

**Size reduction Objectives and Factors affecting size reduction**

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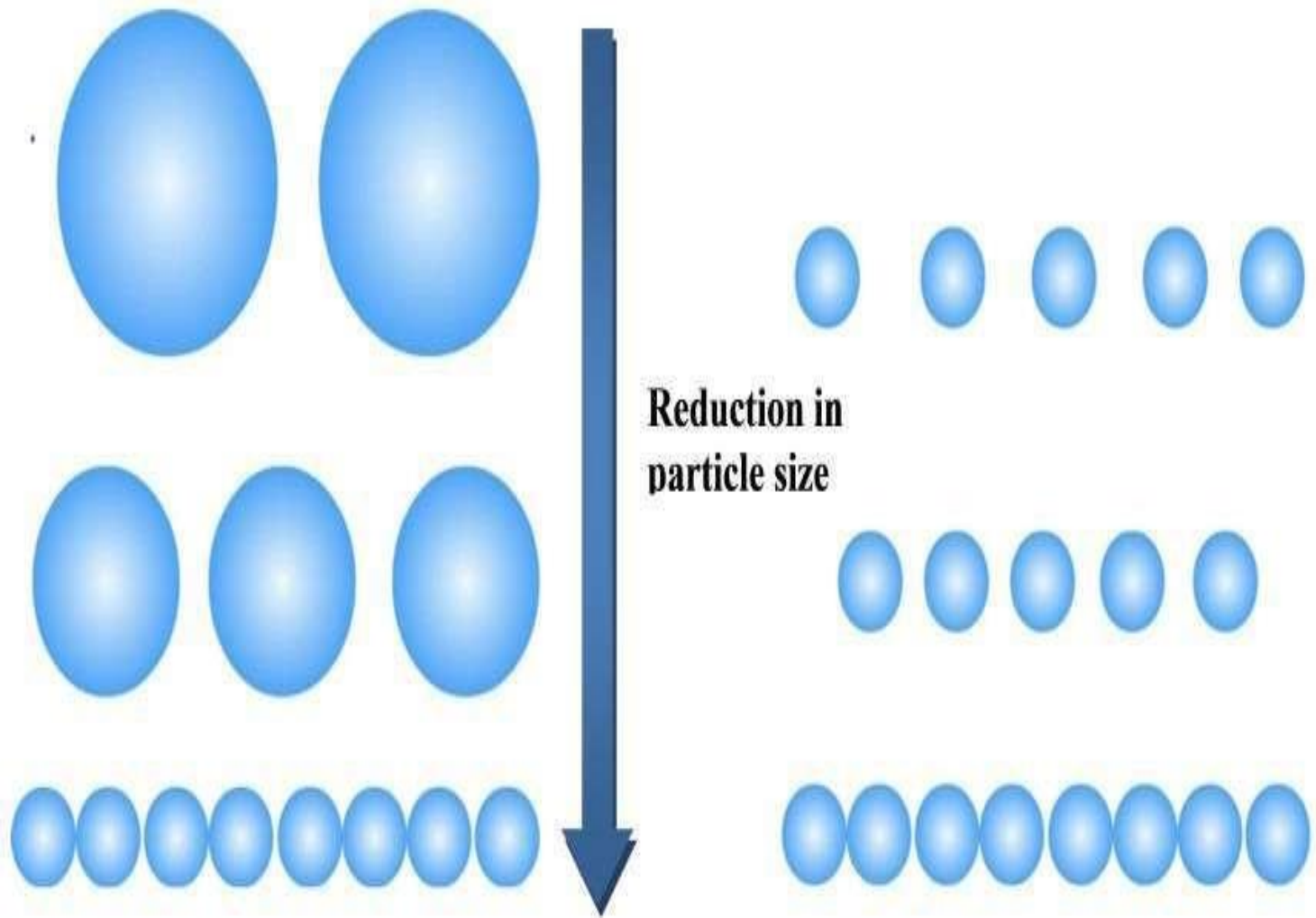
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## SIZE REDUCTION

- Size reduction is the operation carried out for reducing the size of bigger particles into smaller one of desired size and shape with the help of external forces.
- **COMMINUTION** is another term used for size reduction.



# Mechanism of Size Reduction:

**Cutting** – here the material is cut by means of a sharp blade or blades.

**EX:** Cutter mill

**Compression** – in this method, the material is crushed between the rollers by application of pressure.

**Ex:** Roller mill

**Impact** – impact occurs when the material is more or less stationary and is hit by an object moving at high speed or when the moving particle strikes a stationary surface. In either case, the material shatters to smaller pieces.

Usually both will take place, since the substance is hit by a moving hammer and the particles formed are then thrown against the casing of the machine. **EX:** hammer mill

**Attrition** – In attrition, the material is subjected to pressure as in compression, but the surfaces are moving relative to each other, resulting in shear forces which break the particles.

**Ex:** Fluid energy mill

## OBJECTIVES OF SIZE REDUCTION:

- Increase the surface area because, in most reactions involving solid particles, the rate of reactions is directly proportional to the area of contact with a second phase.
- Break a material into very small particles in order to separate the valuable amongst the two constituents.
- Achieve intimate mixing.
- To dispose solid wastes easily .
- To improve the handling characteristics.

# ADVANTAGES:

- Content uniformity
- Uniform flow
- Effective drying
- Increases surface area or viscosity
- Uniform mixing and drying
- Improve rate of absorption. Smaller the particles greater is absorption.
- Improve dissolution rate.

# **DISADVANTAGES:**

- Drug degradation
- Contamination



# Factors Affecting Size Reduction

## **Hardness:**

Hardness is a surface property of the material, although it is frequently confused with a property that could be better described as strength.

An arbitrary scale of hardness has been devised known as Moh's Scale; a series of mineral substances has been given hardness numbers between 1 and 10, ranging from graphite to diamond.

Up to 3 are known as soft and can be marked with the fingernail. Above 7 are hard and cannot be marked with a good pen knife blade, while those between are described as intermediate.

In general, the harder the material the more difficult it is to reduce in size.



## **Toughness:**

Toughness of a material is sometimes more important than hardness, a soft but tough material may present more problems in size reduction than a hard but brittle substance for example

*It is difficult to break rubber than a stick of blackboard chalk.*

Toughness is encountered in many pharmaceutical materials, particularly in fibrous drugs, and is often related to moisture content.

## **Abrasiveness:**

Abrasiveness is a property of hard materials (particularly those of mineral origin) and may limit the type of machinery that can be used.

During the grinding of some very abrasive substances the final powder may be contaminated with more than 0.1 percent of metal worn from the grinding mill.

## **Stickiness:**

Stickiness is a property that causes considerable difficulty in size reduction, for material may adhere to the grinding surfaces, or the meshes of the screen may become choked.

If the method used for size reduction produces heat then substances that are gummy or resinous may be troublesome to the size reduction process.

Sometimes the addition of inert substances may be of assistance such as kaolin to sulphur.

### **Softening temperature:**

During size reduction process sometimes heat is generated which may cause some substances to soften, and the temperature at which this occurs can be important.

Waxy substances, such as stearic acid, or drugs containing oils or fats are examples that may be affected. Some methods can be used to overcome this like cooling the mill, either by a water jacket or by passing a stream of air through the equipment. Another alternative is to use liquid nitrogen, as discussed earlier.

### **Material structure:**

Some substances are homogeneous in character, but the majority show some special structure, for example, mineral substances may have lines of weakness along which the materials splits to form flake-like particles, while vegetable drugs have a cellular structure often leading to long fibrous particles.

### **Moisture content:**

Moisture content influences a number of properties that can affect size reduction, for example, hardness, toughness or stickiness. In general materials should be dry or wet and not merely damp. Usually, less than 5 percent of moisture is suitable if the substance is to be ground dry or more than 50 if it is being subjected to wet grinding

**Purity required:**

Certain types of size reduction apparatus cause the grinding surfaces to wear, and such methods must be avoided if a high degree of purity of product is needed. Similarly, some machines will be unsuitable if cleaning between batches of different materials is difficult.

**Ratio of feed size to product ratio:**

Machines that produce a fine may be necessary to carry out the size reduction process in several stages with different equipment, for example, preliminary crushing, followed by coarse grinding and then fine grinding.

**Bulk density:**

The capacity of most batch mills depend on volume, whereas processes usually demand solid materials by weight. Hence, all other factors being equal, the output of the machine is related to the bulk density of the substance.

**Physiological effect:**

Some substances are very potent and small amounts of dust have an effect on the operators. To avoid this dust, enclosed mills must be used, systems that can extract air are also desirable, and wet grinding also, if possible, as it eliminates the problem entirely.

<b>S.No.</b>	<b>Name of the mill</b>	<b>Mechanism of action</b>	<b>Uses</b>
1	Hammer mills	Impact	Used for almost all the drugs
2	Roller mills	Attrition & compression	Soft materials
3	Colloid mills	Impact & attrition	Used for almost all the drugs
4	Ball mill	Impact & attrition	Brittle drugs
5	Fluid energy mill	Impact & attrition	Moderately hard and friable materials

# ***Basic parts of mill***

- Feed chute/hopper, which delivers the material.
- Grinding mechanism usually consisting of a rotor and stator.
- The discharging chute /sieves.

