasing the centrifugal force.

Ultracentrifugation: The term "ultracentrifugation" was coined by Svedberg. He worked as a chemist. He used the ultracentrifuge to determine hemoglobin's MW and subunit structure. In 1940, the first commercial ultracentrifuge was produced. The centrifuge is an important tool in biochemical research because it imposes high centrifugal forces on suspended particles or even molecules in solution and causes separation of such matter based on weight differences. Red cells, for example, can be separated from blood

plasma, nuclei from mitochondria and cell homogenate, and one protein from another in complex mixtures.

CONCLUSION

Therefore centrifugal force is used as the driving force for particle separation in centrifugation. The sedimentation of two particles is caused by centrifugal force rather than gravitational force. Thus, centrifugation is useful when conventional filtration methods do not work for particle separation. When two particles of different sizes but the same density are suspended in any liquid medium, they may be unable to separate using a simple filtration method. In such cases, the centrifugation method comes in handy.

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