SIZE REDUCTION-

Definition- It is a unit operation of reducing large solid masses (Vegetable or chemical substances) into small unit masses i.e. coarse particles or fine particles.

Size reduction and size separation are used in combination.

It is important unit operation in pharmacy.

It is also known as cutting, grinding, crushing, pulverization, comminution, diminution.

Size Reduction carried out by following methods-

(1) Precipitation Techniques-

e. g Calcium Carbonate and Magnesium Carbonate.

(2) Mechanical Method- Grinding equipments (mills)

e. g Suspension, Emulsion, Ointments.

(3) Other-

Crystallization Technique, drying a spray of solution

Next, we will discuss Advantages or importance of Size Reduction.

Objective /Advantages/Importance -:

(1) Content Uniformity-

If Particle size is uniform and small then it will helpful for effective mixing. This is essential in case on potent drugs.

(2) Uniform Flow-

Uniform particle size result in uniform flow of granules from hopper during tablet manufacturing.

(3) Effective extraction of drugs-

If particles are Smaller, then rapid penetration of solvent into tissues or cells of crude drug. Therefore, it increases rate of extraction of drug.

(4) Effective Drying-

For effective drying, size reduction is important which is important in case of production of tablets i.e. drying of granules, also in drying of medicinal plant parts.

(5) Improved Physical Stability-

Size reduction improves physical stability of dosage forms like suspension and emulsion.

Rate of sedimentation decreases if particle size is small.

(6)Improved Dissolution Rate-

Size reduction increases surface area, which increases rate of dissolution**.**

(7)Improved rate of absorption-

Due to increase in surface area, rate of dissolution increases which increases rate of absorption.

Disadvantages-

Next, we will discuss disadvantages of size Reduction.

(**1)Drug Degradation-**

Due to heat produced during milling, drug degradation occurs mainly in thermolabile drugs.

Waxy material becomes soft due to heat generated.

(2)Poor Mixing-

Small particles has strong cohesive forces causes aggregation of particles which results in poor mixing.

(3)Contamination-

Grinding surfaces wear off which imparts impurities in the powder.

Next we will discuss modes of size reduction.

Modes of stress applied in size reduction-

1) **Cutting**
2) **Compression**
3) **Impact**
4) **Attrition**

(1) Cutting- Size reduction is done by sharp blade e. g Cutter mill.

(2) Compression- Size Reduction by application of pressure between two rollers.

e. g Roller mill

(3) Impact-Rotation of hammers with high speed. Size reduction occurs due to striking of material on hammers and stationary surface.

e. g Hammer mill

(4)Attrition- Breakdown of material by rubbing action between two surfaces.

e. g Fluid energy mill

Theories of Size Reduction

- **Kick's Law**: Assumes the energy required for size reduction is proportional to the size reduction ratio.
- **Rittinger's Law**: Assumes the energy required is proportional to the new surface area generated.
- **Bond's Law**: Considers both the size reduction ratio and new surface area created.

Factors Affecting Size Reduction

- **Hardness**: Harder materials require more energy for size reduction.
- **Moisture Content**: High moisture can lead to clogging and inefficient operation.
- **Material Structure**: Brittle materials are easier to break, while fibrous materials are more challenging.
- **Feed Size and Desired Product Size**: Larger feed sizes and smaller desired particle sizes generally require more energy.

Types of Size Reduction Equipment

- **Ball Mill**: Suitable for both wet and dry grinding; reduces particle size primarily by impact and attrition.
- **Hammer Mill**: Uses impact to reduce size; effective for coarse and moderately fine grinding.
- **Roller Mill**: Uses compression to reduce particle size; ideal for brittle and less dense materials.
- **Cutting Mill**: Uses shear forces; often used for fibrous materials.
- **Fluid Energy Mill (Jet Mill)**: Uses high-speed jets of compressed air or gas to reduce particles; suitable for very fine grinding.

Applications of Size Reduction in the Pharmaceutical Industry

- **Tablet and Capsule Production**: Ensures uniform particle size for better formulation.
- **Pulmonary Delivery**: Fine particles are required for inhalable drugs.
- **Topical Formulations**: Fine powders improve homogeneity in creams and ointments.

- **Oral Suspensions**: Reducing particle size helps in achieving a stable suspension with improved dissolution rates.

Evaluation of Size Reduction

- **Particle Size Analysis**: Commonly done through sieving, microscopy, or laser diffraction to determine particle size distribution.
- **Efficiency Assessment**: Involves determining the energy required per unit of size reduction and comparing it with theoretical values (e.g., Kick's, Rittinger's, and Bond's theories).