

# Design and Manufacturing of Horizontal Cylinder Pulverizer Machine

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**Abstract**—Pulverizers are essential equipment in industries ranging from agriculture and pharmaceuticals to cement and chemical processing. The design of a pulverizer determines its efficiency, durability, and cost-effectiveness. This paper presents a comprehensive review of the design and manufacturing considerations of horizontal cylinder pulverizers. The study highlights working principles, stress and material considerations, fabrication methods, and challenges in manufacturing. Comparisons with other pulverizer designs are discussed, along with potential improvements through modern materials and automation. The review concludes that optimized design and advanced manufacturing methods can significantly enhance pulverizer performance and service life

**Index Terms**—Pulverizer, horizontal cylinder, design, manufacturing, grinding, material handling, fabrication.

## I. INTRODUCTION

Pulverization is a fundamental process in industries where raw materials need to be reduced into smaller, uniform particles for further processing. Machines designed for this purpose, known as pulverizers, are widely used in agriculture, food processing, pharmaceuticals, chemicals, and recycling. Among various designs, the horizontal cylinder pulverizer is particularly valued for its stability, efficiency, and continuous operation. The operating principle involves feeding raw material into a horizontal cylinder equipped with rotating elements such as blades, hammers, or rollers. These elements apply mechanical forces—impact, shear, compression, and attrition—to break down materials into finer particles. A sieve or mesh at the discharge ensures uniform particle size. Horizontal orientation offers several advantages over vertical mills: smoother material feeding, reduced vibration, enhanced stability, and continuous throughput. This design is particularly suitable for applications such as grinding cereals, crushing crop residues, preparing spices, and producing fine powders for pharmaceutical and chemical industries.

Designing a horizontal pulverizer involves considering cylinder dimensions, rotor speed, motor power, material hardness, and throughput capacity, among other parameters. Modern manufacturing techniques like CNC machining, automated welding, and advanced coating technologies enhance machine durability and operational efficiency. The objective of this review is to analyze existing literature, examine design and manufacturing considerations, explore applications, and highlight challenges and future innovations in horizontal cylinder pulverizer machines.

## II. LITERATURE REVIEW

Researchers have studied pulverizer mechanisms for decades. Hammer mills and impact pulverizers have been optimized for energy efficiency, but most studies highlight limitations in wear and energy demand. Recent works suggest that **horizontal orientation** provides advantages in distributing impact loads, reducing vibration, and achieving finer particle sizes. The evolution of pulverization technology ranges from primitive stone grinders to highly efficient industrial machines. Traditional vertical hammer mills, roller mills, and ball mills were limited by uneven material distribution and higher vibration levels. Horizontal pulverizers emerged as a more stable, high-throughput alternative. Researchers have identified four primary forces in pulverization: impact, shear, compression, and attrition. Horizontal pulverizers combine these forces effectively, enabling better grinding efficiency. Comparative studies have shown that horizontal pulverizers can achieve up to 25% higher energy efficiency than conventional vertical designs for agricultural grains.

Material selection has also been extensively studied. Stainless steel is preferred in food and pharmaceutical applications due to its corrosion resistance and hygienic properties, while mild steel and alloy steels are common in agricultural and chemical industries. Energy optimization remains a critical focus, with variable frequency drives (VFDs) and rotor design optimization improving performance while reducing power consumption. Applications discussed in the literature include agriculture (grains and fodder), food processing (flour, spices), pharmaceuticals (herbal and medicinal powders), and chemicals (fertilizers and pigments). Challenges like component wear, dust emission, noise, and maintenance downtime are well-documented. Emerging trends include IoT-enabled monitoring, predictive maintenance, and eco-friendly designs.

- Studies on agricultural pulverizers demonstrate that horizontal configurations reduce clogging.

- In pharmaceutical industries, horizontal pulverizers ensure sterility and easy cleaning.
- Experimental models show reduced **specific energy consumption** compared to vertical mills.

### III. WORKING PRINCIPLE

The horizontal cylinder pulverizer operates in four stages: feeding, grinding, screening, and discharge. Material enters via a hopper, is pulverized by rotating blades, hammers, or rollers, passes through a sieve for particle size control, and exits as a fine product.

The horizontal cylinder orientation ensures uniform material distribution, reduces vibration, and stabilizes high-speed operation. Pulverization involves a combination of forces:

Impact: High-speed blades strike the material.

Shear: Fibrous materials are sliced or cut.

Compression: Hard materials are crushed between rollers or surfaces.

Attrition: Continuous friction reduces particle size further.

Critical components include the cylinder, rotor assembly, feeding system, sieves, bearings, and motor. Performance depends on rotor speed, feed rate, material hardness, and moisture content. Excessive heat from friction can be managed through airflow systems, water jackets, or cooling jackets. Modern designs integrate automation with sensors, VFDs, and PLCs, ensuring consistent output and reduced energy wastage. While limitations like wear, dust, and noise exist, the horizontal cylinder pulverizer remains an efficient, continuous, and versatile machine.

### IV. DESIGN CONSIDERATIONS

Designing a horizontal cylinder pulverizer requires balancing capacity, efficiency, durability, and safety. Key factors include:

1. Capacity and Throughput: Machines range from 50–200 kg/hr (agriculture) to several tons/hr (industrial).
2. Cylinder Dimensions: Length-to-diameter ratio affects material residence time and grinding uniformity.
3. Rotor Speed and Energy Requirements: Optimal speed ensures fine particle size while minimizing energy use. VFDs can further improve efficiency.
4. Pulverizing Mechanism: Blades, hammers, and rollers are chosen based on material type. Hybrid mechanisms improve versatility.
5. Material Selection: Mild steel for cost efficiency, stainless steel for hygiene, and alloy steel for wear resistance.
6. Screening System: Sieve mesh controls particle size; quick-change designs reduce maintenance downtime.
7. Structural Stability: Balanced rotors and rigid frames minimize vibration.
8. Safety Features: Interlocks, emergency stops, and protective covers are integrated.
9. Noise and Dust Control: Enclosures, dust collectors, and soundproofing are critical.
10. Cost and Maintenance: Modular designs and accessible components optimize both maintenance and production cost.

## V. MATERIAL SELECTION

**Material** choice directly impacts durability, performance, and cost. Key components and recommended materials include:

**Cylinder:** Mild steel (agriculture), stainless steel (food/pharma), alloy steel (industrial).

**Rotor & Blades/Hammers:** High carbon steel, heat-treated alloys, or carbide-coated for wear resistance.

**Shaft:** Medium carbon or alloy steel for fatigue strength.

**Bearings:** Hardened steel; bronze/brass for low-speed models.

**Sieve/Screen:** Stainless steel for fine powders; hardened steel for coarse materials.

**Frame:** Mild steel or cast iron for rigidity and vibration damping.

Surface treatments like heat treatment, powder coating, chrome plating, and food-grade coatings enhance lifespan and safety. A hybrid material strategy balances performance and cost. Sustainability considerations include recyclable materials, wear-resistant coatings, and eco-friendly manufacturing practices.

## VI. MANUFACTURING PROCESS

The manufacturing process converts designs into functional machines:

1. Raw Material Preparation: Quality inspection of steel, alloy, and stainless materials.
2. Cylinder Fabrication: Cutting, rolling, welding, stress-relieving, and surface finishing.
3. Rotor & Blades/Hammers: CNC machining, shaping, heat treatment, and dynamic balancing.
4. Frame and Support Structure: Cutting, welding, stress testing, and protective coating.
5. Sieves and Screening: Punching, shaping, and modular placement.
6. Assembly: Rotor installation, motor coupling, sieve placement, and safety guards.
7. Quality Control & Testing: Dimensional inspection, trial runs, performance tests, and safety verification.
8. Final Finishing & Packaging: Painting/polishing, corrosion protection, and secure transport preparation.

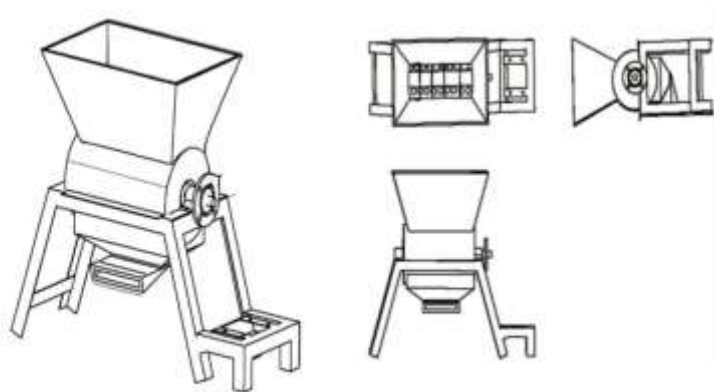
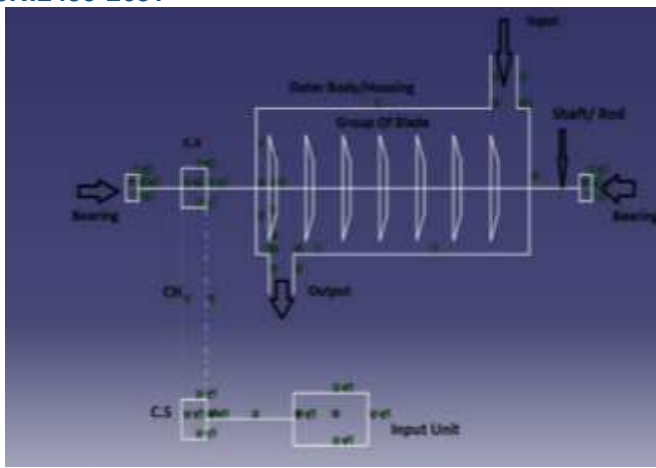
## VII. COMPARATIVE REVIEW

Horizontal vs. Vertical Pulverizers:

Horizontal designs provide more uniform particle size and simpler construction, while vertical designs are compact but prone to higher wear.

- Ball Mills vs. Horizontal Cylinder Pulverizers:

Ball mills are efficient for very fine grinding but consume more energy and are costly. Horizontal cylinder pulverizers balance cost and performance for medium-fine applications. *Units*



### VIII. PERFORMANCE ANALYSIS

Performance evaluation includes:

**Throughput Capacity:** Consistent output matching design specifications.

**Grinding Efficiency:** Maximizing particle size reduction per unit energy.

**Particle Size Distribution:** Ensuring uniformity for industrial applications.

**Power Consumption:** Specific energy consumption (kWh/kg) optimization.

**Noise & Vibration:** Minimizing harmful levels using rotor balancing and enclosures.

**Wear & Tear:** Assessing blade, sieve, and bearing longevity.

**Safety & Reliability:** Verifying dust control, emergency systems, and mean time between failures (MTBF).

### IX. APPLICATIONS

The horizontal cylinder pulverizer is versatile across sectors:

Agriculture: Animal feed, fodder, fertilizers.

Food Industry: Flour, spices, sugar, food waste recycling.

Pharmaceuticals: Medicinal powders, nutraceuticals, herbal grinding.

Chemicals & Industry: Plastics recycling, mineral processing, pigments.

Waste Management: E-waste, municipal solid waste, biomass briquetting.

Laboratories: Sample preparation for chemical analysis.

Advantages include improved homogeneity, increased surface area for reactions, compact storage, and eco-friendly recycling support.

## X. CHALLENGES IN DESIGN & MANUFACTURING

Key challenges include:

**Material Selection**: Balancing strength, wear resistance, and cost.

**Energy Efficiency vs Capacity**: Reducing power usage while maintaining throughput.

**Vibration & Noise Control**: Dynamic balancing and operator safety.

**Wear & Tear**: Frequent replacement of blades, sieves, and bearings.

**Dust & Pollution**: Efficient collection systems required.

**Safety Integration**: Compact design with protective features.

**Manufacturing Complexity**: Need for CNC, precise welding, and skilled labor.

**Maintenance & Accessibility**: Modular, easy-to-service components.

**Cost Constraints**: Affordability without compromising reliability.

## XI. FUTURE SCOPE & INNOVATIONS

Future developments focus on:

**Advanced Materials**: Composites, nano-coatings, and biodegradable alloys.

**Energy Efficiency**: VFDs, regenerative systems, lightweight rotors.

**Automation & Smart Monitoring**: IoT sensors, AI-based optimization, remote monitoring.

**Noise & Dust Reduction**: Acoustic enclosures, advanced filters, and green energy systems.

**Modular & Flexible Designs**: Interchangeable rotors, multi-purpose pulverizers, portable models.

**Sustainability & Recycling**: Integrating shredding, eco-friendly materials, and circular economy principles.

**Research & Collaboration**: Academic-industry partnerships driving innovation.

## XII. CONCLUSION

The horizontal cylinder pulverizer is a critical industrial machine bridging raw materials and final products. Its design balances capacity, efficiency, durability, and safety, while material selection ensures wear resistance and cost-effectiveness. Manufacturing involves precision processes from cylinder fabrication to rotor balancing and assembly. Performance analysis confirms its ability to deliver uniform particle size, high throughput, and reliable operation across sectors. Applications range from agriculture and food processing to pharmaceuticals, chemicals, and waste management, reflecting its versatility.

Challenges in wear, energy efficiency, noise, dust, and cost remain, but innovations in smart automation, advanced materials, modular design, and eco-friendly solutions promise a more sustainable and efficient future. With ongoing research, horizontal cylinder pulverizers will continue to play a vital role in industrial productivity, food security, and environmental sustainability.

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