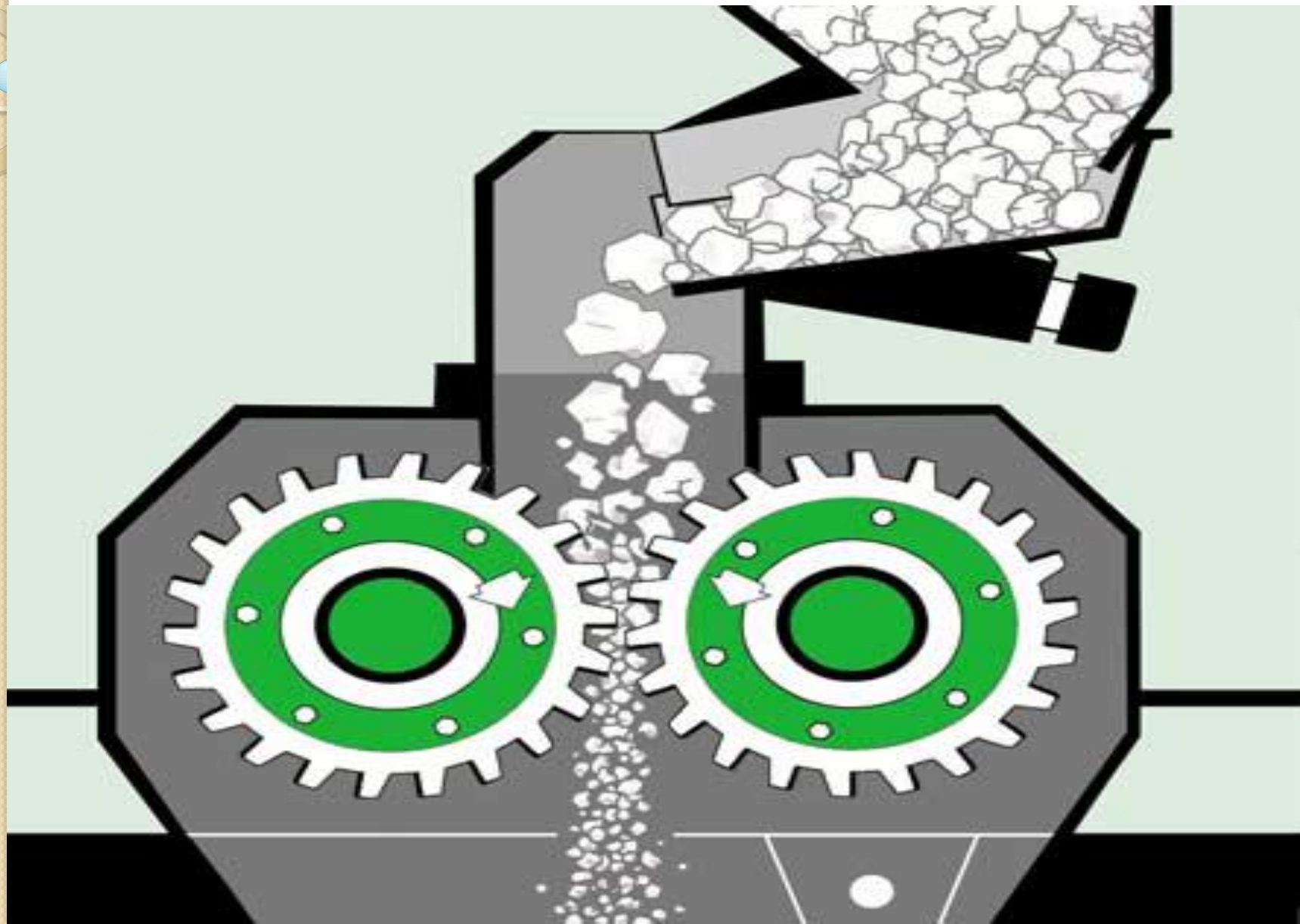
SIZE REDUCTION



Introduction

- Size reduction or comminution is the unit operation in which the average size of solid pieces of food is reduced by the application of grinding, compression or impact forces.

- In addition, when applied to the reduction in size of globules of immiscible liquids(for examples oil globules in water) size reduction is more frequently referred to as homogenisation or emulsification.

- Comminution is the generic term used for size reduction and includes different operations such as crushing, grinding, slicing, milling etc.

Some important applications of size reduction in the food industry:

- Milling of cereal grains to obtain flour.
- Fine grinding of chocolate mass.
- Flaking of soybeans prior to solvent extraction.
- Fine mashing of baby food.
- Homogenization of milk and cream.

Objectives of size reduction

- There is an increase in the surface area to volume ratio of the food which increases the rate of drying, heating or cooling and improves the efficiency and rate of extraction of liquid components.
- Facilitating separation of different parts of a material (for example milling of wheat to obtain flour and bran separately).
- Obtaining a desirable product structure (refining of chocolate mass, meat grinding).

- Facilitating mixing and dispersion (milling or crushing ingredients for dry mixing, homogenization etc.)
- Obtaining pieces and particles of defined shapes(cutting of pineapple to obtain similar shapes slices, cutting dough to make biscuits)

Size reduction of solid foods

There are three types of forces used to reduce the size of foods :

1. Compression forces:

Compressive forces are used for coarse crushing of hard materials. It implies reduction in size to about 3mm.

For example: Crushing rolls

2. Impact forces:

Impact forces can be regarded as general purpose and may be associated with coarse, medium and fine grinding of a variety of food materials.

For example: Hammer mill

3. Shearing forces:

Shear forces are applied for fine pulverization where the size reaches in micrometer range.

For example: Disc attrition mill

Size reduction equipment for solids

The following factors must be considered before selecting an equipment:

a) Structure, composition and mechanical properties of the material to be processed.

b) The desired particle size distribution (PSD) and particle form of the product to be obtained.

c) Desired rate of throughput.

d) Control of product overheating.

e) Inertness of the surfaces in contact with the food.

f) Environmental factors (noise, vibration, dust etc.)

g) Capital and operating cost.

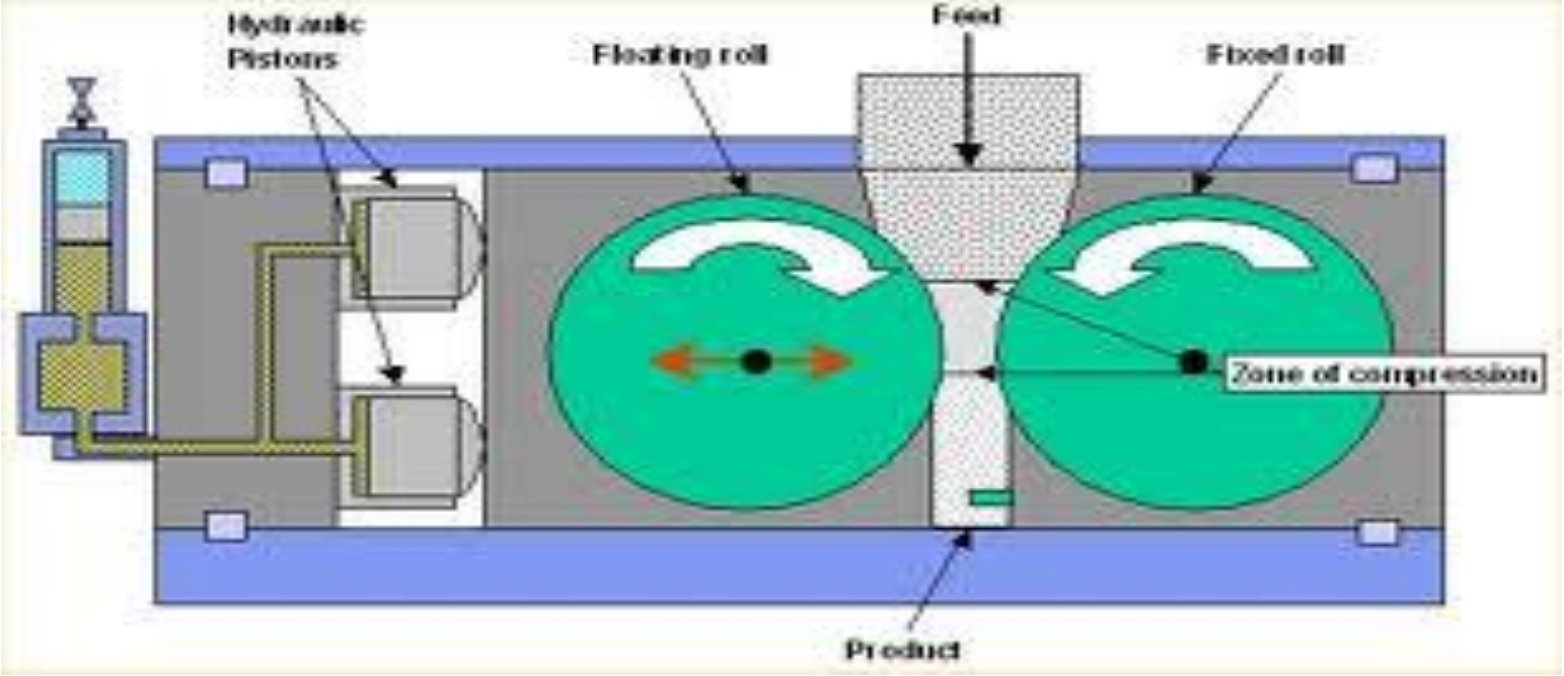
Reduction ratio

The reduction ratio is defined as the relationship between the average size of feed and average size of product.

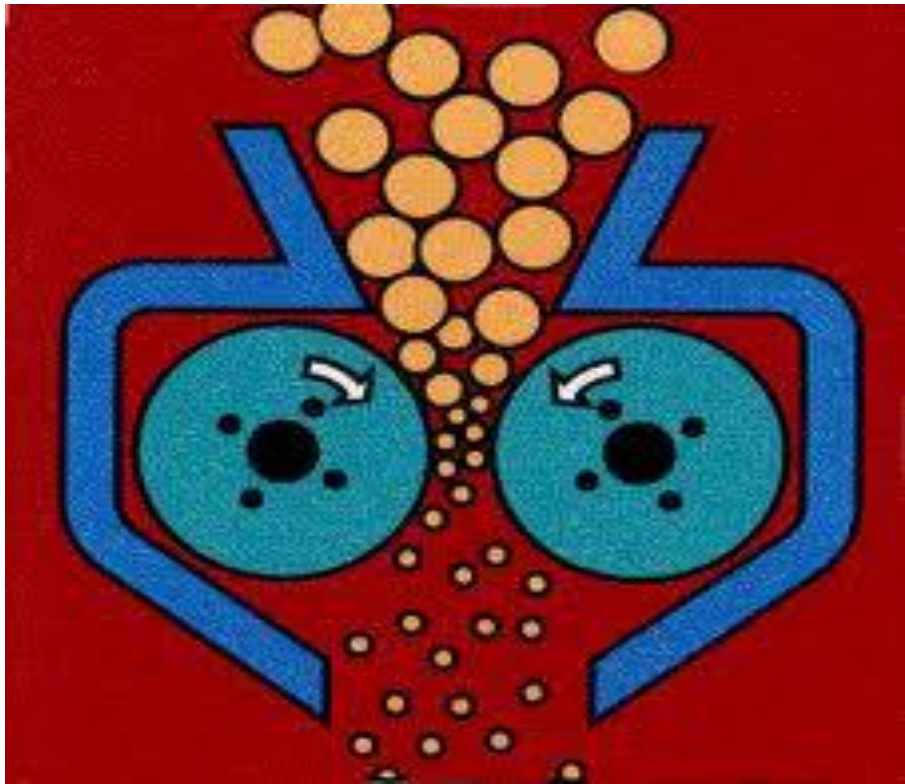
-It is used to estimate the performance of a comminution operation.

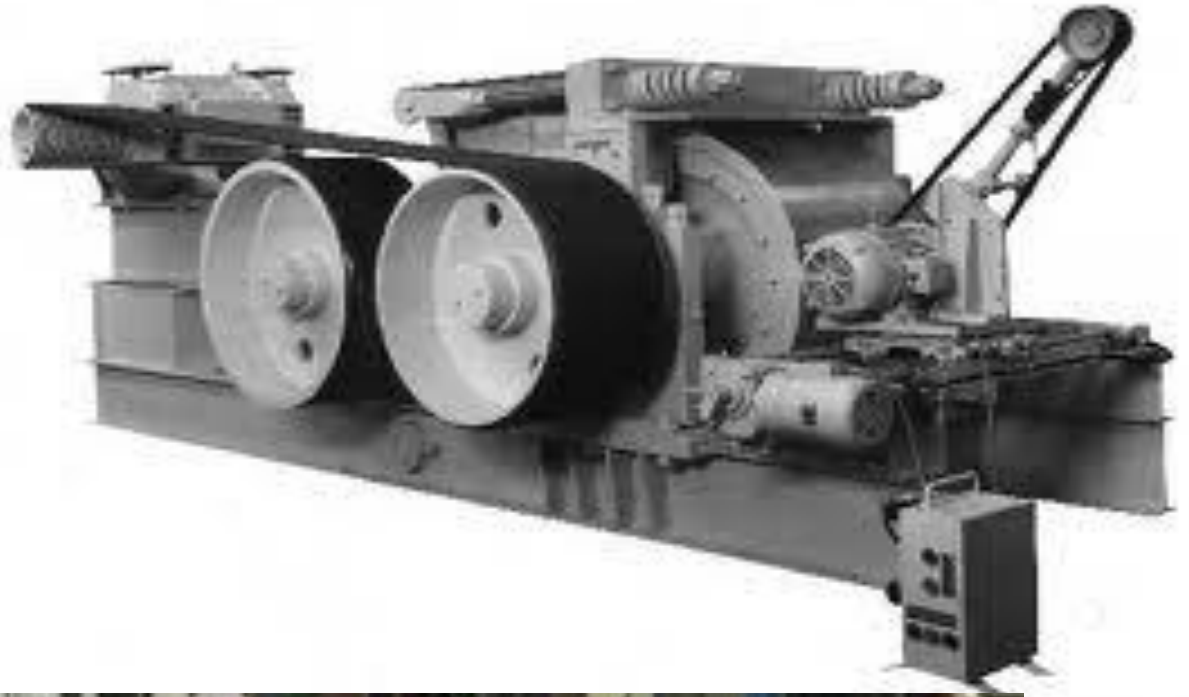
Crushing rolls

- In crushing rolls, two or more heavy steel cylinders revolve towards each other.
- So that, particles in feed are nipped and pulled through the rolls.
- The nipped particles are subjected to a compressive force that causes the reduction in size.



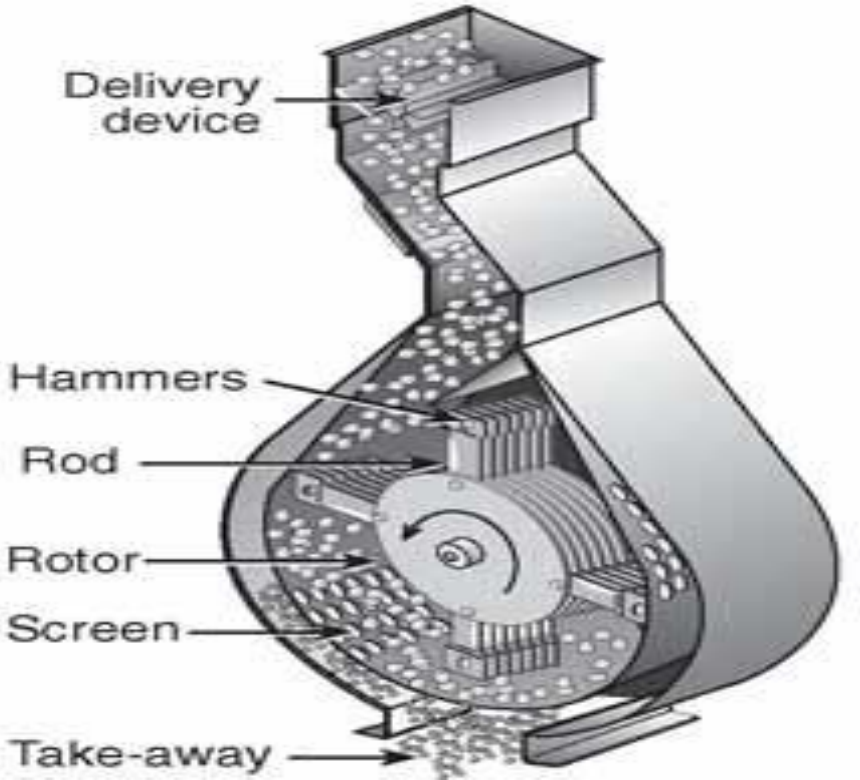
- In some design, the differential speed is maintained to exert shearing forces on the particles.
- The throughput of these units is governed by roller length and diameter and by the speed of rotation.
- Size reduction ratios are low- usually below 5.
- **Application:** Widely used for milling of wheat and the refining of chocolate.





Hammer mill

- A hammer mill, a piece of equipment containing a high speed rotor turning inside a cylindrical case.
- The rotor carries a collar bearing a number of hammers around its periphery.
- In the rotation action, the hammers swing through a circular path inside the casing containing a toughened breaker plate.



- Feed passes into the action zone with the hammers driving the material against the breaker plate.
- Then forcing it to pass through a bottom mounted screen by gravity when the particles attain a proper size.
- Reduction is mainly due to impact forces, although under choke feeding conditions, attrition forces can also play a part in such reduction.

- The hammer mill is a very versatile piece of equipment that gives high reduction ratios and can handle a wide variety of materials from hard to fibrous and sticky materials.

- **Application:** In food industry for grinding spices, dried milk, sugar agglomerate, dry fruits, dry vegetables etc.

Advantages:

- are able to produce a wide range of particle sizes.
- work with any friable material and fibre.
- ease of use.
- lower initial investment when compared with a roller mill
- minimal maintenance needed.
- particles produced using a hammer mill will generally be spherical, with a surface that appears polished.

Disadvantages:

- less energy efficient when compared to a roller mill.
- may generate heat (source of energy loss).
- produce greater particle size variability .
- hammer mills are noisy and can generate dust pollution.

Disc attrition mill

- Disc attrition mills are used shear forces in size reduction, mainly in the fine size range of particles. There are a large number of designs of disc mills for example-

a. Single disc mill: Single disc mills in which food passes through an adjustable gap between a stationary casing and a grooved disc, which rotates at high speed.

b. Double disc mills:

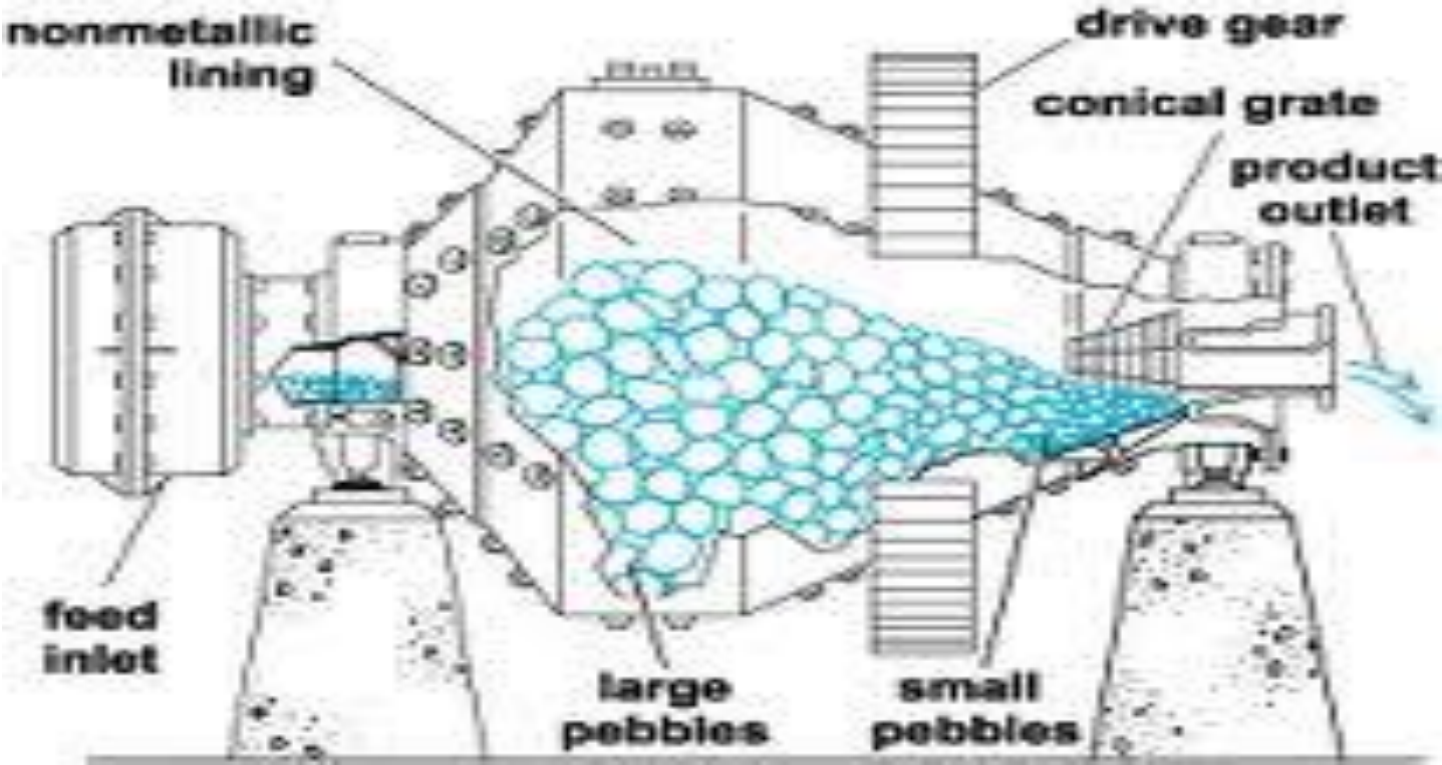
This mill have two discs that rotate in opposite directions to produce greater shearing forces.

c. Pin disc mill: The pin disc mill carries pins on the rotating elements. In this case impact forces also play a significant part in the breakdown of particulate matter.

Application: production of fishmeal, Roasted nuts, grinding sugars, cloves Manufacture of chocolate etc.

Tumbling mill

- It is basically consists of a horizontal, slow speed, rotating cylinder that is particularly filled with either balls or rods.
- The cylinder shell is usually made of steel, lined with carbon – steel plate, porcelain, silica rock, or rubber.
- The balls are normally made of steel, while the rods are usually manufactured with high carbon steel.



- The reduction mechanism is such that when the cylinder rotates, the grinding medium is lifted up the sides of the cylinder and dropped onto the material being comminuted.
- The grinding medium components also tumble over each other, exerting shear action on the feed material.
- This combination of impact and shear forces brings about a very effective size reduction.
- **Application:**

for fine grinding of fluid cocoa mass.