

SIZE SEPARATION



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SIZE SEPARATION

Size separation is a unit operation that involves the separation of a mixture of various size particles into two or more portions by means of screening surfaces. Size separation is also known as sieving, sifting, screening. This technique is based on physical differences b/w the particles such as size, shape and density.

OBJECTIVES / APPLICATION OF SIZE SEPERATION

- ▶ To determine particle size for the production of tablets and capsules.
- ▶ To improve mixing of powders.
- ▶ To improve the solubility and stability of particles during production.
- ▶ To optimize feed rate, agitation, screening during production.
- ▶ Quality control of raw materials.
- ▶ Useful in production of tablets, capsules, suspension, emulsion, ophthalmic preparations, ointments, creams, etc

OFFICIAL STANDARDS FOR POWDERS

The Indian Pharmacopoeia has laid down the standards for powders for pharmaceutical purposes. The I.P. specifies five grades of powder which are as under :

- ▶ **COARSE POWDER-** A powder of which all the particles pass through a sieve with nominal mesh aperture of 1.7 mm (No. 10 sieve) and not more than 40.0 per cent through a sieve with nominal mesh aperture of 355 μm (No. 44 sieve) is called coarse powder.
- ▶ **MODERATELY COARSE POWDER-** A powder of which all the particles pass through a sieve with nominal mesh aperture of 710 μm (No. 22 sieve) and not more than 40.0 per cent through a sieve with nominal mesh aperture of 250 μm (No. 60 sieve) is called moderately coarse powder.

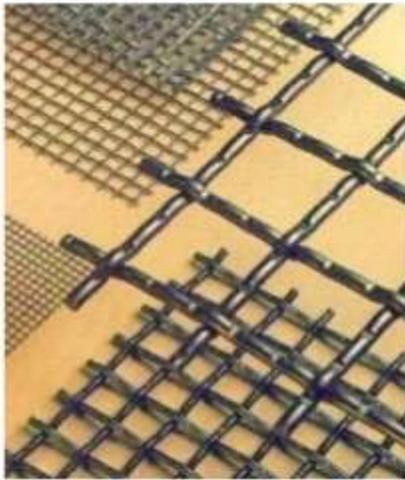
- ▶ **MODERATELY FINE POWDER**- If all the particles of a powder pass through a sieve with nominal mesh aperture of 355 μm (No. 44 sieve) and not more than 40.0 per cent through a sieve with nominal mesh aperture of 180 μm (No. 85 sieve), it falls in this group.
- ▶ **FINE POWDER**- In case all the particles pass through a sieve with a nominal mesh aperture of 180 μm (No. 85 sieve), it is called fine powder,
- ▶ **VERY FINE POWDER** - If all the particles of the powder pass through a sieve with a nominal mesh aperture of 125 μm (No. 120sieve), it is said to be very fine powder.

SIEVES

Sieves are constructed from wire cloth with square meshes, woven from wires of brass, bronze, stainless steel or any other suitable material. The wires should be of uniform circular cross-section and should not be coated or plated. There should not be any reaction between the material of the sieve and the substance which is being sifted from it.

Standards for sieves used to testing must specify the following:

- ▶ **Number of sieve** : Sieve number indicates the number of meshes in a length of 2.54 cm in each transverse direction parallel to the wires.
- ▶ **Nominal size of aperture** : Nominal size of aperture indicates the distance between the wires. It represents the length of the side of the square aperture. The I.P. has given the nominal mesh aperture size for majority of sieves in mm or in cm.



Nominal size of
aperture



sieves

- ▶ **Nominal diameter of the wire :** Wire mesh sieves are made from the wire having the specified diameter in order to give a suitable aperture size and sufficient strength to avoid distortion of the sieve.
- ▶ **Approximate percentage sieving area :** This standard expresses the area of the meshes a percentage of the total area of the sieve. It depends on the size of the wire used for any particular sieve number. Generally the sieving area is kept within the range of 35 to 40 percent in order to give suitable strength to the sieve.
- ▶ **Tolerance average aperture size :** Some variation in the aperture size is unavoidable and when this variation is expressed as a percentage, it is known as the 'aperture tolerance average'.

MECHANISM OF SIZE SEPERATION

The working of mechanical sieving devices are based on any of the following methods.

- ▶ Agitation
- ▶ Brushing
- ▶ Centrifugal

Agitation methods- Sieves may be agitated in a number of different ways, such as:

- ▶ **Oscillation :** This sieve is mounted in a frame that oscillates back and forth. It is a simple method but the material may roll on the surface of the sieve.
- ▶ **Vibration :** The sieve is vibrated at high speed by means of an electric device. The rapid vibration is imparted to the particles on the sieve which helps to pass the powdered material through it.
- ▶ **Gyration :** In this method, a system is made so that sieve is on rubber mounting and connected to an eccentric fly wheel. This gives a rotary movement of small amplitude to sieve which turn gives spinning motion to the particles that helps to pass them through a sieve.

Agitation methods are not continuous methods' but can be made so by inclination of the sieve and the provision of separate outlets for undersize and oversize particles.

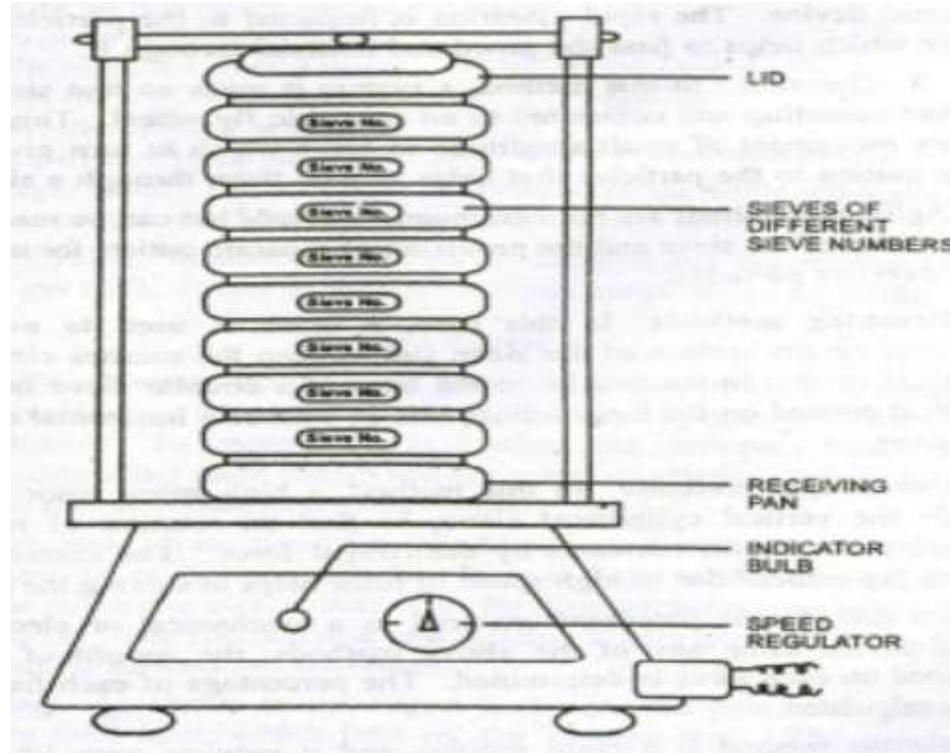
- ▶ **Brushing methods-** In this case, a brush is used to move the particles on the surface of the sieve and to keep the meshes clear. The brush is rotated in the middle in the case of a circular sieve but spiral brush is rotated on the longitudinal axis in case Of a horizontal cylindrical sieve.
- ▶ **Centrifugal methods-** In this method, a high speed rotor is fixed inside the vertical cylindrical sieve, so that on rotation of rotor the particles are thrown outwards by centrifugal force. The current of air which is produced due to high speed of rotor helps in sieving the powder.

SIEVING METHOD

- ▶ In this method, the fine powder is separated from the coarse powder by using sieves of desired number. The degree of fineness of a powder is known with the help of sieve through which the powdered material is passed. Sieves are numbered in order to distinguish from each other.

Working & construction

- ▶ Size separation of powder is done by passing the powdered material through a set of sieves. Sieves are arranged in descending order i.e. sieve of larger size is at the top and the smallest one at the bottom. The bottom sieve is attached to the receiving pan. The material is placed in the uppermost sieve. The sieves are shaken with the help of mechanical sieve shaker or electromagnetic devices. It helps the particles to pass through the sieves



Sieve shaker machine

Advantages-

- ▶ inexpensive
- ▶ Easy to use

Disadvantages –

- ▶ Chance of clogging of sieve if powder is not properly dry
- ▶ During shaking, attrition may occur.

CYCLONE SEPARATOR

Principle

- ▶ In cyclone separator, the centrifugal force is used to separate solids from fluids. The separation depends not only on the particle size but also on density of particles. Hence depending on the fluid velocity, the cyclone separator can be used to separate all types of particles or to remove only coarse particles and allow fine particles to be carried through with the fluid.

Construction

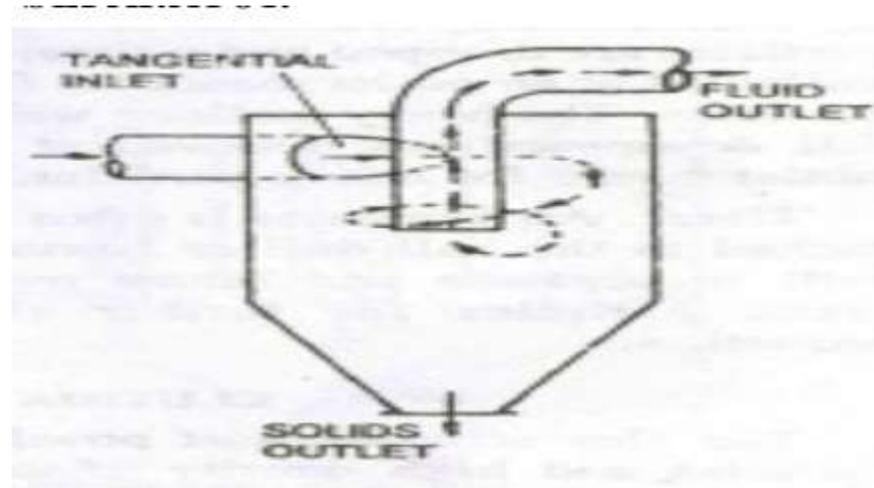
- ▶ It consists of a cylindrical vessel with a conical base. In the upper part of the vessel is fitted with a tangential inlet and a fluid outlet and at the base it is fitted with solid outlet.

Working

- ▶ The suspension of a solid in gas (usually air) is introduced tangentially at a very high velocity, so that rotary movement takes place within the vessel. The fluid is removed from a central outlet at the top. The rotatory flow within the cyclone separator causes the particles to be acted on by centrifugal force. The solids are thrown out to the walls, thereafter it falls to the conical base and discharged out through solids outlet.

Uses

- ▶ Cyclone separators are used to separate the suspension of a solid in a gas (air).
- ▶ It can be used with liquid suspensions of solids



Cyclone separator

AIR SEPARATOR

Principle

- ▶ It works on the same principle as that of cyclone separator. But in this case the air movement is obtained by means of rotating disc and blades. To improve the separation, the stationary blades are used. By controlling these blades and the speed of rotation, it is possible to vary the size at which separation occurs.

Construction

- ▶ It consists of a cylindrical vessel with a conical base. In the upper part of the separator the vessel is fitted with feed inlet, and at the base there are two outlets, one for light particles and other for heavy particles. The rotating disc and rotating blades are attached to the central shaft, to produce air movement

Working

- ▶ the sample powder is passed through the feed inlet, which falls on the rotating disc. The rotating blades are attached to the same shaft. These produce a current of air as shown by the arrows. The fine particles are picked up and are carried into space, where air velocity is sufficiently reduced. The fine particles are dropped and ultimately collected at an outlet meant for fine particles. The heavy particles which fall downward are removed at an outlet meant for heavy particles.

Uses

- ▶ Air separator is often attached to the ball mill or hammer mill to separate and return oversized particles for further size reduction

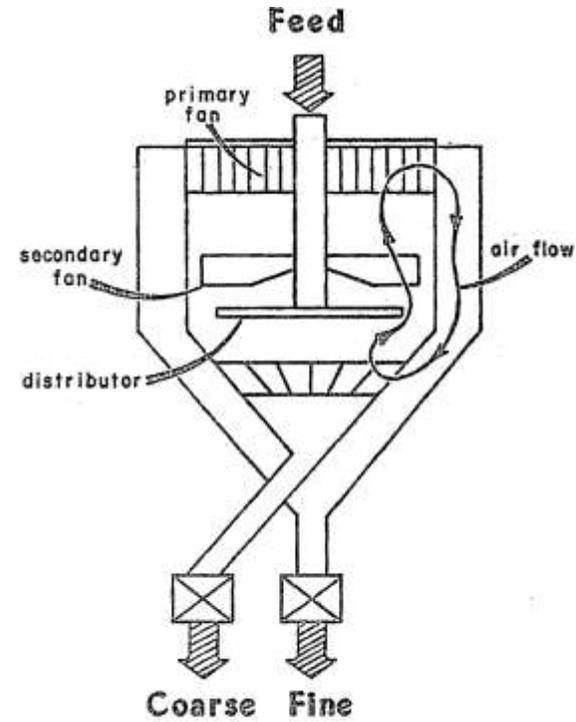
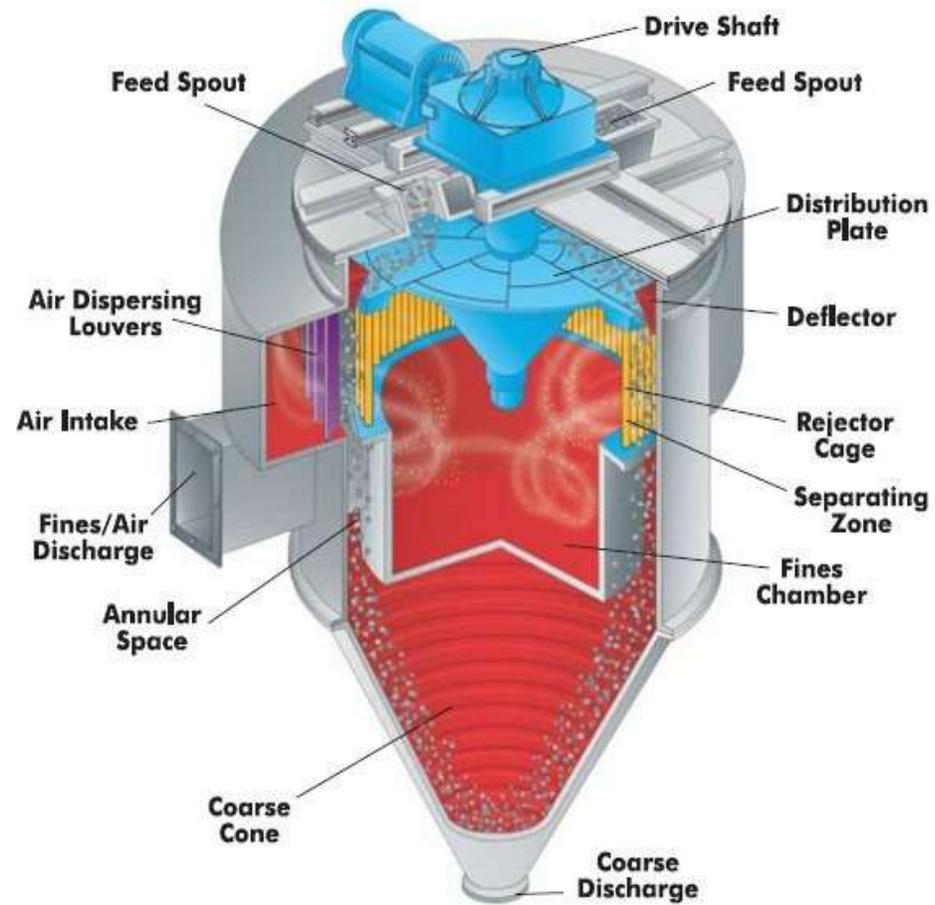


Figure 2 - A mechanical air separator

Air separator

ELUTRIATION METHOD

- ▶ The size separation of powder is based on the low density of fine particles and high density of the coarse particles. Elutriating tank is used to separate the coarse and fine particles of powder after levigation.

Working

- ▶ The dry powder or paste made by levigation process is kept in an elutriating tank and mixed with a large quantity of water.
- ▶ The solid particles are uniformly distributed in the liquid by stirring and then it is allowed to settle down. Depending on the density of solid particles, it will either settle down or remain suspended in water.
- ▶ The sample is withdrawn at different heights through the outlets. These are dried and thus the powder with various size fractions are collected

- ▶ Nowadays in elutriation process, the particles are suspended in a moving fluid, generally water or air. The apparatus consists of a vertical column with an inlet near the bottom for suspension, an outlet at the base for coarse particles and an overflow near the top for fluid and fine articles. One column will give single separation into two fractions. If more than one fraction is required a number of tubes of increasing area of cross section can be connected in series. The velocity of the fluid decreases in succeeding tubes as the area of cross section increases, thus giving a number of fractions. These fractions are separated and dried.

Advantages

- ▶ The process is continuous.
- ▶ Depending on the number of fractions required, the same number of tubes of different area of cross section can be connected.
- ▶ The separation is quick as compare to other methods of separation.
- ▶ The apparatus is more compact than as that used in sedimentation methods.

Disadvantage

- ▶ The suspension of solid particles has to be diluted which may not be desired in certain cases.

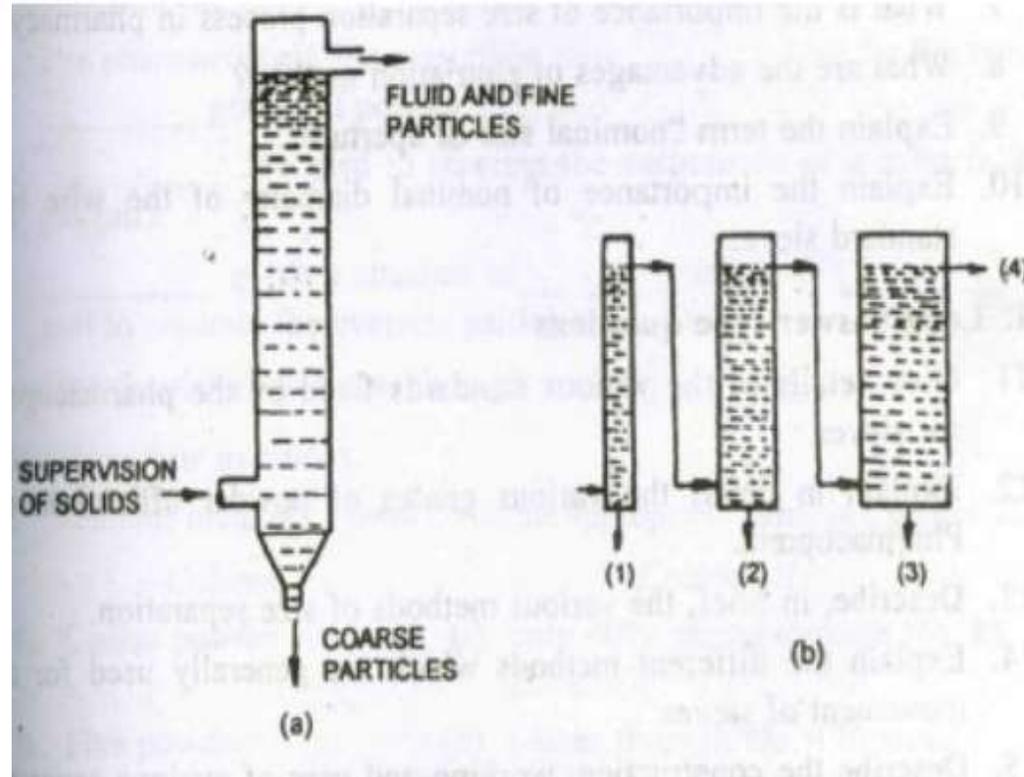


Fig. elutriation tank

BAG FILTER

- ▶ Size separation of fine dust from the milled powder is achieved in 2 steps
- ▶ In 1st step, the milled powder is passed through a bag filter (cloth) by applying the suction on the opposite side of feed entry
- ▶ In the 2nd step pressure is applied in order to shake the bags so that powder adhering to bags falls off, which is collected from the conical base

Construction:

- ▶ It consist of number of bags made of cotton or wool fabric. These are suspended in a sheet metal container. A bell crank lever arrangement is made to bring the filter to normal atmospheric condition.

Working:

- ▶ Step I-Feed is separated from air by passing it through the cloth bags
- ▶ Step II-Bags are shaken to collect the fines that are adhered to the bags

These 2 steps are subsequent and are controlled at different interval with the help of bell crank lever arrangement.

- ▶ **Filtering period-**: The exhaust fan positioned at the top keeps the bags under less pressure than atmospheric pressure. The gas containing fine particles or dust enters the hopper and passes up. The gas feed passes through the fabric of bag. During this process, the fines are retained in the bags, while gas reaches the top of the casing. Because of air the bag remains taut during filtration operation.

- ▶ **Shaking period-:** Since vacuum is cut off in the chamber, air from outside enters the casing and passes through the bags. This result in violent shaking of the bags, so that the dust and fine particles are displaced from the bags and falls into the conical base.

Uses

- ▶ Bag filters are used along with other size separation equipment e,g cyclone separator It is connected to the fluidized energy mill to discharge end.

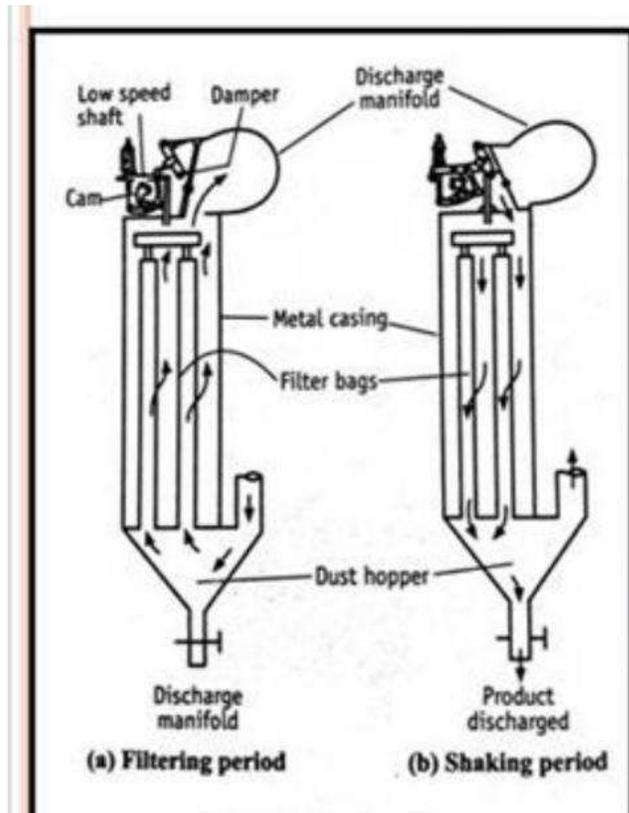


Fig. Bag filter

T H A N K

Y O U