

## Unit 2

### Size Reduction

#### Pulverizers

##### **Definition:**

Pulverizers are mechanical devices used in the food industry to grind, crush, or pulverize food materials into fine powders or smaller particles. They are widely used in food processing for size reduction to improve the texture, solubility, digestibility, and mixing properties of various food ingredients. Pulverizers are essential in industries like spice grinding, flour milling, and the production of powdered food products.

##### **Principle of Pulverizers**

Pulverizers work on the principle of impact, attrition, compression, or cutting to break down food materials into smaller particles. The working mechanism depends on the type of pulverizer:

1. **Impact:** High-speed rotating hammers or blades strike the food particles, breaking them into smaller pieces.
2. **Attrition:** Grinding occurs due to friction between two surfaces, such as in disc mills.
3. **Compression:** Food materials are crushed between rollers or plates.
4. **Cutting:** Sharp blades cut the materials into finer particles, common in cutter mills.

##### **Construction of Pulverizers**

A pulverizer consists of the following major components:

1. **Feeding Hopper:** Raw material is fed into the machine through a hopper.
2. **Grinding Chamber:** Contains rotating blades, hammers, or rollers for size reduction.
3. **Grinding Mechanism:** Can be hammer mill, ball mill, roller mill, or pin mill, depending on the type.
4. **Screen or Classifier:** Separates fine particles from coarse ones.
5. **Discharge Outlet:** Collects the processed material.
6. **Motor and Drive System:** Powers the pulverizer, ensuring rotation of grinding components.
7. **Cooling System (optional):** Some pulverizers include cooling systems to prevent overheating.

## Working of Pulverizers

1. Raw material is fed into the feeding hopper.
2. The material enters the grinding chamber, where it is subjected to impact, compression, or cutting forces.
3. High-speed rotating components (hammers, blades, or rollers) break down the material into fine particles.
4. The ground material passes through a sieve or classifier to separate different particle sizes.
5. The final product is collected at the discharge outlet, while oversized particles may be recirculated for further grinding.

## Ball Mill

A **ball mill** is a grinding device used in the food industry to break down solid materials into fine powders or pastes. It operates through impact and attrition, where rotating balls inside a drum crush and grind the material.

### Principle of Working

- A ball mill consists of a rotating cylindrical chamber filled with grinding media (steel, ceramic, or rubber balls).
- The rotation causes the balls to lift and drop, creating an impact force that crushes the food material.
- The material undergoes both impact (collision with balls) and attrition (rubbing between balls and chamber), leading to size reduction.

### Types of Ball

- **Batch Ball Mill** – Processes a fixed amount of material at a time.
- **Continuous Ball Mill** – Operates continuously, with material input and output happening simultaneously.
- **Planetary Ball Mill** – Used for ultrafine grinding by subjecting materials to high-energy impacts.
- **Vibratory Ball Mill** – Uses vibrations to improve grinding efficiency.

### Applications in the Food Industry

- **Chocolate Production** – Used for refining cocoa mass to achieve smooth texture.
- **Spice Grinding** – Helps in the size reduction of spices like pepper, cinnamon, and cardamom.
- **Flour Milling** – Used to produce superfine wheat or rice flour.
- **Dairy Industry** – Assists in emulsifying and processing dairy powders.
- **Nutraceuticals** – Used for grinding herbs and dietary supplements into fine powders.

## Advantages and Disadvantages

### Advantages:

- Provides uniform and fine grinding.
- Can handle both dry and wet grinding processes.
- Suitable for heat-sensitive materials when used with cooling.
- Low maintenance and long operational life.

### Disadvantages:

- High energy consumption.
- Can generate excessive heat, affecting heat-sensitive materials.
- Requires regular cleaning to prevent contamination.

## Hammer mill:

A **hammer mill** is a size reduction machine commonly used in the **food industry** for grinding, pulverizing, and crushing food materials. It operates by impact forces, where rapidly rotating hammers strike the food particles to break them down into smaller sizes. Hammer mills are widely used in food processing for their efficiency and ability to handle a variety of materials.

## Principle of Working

- A hammer mill consists of a **rotating shaft** fitted with multiple hammers.
- As the shaft spins, the hammers swing outward due to centrifugal force.
- When food materials enter the mill, they are struck by the fast-moving hammers, causing **impact and shattering**.
- The crushed particles pass through a **perforated screen**, ensuring that only the desired size particles exit the mill.
- The final particle size is determined by the speed of rotation, number of hammers, and screen size.

## Types of Hammer Mills

1. **Gravity Discharge Hammer Mill** – Uses gravity to pull material through the screen after grinding.
2. **Pneumatic Discharge Hammer Mill** – Uses airflow to carry ground material out of the mill.
3. **Full Circle Screen Hammer Mill** – Has a larger screen area for higher throughput.
4. **Reversible Hammer Mill** – Allows hammers to be reversed to extend their lifespan.

## Applications in the Food Industry

- **Grain Milling** – Used for grinding wheat, corn, rice, and other grains into flour.
- **Spice Grinding** – Efficiently crushes spices like turmeric, pepper, and cloves.
- **Sugar Processing** – Helps in pulverizing sugar into fine powder.
- **Animal Feed Production** – Used to grind grains and other ingredients for livestock feed.
- **Fruit and Vegetable Processing** – Used for size reduction in dried fruits and vegetable powders.
- **Nut Processing** – Cracks and grinds nuts like almonds and peanuts for various food products.

## Advantages and Disadvantages

### Advantages:

- High-speed operation allows rapid processing.
- Can handle a variety of materials (hard, soft, dry, and wet).
- Adjustable screen sizes for different particle sizes.
- Simple design and easy maintenance.

### Disadvantages:

- Generates heat, which may affect heat-sensitive materials.
- Produces dust, requiring dust collection systems.
- High energy consumption.

## Commercial Pulverizer Machine

**Commercial Pulverizer Machine** is used for grinding **grains and spices** in food industries. It is designed for **continuous operation**, making it suitable for commercial settings like flour mills, spice processing plants, and food manufacturing units.

# Construction of the Machine

The **commercial pulverizer** consists of the following main components:

## 1. Frame and Body

- Made of **stainless steel** for durability and hygiene.
- Ensures **corrosion resistance** and easy cleaning.

## 2. Motor (2 HP)

- Powers the grinding mechanism, ensuring high-speed operation.
- Provides **consistent performance** for continuous grinding.

## 3. Grinding Chamber

- Contains rotating **hammers, blades, or burrs** that crush the material.
- Designed to **reduce food materials into fine powder**.

## 4. Feeding Hopper

- Used for **inputting grains or spices** into the grinding chamber.
- Ensures **smooth and controlled feeding** of materials.

## 5. Sieves or Mesh Screens

- Available in different sizes to **control the final particle size**.
- Helps in **filtering out coarse particles**, ensuring uniform grinding.

## 6. Discharge Outlet

- The finely ground **food powder exits** through this outlet.
- Connected to **collection bins or packaging units**.

## 7. Safety Features

- Includes **overload protection** to prevent motor damage.
- Dust collector attachment (optional) to maintain cleanliness.

## Working Principle of the Pulverizer

The working of the Automatic Pulverizer Machine involves size reduction by impact and attrition forces:

### Step-by-Step Working Process

#### 1. Feeding the Material

- Grains or spices are **loaded into the hopper**.
- The material is gradually fed into the **grinding chamber**.

#### 2. Grinding Process

- The **2 HP motor rotates** the hammers or blades at high speed.
- Food materials are struck by the **moving hammers**, breaking them into smaller pieces.
- The **particles rub against each other** (attrition) and are further reduced in size.

#### 3. Separation and Filtration

- The ground material **passes through the sieve/mesh screen**.
- **Larger particles are re-ground**, while **fine particles pass through**.

#### 4. Collection of the Final Product

- The **fine powder exits** through the discharge outlet.
- The ground product is collected for **packaging or further processing**.

## Applications in the Food Industry

- **Flour Milling** – Produces wheat, rice, and corn flour.
- **Spice Grinding** – Processes turmeric, black pepper, cumin, etc.
- **Herbal and Ayurvedic Processing** – Used for grinding medicinal plants.
- **Sugar Pulverization** – Converts sugar into powdered sugar.
- **Animal Feed Production** – Grinds grains for livestock feed.

## Advantages and Disadvantages

### Advantages

- Dual-purpose machine – **Works for grains and spices**.
- Fully automatic – **Reduces manual labor**.
- Fast and efficient – **Handles bulk quantities**.
- Durable and hygienic – **Made of stainless steel**.

## Disadvantages

- High power consumption.
- Produces heat, **affecting heat-sensitive materials.**
- Requires periodic maintenance.

The **Automatic Commercial Pulverizer Machine** is an **essential tool in food processing** due to its **efficiency, versatility, and durability**. It is widely used in flour milling, spice grinding, and commercial food production, ensuring **high-speed and uniform grinding**.

## Applications of Pulverizers in the Food Industry

Pulverizers are widely used in various food processing applications, including:

1. **Spice Grinding:** Used for grinding spices like turmeric, pepper, and cardamom into fine powders.
2. **Flour Milling:** Helps in producing wheat flour, rice flour, and other grain-based powders.
3. **Sugar Pulverization:** Converts sugar crystals into powdered sugar for confectionery applications.
4. **Cocoa and Coffee Processing:** Used in grinding cocoa beans and coffee beans into fine powder.
5. **Protein and Nutrient Powders:** Helps in making soy protein powder, milk powder, and other supplements.
6. **Dehydrated Food Processing:** Reduces dried fruits, vegetables, and herbs into powder form.
7. **Starch and Gum Production:** Used in the preparation of starch powders and food gums.

## Advantages of Pulverizers

1. **Efficient Size Reduction:** Produces uniform and fine particle sizes.
2. **Enhances Product Quality:** Improves texture and solubility of food ingredients.
3. **High Processing Speed:** Capable of handling large volumes of material quickly.
4. **Versatile Applications:** Suitable for a wide range of food products.
5. **Customizable Grinding Mechanisms:** Different designs available for specific applications.
6. **Improves Shelf Life:** Powdered food products have longer storage stability.
7. **Automated Operation:** Reduces manual effort and ensures consistency.

## Disadvantages of Pulverizers

1. **High Initial Cost:** Expensive to purchase and install.
2. **Energy Consumption:** Requires significant power for operation.
3. **Heat Generation:** Overheating may degrade heat-sensitive food products.
4. **Maintenance Requirements:** Regular maintenance needed to prevent wear and tear.

5. **Dust Generation:** Can cause contamination if not properly managed.
6. **Limited to Dry Materials:** Some models are ineffective for wet or sticky substances.

Pulverizers play a crucial role in the food industry by efficiently reducing the size of raw materials, improving processing efficiency, and enhancing product quality. Different types of pulverizers operate on various principles such as impact, attrition, compression, or cutting, making them suitable for diverse applications like spice grinding, flour milling, and food powder production. However, despite their numerous advantages, they also come with challenges such as high energy consumption, heat generation, and maintenance requirements. Selecting the right pulverizer depends on the specific needs of the food processing application.