WELCOME

TO

This is an Education Platform

We Provide PDF Notes for Pharmacy Students

Web Site http://www.fdspharmacy.in/

You tube https://www.youtube.com/c/FDSpharmacy

Telegram https://t.me/Fdspharmacy

App https://play.google.com/store/apps/details?id=com.FDSPharmacyMedia.FDSPharmacy

E-mail fdspharmacyinfo@gmail.com

PHARMACEUTICAL ENGINEERING

UNIT 1

TOPIC :

- **Size Separation :** Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.

SIZE SEPARATION

→ Size separation is a pharmaceutical process used to separate particles of the desired size from a mixture of various sized particles.
→ It is also known as Sieving, Screening, or Sifting.
→ Since size reduction produces particles of irregular and varying sizes, it becomes necessary to carry out size separation to obtain powders of uniform particle size.

Objectives / Applications of Size Separation

1. To prepare granules of desired size for further processing.
2. To classify materials into different size ranges, e.g., fine, medium, and coarse particles.
3. To obtain uniform dosage forms, ensuring accuracy of weight and dose.
4. To separate undesirable particles (oversized or foreign materials) from a mixture.
5. To evaluate the efficiency of size reduction equipment by checking particle size distribution.
6. To improve mixing of powders by ensuring uniformity in size.
7. To improve solubility and stability of drugs, since smaller and uniform particles dissolve more easily.
8. For the preparation of tablets, suspensions, and other pharmaceutical formulations, where uniformity is essential.
9. During capsule filling, uniform particle size ensures consistent weight and dosage.
10. Used in quality control to check compliance with official standards (IP, BP, USP).

Mechanism of Size Separation

Size separation in the pharmaceutical industry is mainly carried out by the following **three mechanisms**:

1. **Agitation**
2. **Brushing**
3. **Centrifugation**

1. Agitation Method

- Agitation involves the use of sieves where particles are passed through mesh openings by providing motion to the sieve.
- Different modes of agitation include:

(a) Oscillation

- The sieve moves in an oscillatory motion (to-and-fro).
- Material is spread over the sieve surface and particles pass through according to mesh size.

(b) Vibration

- The sieve vibrates in up–down or side-to-side motion.
- Vibration helps smaller particles to pass through quickly, improving efficiency.

(c) Gyration

- In this type, the sieve undergoes a rotatory (circular) motion.
- This allows particles to **spin** and pass through the sieve meshes effectively.

2. Brushing Method

- A brush is used to keep the sieve meshes clean and free from clogging.
- The brush rotates in the center in the case of circular sieves.
- Useful for greasy, sticky, or light powders which otherwise block the sieve openings.

3. Centrifugation Method

- A high-speed rotor is fixed inside a vertical cylindrical sieve.
- Works on the principle of centrifugal force.
- The rotor creates a stream of air due to rotation, which pushes fine particles outward through the sieve mesh.
- Commonly used for separating fine powders where other methods are less effective.

Official Standards of Powders (According to Indian Pharmacopoeia – IP)

→ Powders are classified based on the degree of fineness or coarseness.
→ According to IP standards, classification is expressed with reference to the sieve number through which the particles can pass.
→ The sieve number corresponds to the number of meshes per linear inch.

Classification of Powders as per IP

Grade of Powder	Sieve through which all particles pass	Sieve through which not more than 40% pass
Coarse Powder	Sieve No. 10	Sieve No. 44
Moderately Coarse Powder	Sieve No. 22	Sieve No. 60
Moderately Fine Powder	Sieve No. 44	Sieve No. 85
Fine Powder	Sieve No. 85	–
Very Fine Powder	Sieve No. 120	–

1. Coarse Powder

- All particles pass through **Sieve No. 10**.
- Not more than **40%** of the particles pass through **Sieve No. 44**.

2. Moderately Coarse Powder

- All particles pass through **Sieve No. 22**.
- Not more than **40%** pass through **Sieve No. 60**.

3. Moderately Fine Powder

- All particles pass through **Sieve No. 44**.
- Not more than **40%** pass through **Sieve No. 85**.

4. Fine Powder

- All particles pass through **Sieve No. 85**.

5. Very Fine Powder

- All particles pass through **Sieve No. 120**.

SIEVES

- Sieves are devices used for size separation of particles, i.e., separating wanted material (desired size) from unwanted material (oversized or undersized).
- Sieving is one of the simplest and most frequently used methods of particle size separation in pharmacy.
- Sieves are standardized under Indian Pharmacopoeia (IP), USP, BP for uniformity in particle size.

Types of Sieves

Sieves are broadly classified into the following categories:

1. Woven Wire Sieves

- These are general-purpose sieves, widely used in pharmaceutical operations.
- Made from woven metal wires**.**
- Subtypes include:
  - **Plain Weave Sieve** – simplest form with wires woven over and under alternately.
  - **Twill Weave Sieve** – stronger, where each wire crosses over two and under two.
  - **Dutch/ Fish Weave Sieve** – provides very fine openings, used for fine powders.

2. Bolting Cloth Sieves

- Made **of** nylon, silk, or synthetic cloth instead of wire mesh.
- Mainly used for the separation of fine powders**.**
- Useful in pharmaceutical industries for powders that may damage metallic sieves.

3. Bar Screens

- Used for handling very large and heavy materials**.**
- Constructed from iron or aluminum bars**.**
- Act as large mechanical filters to remove oversized materials.

4. Punched Plates (Perforated Screens)

- Also known as perforated sieves**.**
- Made from metal sheets (iron, steel, or aluminum).
- Perforations may be round, oval, square, or rectangular**.**
- Mainly used for coarse sizing and separation of granules or aggregates.

Equipments Used for Size Separation

Size separation (sieving, classification) is an important step in pharmaceutical operations for ensuring uniform particle size. Various equipments are used for this purpose, such as:

1. Sieve Shaker
2. Cyclone Separator
3. Air Separator
4. Bag Filter
5. Elutriation Tank

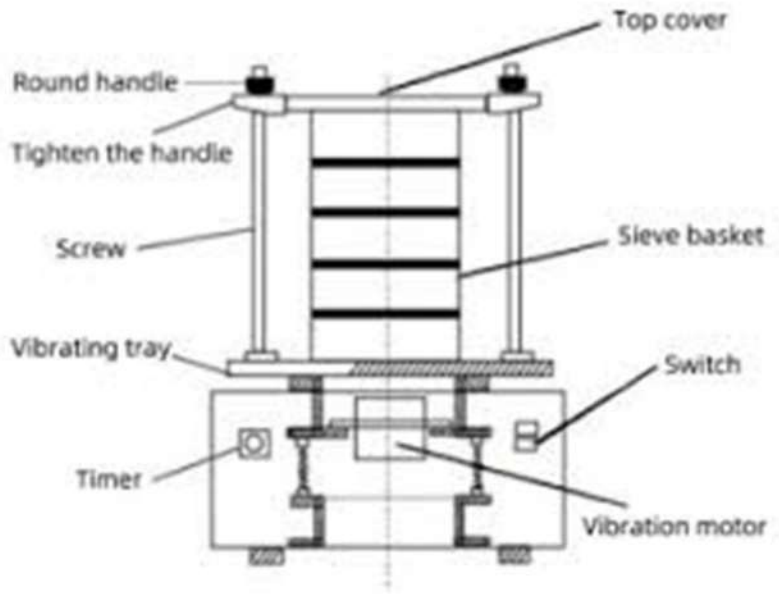
1. Sieve Shaker

A sieve shaker is a laboratory equipment used to separate powders into different particle sizes using vibration.
It is an automated version of the manual agitation process.

Principle

- Works on the principle of agitation/vibration.
- Powdered material gets separated depending on particle size and passes through sieves of decreasing mesh size arranged in a sequence.

Construction & Working



- It consists of a base frame on which a stack of standard sieves is mounted.
- Sieves are arranged largest mesh size at the top → smallest mesh size at the bottom.
- The powdered sample is placed in the top sieve.
- The device vibrates/shakes (usually 10–20 minutes).
- Powder particles pass through sieves depending on their size.
- Material retained on each sieve is collected and weighed → gives particle size distribution.

Uses

- For size separation of powders.
- For standardization and quality control of powders.
- Used in tablet and capsule formulation to ensure uniform particle size.

Advantages

- Requires less manual effort (automatic operation).
- Simple to install and operate.
- Provides reliable particle size distribution.
- Saves time compared to manual sieving.

Disadvantages

- During shaking, attrition (powder breakdown) may occur.
- Possibility of clogging of sieve mesh if powder is moist or sticky.
- Generates dust if not covered properly.

2. Cyclone Separator

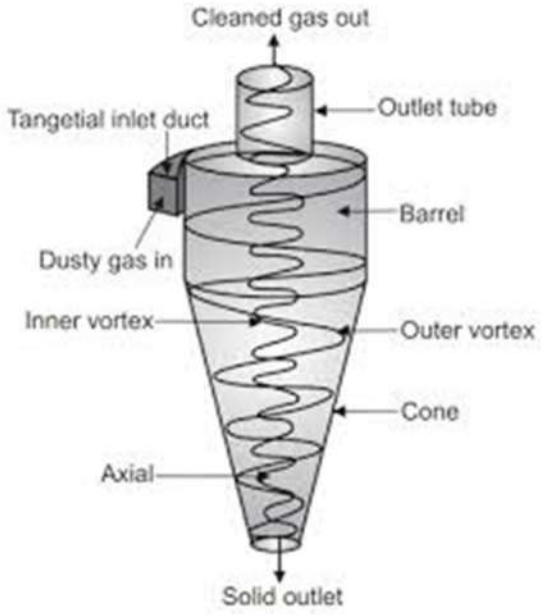
A cyclone separator is a mechanical device used for separating fine particles from air, gas, or liquid stream without the use of filters.
It is widely used in pharmaceutical industries for separating powders and controlling dust.

Principle

- Works on the principle of centrifugal force.
- When a mixture of solid particles and air enters tangentially at high speed into a cylindrical chamber, a whirling (cyclonic) motion is produced.
- Due to centrifugal force:
  - Heavier particles move outward and fall down into a collection chamber.
  - Lighter particles/air move upward and escape through the outlet.

Construction

- Consists of a cylindrical body with a conical base.
- At the top, there is a tangential inlet for powder + air mixture.
- An outlet pipe (vortex finder) is fixed at the center of the top cover for clean air/gas.
- At the bottom, a dust outlet or collection chamber is provided for separated particles.



Working

1. Powder-laden air enters tangentially into the cylindrical chamber.
2. A spiral vortex motion is created inside the cyclone.
3. Centrifugal force pushes coarse/heavy particles outward → they lose momentum and fall into the collection chamber.
4. The cleaned air/light particles move upward in a central vortex and exit through the outlet pipe.

Uses

- Separation of powders from air in pharmaceutical industries.
- Dust collection from grinding, milling, and size reduction equipment.
- Pre-cleaning of air before it enters air filters.
- Used in tablet and capsule manufacturing units for dust control.

Advantages

- Simple design, no moving parts.
- Can handle large volumes of powder-laden air.
- Low maintenance cost.
- Durable and reliable for continuous operation.

Disadvantages

- Not suitable for very fine particles (<5 μm) – efficiency decreases.
- Efficiency depends on air velocity and particle size.
- Requires large space for installation.
- Generates back pressure in the system.

3. Air Separator

An Air Separator is a mechanical device used for classifying and separating fine powders in pharmaceutical and chemical industries.
It separates light particles from heavy particles using a controlled stream of air.

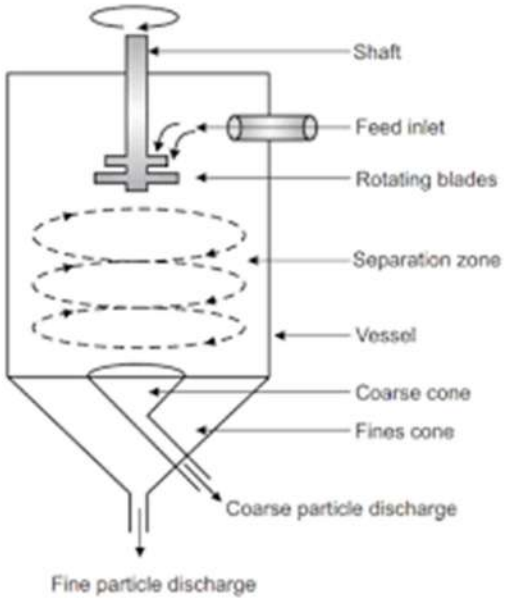
Principle

- Works on the principle of air classification.
- When a stream of air passes through a mixture of particles:
  - Light and fine particles are carried away with the air stream.
  - Heavy particles fall due to gravity and centrifugal forces.

Thus, particles are separated based on their size, weight, and aerodynamic properties.

Construction

- Consists of:
  - Feed inlet: for powder to be separated.
  - Air blower/fan: generates high-velocity air stream.
  - Separation chamber: where the classification of particles occurs.
  - Fine particle outlet: light particles exit with air.
  - Coarse particle outlet: heavy particles settle and are collected separately.



Working

1. The powder mixture is introduced into the separator.
2. A strong air stream is passed through the powder.
3. Fine/light particles are lifted by the air stream and carried to the outlet.
4. Heavy/coarse particles fall down and are collected separately.
5. Thus, the powder is separated into fine fraction and coarse fraction.

Uses

- Used for separation of powders after milling and grinding operations.
- Employed in the manufacture of tablets and capsules for uniform powder size.
- Used in industries for air classification of bulk powders.
- Helps in removal of fine dust particles.

Advantages

- Continuous process with high capacity.
- Efficient for separation of fine particles.
- No clogging of screens (unlike sieves).
- Adjustable air flow allows control of particle size cut-off.

Disadvantages

- Not suitable for sticky or moist powders.
- Requires high energy for air generation.
- Efficiency depends on air velocity and particle properties.
- More costly than simple sieving methods.

4. Bag Filter

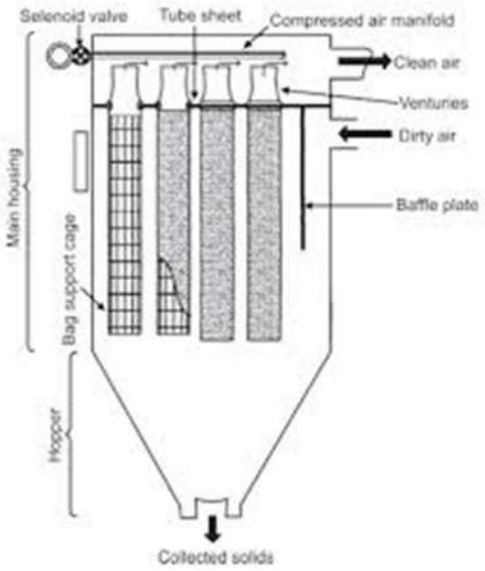
A Bag Filter is a mechanical device used to separate solid fine particles from air or gas streams.
It consists of fabric bags that act as a filter medium, trapping particles while allowing clean air to pass through.

Principle

- Works on the principle of filtration and dust collection.
- When dust-laden air passes through a porous fabric bag:
  - Solid particles are retained on the surface of the bag.
  - Clean air passes through and exits.
- The collected particles are removed periodically by shaking or reverse air flow.

Construction

- Consists of:
  - Inlet duct → for dust-laden air.
  - Filter bags (cylindrical fabric bags made of cotton, wool, nylon, or synthetic fiber).
  - Supporting cage/frame → provides shape and support to the bags.
  - Dust collection hopper → collects separated dust particles.
  - Outlet duct → for clean air exit.
  - Shaking/Reverse air mechanism → cleans the bags periodically.



Working

1. Dust-laden air enters through the inlet duct.
2. The air passes through fabric bags where:
    - Fine particles are trapped on the outer surface of the bag.
    - Clean air passes through the filter material and exits.
3. As dust accumulates, the filter resistance increases.
4. To clean the bags, they are shaken mechanically or back-flushed with reverse air.
5. Collected dust falls into the hopper and is removed.

Uses

- Widely used in pharmaceutical industries to maintain dust-free environments.
- Used in tablet and capsule manufacturing units to collect fine drug particles.
- Employed in chemical and food industries for air purification.
- Helps in controlling industrial air pollution.

Advantages

- High efficiency in removing fine particles (up to 99% efficiency).
- Simple construction and operation.
- Can handle large volumes of air/dust.
- Provides clean air environment in pharmaceutical production.

Disadvantages

- Not suitable for moist or sticky powders (clogging may occur).
- Bags require periodic replacement due to wear and tear.
- Higher maintenance cost compared to simple sieves.
- Large size requires more installation space.

5. Elutriation Tank

An Elutriation Tank is a device used for size separation of fine particles suspended in a fluid (generally water or air) based on their settling velocity.

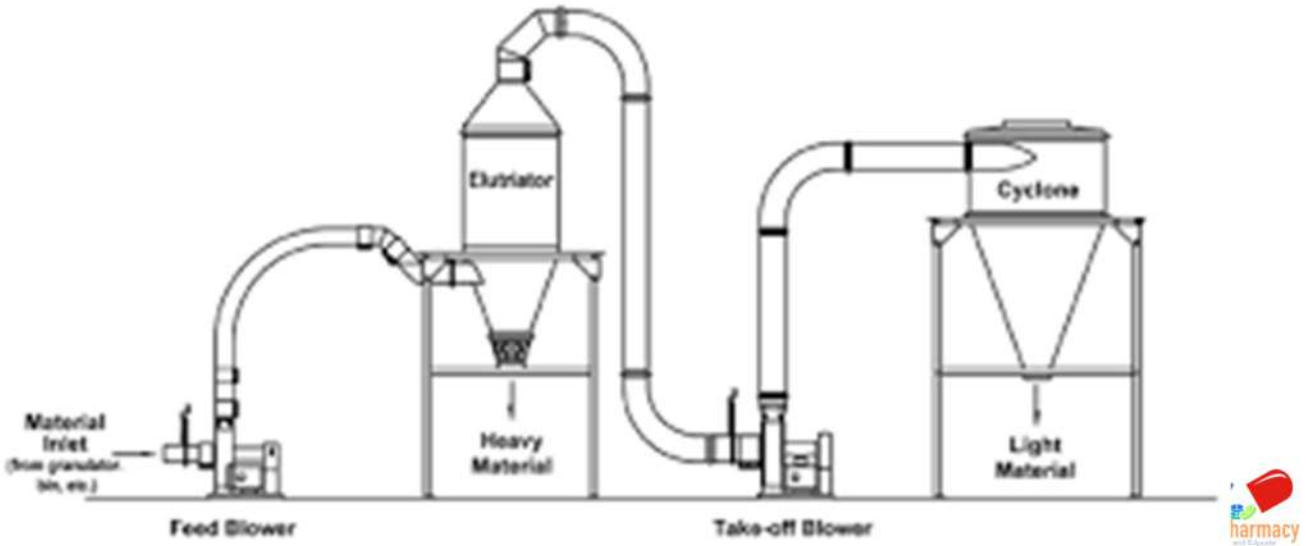
- It is commonly used in pharmaceutical, chemical, and mineral industries for classifying powders.

Principle

- Works on the principle of sedimentation and Stokes' law.
- When a fluid (water/air) flows upward through a vertical column containing a mixture of particles:
  - Fine and light particles are carried upwards with the fluid stream.
  - Coarse and heavy particles settle down due to gravity.
- Thus, particles are separated based on their size and density.

Construction

- Consists of:
  - Vertical tank/column (cylindrical in shape).
  - Inlet at bottom → for upward flow of water/air.
  - Outlet at top → for carrying away fine particles.
  - Hopper/base → for collecting coarse particles that settle.
- Flow rate of fluid can be adjusted to control separation efficiency.



Working

1. The powdered sample is introduced into the vertical tank.
2. Fluid (air or water) is passed upward at a controlled velocity.
3. Based on settling velocity:
    - Fine particles (with lower settling velocity) are carried upward and removed from the outlet.
    - Coarse particles (with higher settling velocity) remain and settle at the bottom.
4. The collected fractions are removed separately.

Uses

- Used in pharmaceutical industry for classifying fine drug powders.
- Helps in separating powders for tablet and capsule formulations.
- Used in chemical, food, and mining industries for size classification.
- Suitable for heat-sensitive substances since no heating is involved.

Advantages

- Simple design and operation.
- Useful for separating very fine particles.
- Can handle large amounts of powder.
- No mechanical shaking → hence less attrition of particles.

Disadvantages

- Separation efficiency depends on fluid velocity control.
- Not suitable for sticky or cohesive powders.
- Requires large space for installation.
- Less effective for powders with very similar densities.