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Subject Name	**: Pharmaceutics**
Topic Name	**: Size Separation**

Ch - 5

Size Separation

Size Separation: A special technique is used to separate particles of specified size which is knownas the "process of size separation".

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 whichare as under:

1. **Coarse powder:** A powder of which al! the particles pass through a sieve with nominal mesh aperture of 1.70 mm (No. 10 sieve) and not more than 40.0 per cent through a sieve with nominalmesh aperture of 355 urn (No. 44 sieve) is called coarse powder.
2. **Moderately coarse powder:** A powder of which all the particles pass through a sieve with nominal mesh aperture of 710 nm (No. 22 sieve) and not more than 40.0 per cent through a sievewith nominal mesh aperture of 250 nm (No. 60 sieve) is called moderately coarse powder.
3. **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.
4. **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.
5. **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 for pharmacopoeial testing are constructed from wire cloth with square meshes,woven from wires of brass, bronze, stainless steel or any other suitable material. The wires shouldbe 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 shifted from it.

Standards for sieves used for pharmacopoeial testing must specify the following:

1. **Number of sieves:** Sieve number indicates the number of meshes in a length of 2.54 cm in each transverse direction parallel to the wires.
2. **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.
3. **Nominal diameter of the wire:** Wire mesh sieves are made from the wire having the specifieddiameter in order to give a suitable aperture size and sufficient strength to avoid distortion of the sieve.

4. **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 particularsieve number. Generally the sieving area is kept within the range of 35 to 40 per cent in order to give suitable strength to the sieve.
5. **Tolerance average aperture size:** Some variation in the aperture size is unavoidable and whenthis variation is expressed as a percentage, it is known as the 'aperture tolerance average'.

SIEVING METHOD: In this method, the fine powder is separated from the coarse powder by usingsieves 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 fromeach other. Size separation of powder is done by passing the powdered material through a set ofsieves. 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 mechanicalsieve shaker or electromagnetic devices. It helps the particles to pass through the sieves.

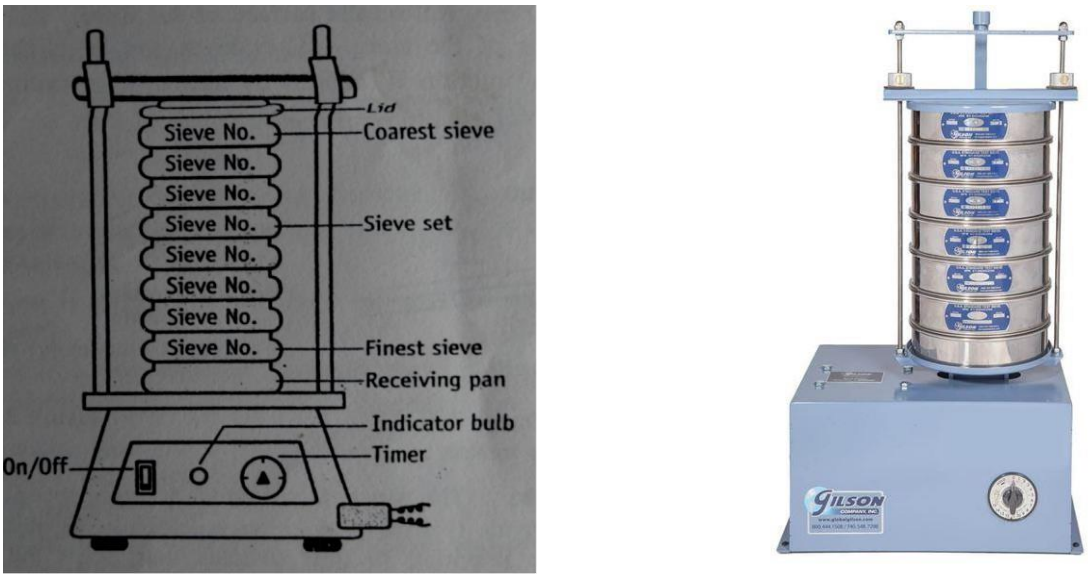


Fig: 5.1 Sieve Shakers

The working of mechanical sieving devices is based on any of the following methods:

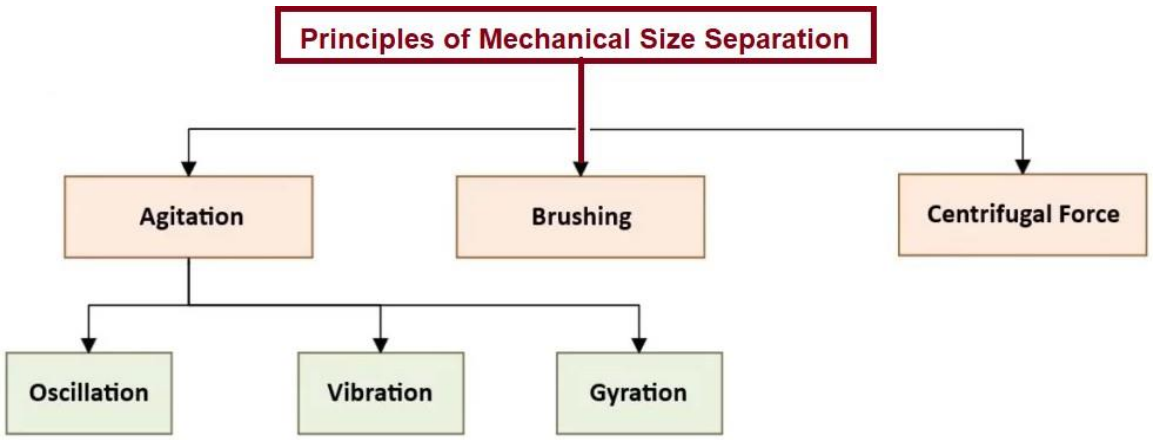
1. Agitation
2. Brushing
3. Centrifugal Agitation methods Sieves may be agitated in a number of different ways, such as:

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

a. Oscillation: This sieve is mounted in a frame that oscillates back and forth. It is a simple methodbut the material may roll on the surface of the sieve.

b. 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.

c. Gyration: In this method, a system is made so that sieve is on rubber mounting and connectedto an eccentric fly wheel. This gives a rotary movement of small amplitude to sieve which hi turn gives spinning motion to the particles that helps to pass them through a sieve.



2. 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.

3. 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 currentof air which is produced due to high speed of rotor helps in sieving the powder. On shaking the powdered material in a mechanical or electromagnetic device using any of the above methods, the weight of powder retained on each sieve is determined. The percentage of each fraction is then calculated. Sieving method is a rapid process and it requires very little skill. The equipment used for sieving is not expensive.

CYCLONE SEPARATOR

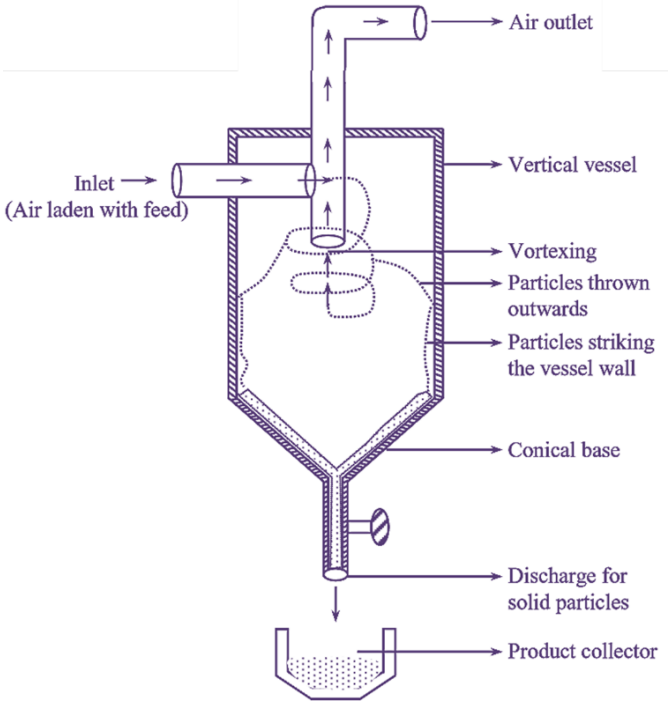


Fig: 5.2 Cyclone Separator

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 dependingon 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 vesselis fitted with a tangential inlet and a fluid outlet and at the base it is fitted with solid outlet.

Working:

1. 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.
2. The fluid is removed from a central outlet at the top.
3. The rotatory flow within the cyclone separator causes the particles to be acted on by centrifugalforce.
4. The solids are thrown out to the walls, thereafter it falls to the conical base and discharged outthrough solids outlet.

Uses: Cyclone separators are used to separate the suspension of a solid in a gas (air). It can beused with liquid suspensions of solids.

AIR SEPARATOR

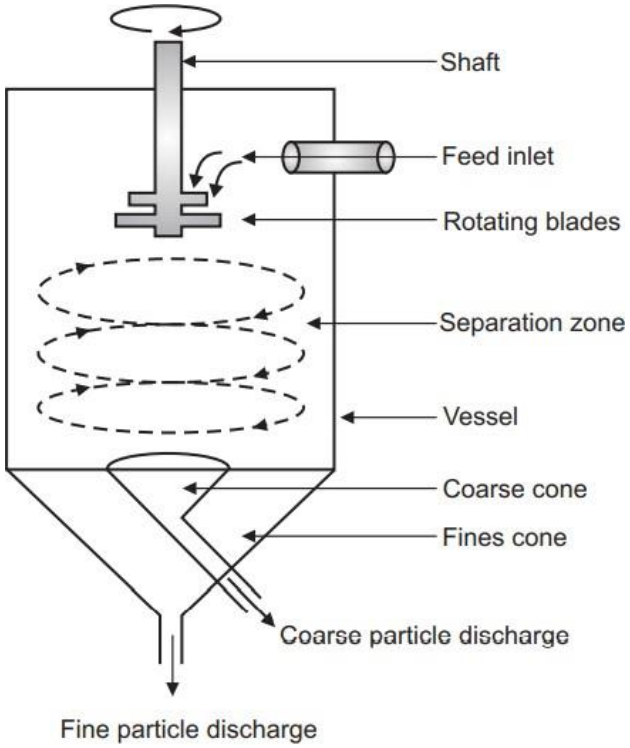


Fig:5.3 Air Separator

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 tovary 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 line particles and other for heavy particles. The rotating disc and rotating blades are attached to the central shaft, to produce air movement

Working:

1. The sample powder is passed through the feed inlet, which falls on the rotating disc.
2. The rotating blades are attached to the same shaft.
3. These produce a current of air as shown by the arrows.
4. The fine particles are picked up and are carried into space, where air velocity is sufficientlyreduced.
5. The fine particles are dropped and ultimately collected at an outlet meant for fine particles.
6. 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.

Elutriation Method:

1. The size separation of powder is based on the low density of fine particles and high density of the coarse particles.
2. Elutriating tank is used to separate the coarse and fine particles of powder after levigation.
3. The dry powder or paste made by levigation process is kept in an elutriating tank and mixed with a large quantity of water.
4. The solid particles are uniformly distributed in the liquid by stirring and then it is allowed to settledown. Depending on the density of solid particles, it will either settle down or remain suspended in water.
5. The sample is withdrawn at different heights through the outlets.
6. 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.

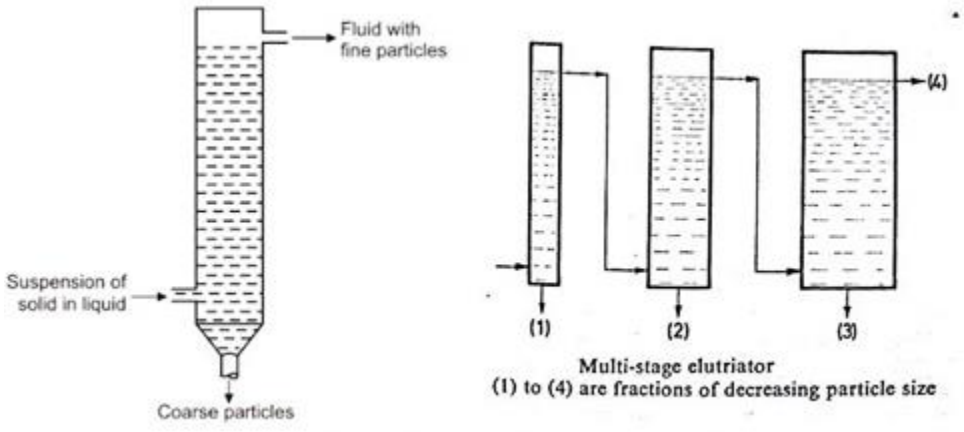


Fig: 5.4 Elutriation method of size separation

Construction: 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 isrequired 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 of Elutriation Method:

(1) The process is continuous.

(2) Depending on the number of fractions required, the same number of tubes of different area of cross section can be connected.

(3) The separation is quick as compare to other methods of separation.

(4) The apparatus is more compact than as that used in sedimentation methods. The main disadvantage of this method is that the suspension of solid particles has to be diluted.