Boyee

Grinding & Dispersion Solutions

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Grinding & Dispersion Solutions

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Who is Boyee?—— China's Benchmark in Grinding and Dispersion

Boyee not only focuses on standard equipment but also possesses strong project management capabilities, providing turnkey solutions for nano-material production lines.

Boyee's nano-level grinding technology breaks international monopolies	Ultra-fine grinding and uniform dispersion	Self-developed turbine and pin-type rotors

Boyee was founded in 2004 and is headquartered in Shenzhen. As a national-level "Specialized, Sophisticated, Distinctive, and Innovative" (Little Giant) enterprise and a national high-tech enterprise, the company specializes in the R&D and manufacturing of grinding and dispersion equipment. With over 20 years of expertise in wet grinding and dispersion technology, it has become a leader in thve field.

As early as 2007, Boyee successfully developed an all-ceramic structured nano-level bead mill, breaking foreign technological monopolies in one stroke. Since then, it has continued to innovate, developing and manufacturing equipment such as nano-level grinding and dispersion systems for lithium iron phosphate (LFP) battery cathode materials and silicon-carbon anode materials, consistently driving technological advancements in the industry.

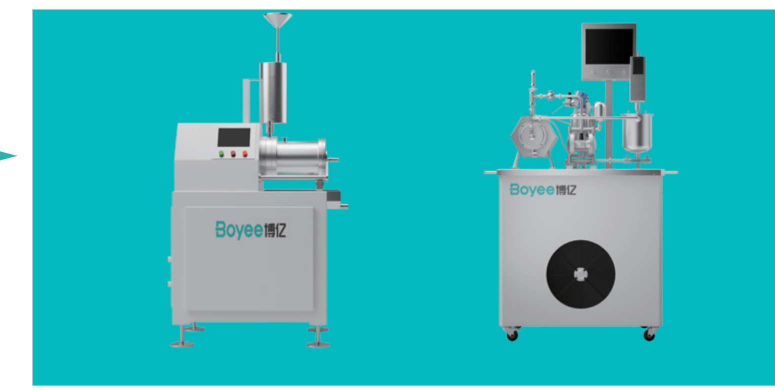
In grinding and dispersion technology, Boyee's unique application of mechanical force, shear force, and impact force enables precise and efficient particle size reduction and uniform dispersion of materials.

For different material characteristics, ultra-fine grinding and uniform dispersion are achieved through powerful forces generated by high-speed rotation.

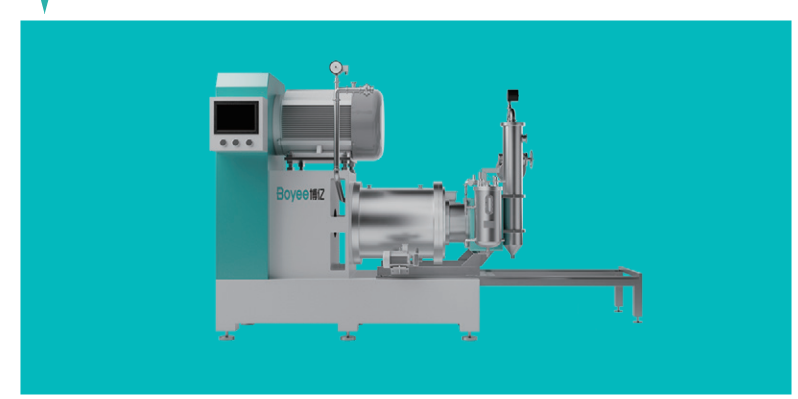
Product Development

Boyee steadily advances in material processing, standing out with its unique microparticle technology.
In grinding, Boyee leverages this technology to precisely regulate energy transfer, optimizing interparticle interactions. Even the hardest and most structurally complex materials can be efficiently ground to the desired particle size with uniform and controllable distribution.
For dispersion, Boyee maximizes the advantages of microparticle technology. By precisely controlling particle trajectories and applied forces, it breaks agglomerations and achieves uniform dispersion of diverse particles in media, solving industry-wide dispersion challenges.
Built on advanced microparticle technology and exceptional grinding-dispersion capabilities, Boyee has developed a series of high-performance products. From precision bead mills to high-efficiency mixing equipment, each product integrates cutting-edge technology. With stable performance and superior processing efficiency, Boyee provides tailored solutions for industries such as battery industries, driving industrial upgrading.

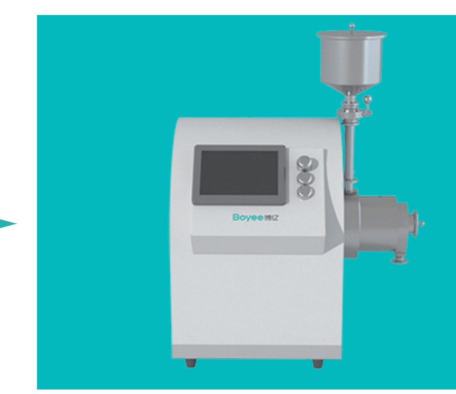
The first all-ceramic bead mill mass production in 2007



Post-development SW/NMM experimental machine



Mass production model NMM/LMM



Dry bead mill technology breakthrough

Application Fields

New Energy Battery Materials	Ink and Coatings	Semiconductors
Pharmaceuticals	Food	Electronic Ceramics
Cosmetics	Advanced Materials	Mineral Resources

Nanoscale Grinding and Uniform Dispersion

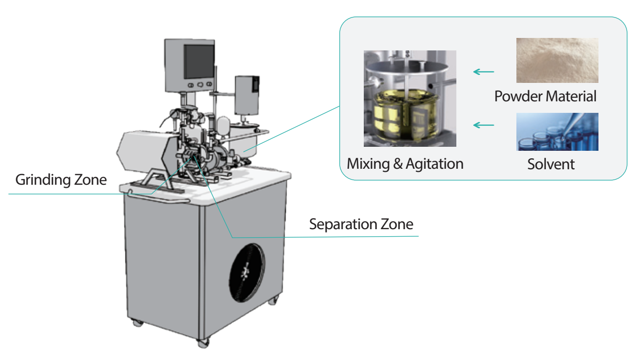
—— From microns to nanometers, Boyee provides advanced nano-level technology solutions

How to distinguish grinding from dispersion at the physical essence level?

Grinding is a process of reducing particle size through mechanical stress, involving the breaking of chemical bonds and destruction of crystal structures.Dispersion, on the other hand, is a physical process that breaks up particle agglomerates through shear forces, wetting effects, etc., while preserving the original particle morphology.The fundamental distinction lies in whether the crystal structure and surface characteristics of the material are altered.

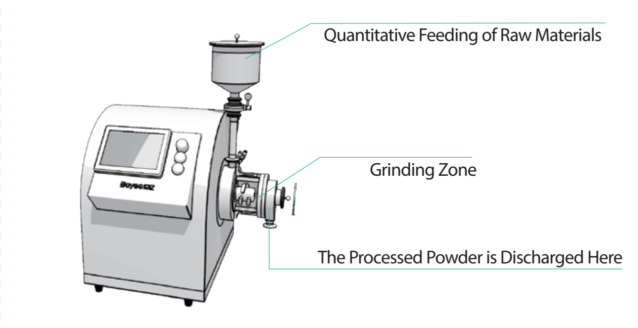
Working Principle of Wet Bead Mill

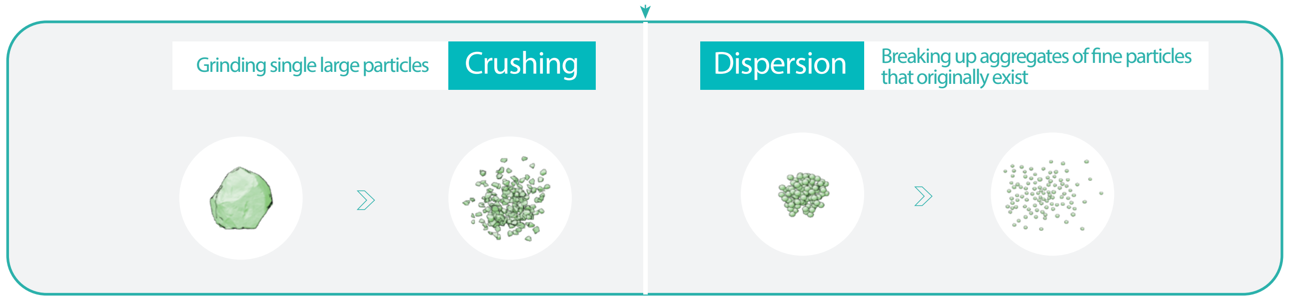
1. **Material Pre-treatment & Feeding**
   The material to be ground is pre-dispersed and wetted in a mixing tank, then pumped into the bead mill chamber where it mixes with grinding media (e.g., zirconia beads).
2. **High-speed Grinding & Dispersion**
   The high-speed rotating agitator drives the grinding media to generate intense collision, friction, and shear forces, reducing particles to nano-scale while achieving uniform dispersion
3. **Dynamic Separation & Discharge**
   The ground material passes through a dynamic separator screen, retaining the grinding media while continuously discharging the final slurry from the outlet.
4. **Cooling & PLC Intelligent Control**
   Cooling system circulates to prevent overheating, while the PLC control system monitors real-time parameters (pressure, temperature, flow rate, etc.) to optimize grinding efficiency.



Working Principle of Dry Bead Mill

- **Material & Media Feeding**
  Dry material media are directly fed into the grinding chamber through the inlet without pre-wetting treatment, proceeding to immediate grinding.
- **Three-stage Grinding & Dispersion**
  Pre-grinding stage: The main shaft drives the stirring impeller to rotate, forming an axial spiral structure to propel materials into the fine grinding chamber.
  Fine grinding stage: Paired grinding impellers subject materials to high-intensity shearing and collision for particle refinement.
  Precision grinding stage: The grinding impellers in the precision chamber optimize contact surfaces, achieving ultimate refinement through the pre-screen baffle.
- **Screen Separation & Discharge**
  The ground material is separated from the grinding media via a screen, with the powder discharged from the outlet. The screen aperture can be adjusted as required.





Grinding and Dispersion Technology 1

Working Principle of Bead Mill

The bead mill is a grinding and dispersion device that refines target materials (particles) to nano-scale levels. The rotating shaft agitates zirconium beads (grinding media) within the grinding chamber. Through collisions and shear forces between the beads and materials, particle size reduction is achieved.The separation screen at the chamber outlet retains the beads while allowing processed material to discharge through the outlet.

Working Principle of Turbo Rotor

Grinding media and materials near the impeller surface → Viscous resistance → Moving with the impeller → Centrifugal force → Flung toward the chamber wall → Forming double-ring turbulent flow

Grinding media → Violent motion → Shear and extrusion friction forces → Force-induced deformation → Stress field

Stress field → Crushed particles → Centrifugal force → Flung toward the chamber wall

Stress field → Finely ground particles → Separation from grinding media → Discharged from the bead mill

Working Principle of Pin Rotor

The pin rotor consists of uniformly distributed rod-shaped pins along the circumference. — The main shaft rotates at high speed. — Formation of a dynamic mixing field → High-speed motion transfers mechanical energy to the grinding media

High-speed motion transfers mechanical energy to the grinding media — Violent motion — High-intensity collision forces → Material is crushed under the impact between pins and grinding media. → The stagnant flow field formed by pin gaps generates strong shear forces, achieving rapid particle deagglomeration through dual effects.

The stagnant flow field … → Crushed particles → Centrifugal force → Flung toward the chamber wall

The stagnant flow field … → Finely ground particles → Separation from grinding media → Discharged from the bead mill

Grinding and Dispersion Technology 2

Analysis of Grinding Process Technology: Principles and Effects

01 Single-machine Continuous Grinding Process

Principle

Material completes grinding in a single pass through one machine (no reflux), adapting to high-flow continuous production.Dynamically adjust rotor speed and bead filling rate (70%-85%) to balance efficiency and precision.

Effect on Materials

High output & low consumption: Energy consumption ≤25kWh per ton, suitable for mass production like LFPWide applicability: Adapts to particle sizes from 50mm to 10μm, but limited support for ultra-narrow distribution.

02 Multi-machine Series Grinding Process

Principle

Multiple grinding units connected in series, each with customized parameters (e.g., speed, media ratio).Material passes through units sequentially for "coarse medium fine" grinding.Gradient-based precision grinding.

Effect on Materials

Ultra-narrow distribution: Meets demands of high-end nanomaterials (e.g., carbon nanotube slurries).

03 Combined Cyclic Grinding Process

Principle

Dual-mode synergy of "continuous + cyclic" grinding.
First stage: Small-flow continuous grinding uses high shear forces to rapidly break coarse particles Subsequent stage: Cyclic grinding with material repeatedly passing through the chamber, dynamically screening and refining to precisely remove large particles.

Effect on Materials

Uniform particle size: Reduces initial particle size and narrows distribution via cyclic screening.

Ideal for materials requiring extreme uniformity (e.g., new energy battery materials).

04 Single-tank Cyclic Grinding Process

Principle

Material circulates within a single tank, driven by a pump to repeatedly pass through the grinding chamber.Adjustable cycle count and flow rate to flexibly control grinding duration and fineness until target size is achieved.

Effect on Materials

Suitable for small-batch, multi-variant customized production, especially R&D or pilot stages, balancing efficiency and cost.

Process Comparison & Selection Guide

Boyee's four grinding processes cover full-scenario needs from R&D to mass production, focusing on precise particle control and energy efficiency to push material performance limits.

Process Type	Core Advantage	Application
Combined Cyclic	Narrow distribution, low energy	Mass production (e.g., Si-C anode)
Single-machine Continuous	High output, easy maintenance	LFP, conductive agents, large-scale production
Multi-machine Series	Multi-stage precision, ultra-fine dispersion	Nanomaterials (CNTs, solid electrolytes)
Single-tank Cyclic	Multi-stage precision, ultra-fine dispersion	Lab R&D, new material validation

Grinding and Dispersion Technology 3

Dry and Wet Grinding Technologies

Why Different Particle Size Requirements Demand Grinding Processes?

Dry Grinding (Particle size ≥1μm)
Uses large-diameter grinding media (1-8mm); centrifugal force drives media collisions for impact-based crushing. Ideal for coarse grinding of brittle materials.

Wet Grinding (Particle size ≤100nm)
Employs micro/nano media (0.05-2.0mm); achieves ultra-fine dispersion via high shear (linear speed >10m/s) and viscous drag,Suitable for nanomaterial preparation.

How to Select Grinding Methods Based on Material Properties?

Material Property	Dry Grinding	Wet Grinding
Thermal Sensitivity	Limited for heat control (mechanical friction generates heat)	Liquid medium dissipates heat effectively, ideal for heat-sensitive materials
Agglomeration Tenden	High shear needed but airflow may worsen agglomeration	Liquid coating prevents particle agglomeration
Flowability	Poor powder flow risks chamber clogging	Slurry flow is controllable, suits complex channel designs
Dispersion Precision	Avoid over-grinding for surface-sensitive materials	Gentle dispersion preserves original particle properties

Dry VS Wet Grinding Technology Comparison Table

Comparison Dimension	Dry Grinding	Wet Grinding
Grinding Principle	Achieves volumetric crushing through collisions, shear, and impact forces between grinding media (kinetic energy transfer via high-speed rotation).	Achieves deagglomeration via shear, compression, and friction in liquid medium (fluid dynamics dominated).
Dominant Force Types	Primary forces: Impact (media collisions) + Shear (inter-media friction)	Primary forces: Fluid shear (laminar-turbulent flow) + Compressive stress (inter-media pressure).
Particle Size Control Precision	Depends on media size, rotation speed, and flow rate; broader distribution	Optimized via media size, slurry concentration, and cycle count; narrower distribution.
Energy Cost	Higher (high-speed rotation required; significant idle energy consumption)	Moderate (pump energy dominates; liquid environment enhances energy transfer efficiency; lower overall energy for fine grinding).
Shaft Sealing Requirements	Simple (gas sealing suffices to prevent powder leakage)	Precise (mechanical sealing required to prevent liquid leakage; higher maintenance cost)
Component Wear	Lower (no liquid corrosion; media wear is primary)	Higher (dual effects of liquid corrosion + media wear; corrosion-resistant materials required)
Particle Agglomeration Tendency	Strong	[Weak] (liquid medium coats particles, enhancing dispersion
Particle Compositing	Good	[Possible] (shear-dominated; lower compositing efficiency)
Mechanochemical Effects	Significant (high-frequency collisions induce lattice defects/surface activation)	[Minimal] (liquid buffers localized stress concentration

Grinding and Dispersion Technology 4

Impact of Grinding Beads on Material Breakage (Grinding Media)

How Do Grinding Media Parameters Affect Grinding Efficiency?

Pameter	Dry Process	Wet Process	Mechanism
Bead Diameter	1-8mm（coarse crushing）	0.05 -0.2mm（nano dispersion	Diameter reduction → 400% increase in media count per unit volume (by volume ratio))
Filling Rate	60-70%（high kinetic impact)	70-85%（high shear density）	Filling rate increase → 25% more contact points
Linear Speed	4-6m/s（impact-dominated)	10 -15m/s（shear-dominated)	Speed doubled → shear stress quadrupled

Bead Diameter vs. Efficiency Relationship

01 Coarse Grinding: 3-5mm beads preferred (impact-dominated)

02 Fine Grinding 0.3-1mm microbeads required (shear contributes 70%)

03 Efficiency Gain:

When bead size reduces from φ5mm to φ1mm (25x more beads).

Contact point density increases 10x; refinement rate accelerates 5-8x

Optimizing Media Filling Rate

Dry Process: 60-70% filling rate (20-30% porosity) ensures fluidization

Wet Process: 70-85% filling rate prevents sedimentation/layering

Impact of Bead Diameter and Quantity

Type	Effect	Application
Reducing Bead Dimension	Increases contact points, enhancing grinding efficiency.	Nano-level fineness (wet process preferrevd)
Increasing Bead Quantity	Improves grinding uniformity via centrifugal media distribution (e.g., 300% higher collision frequency at 70-85% filling rate).	Requires balancing to avoid excessive energy consumption (dry: larger beads; wet: smaller beads)

Advantages of Gentle Dispersion

Gentle dispersion is Boyee's proprietary technology that maintains the size, shape, crystalline structure, and surface state of secondary particles during the dispersion process.

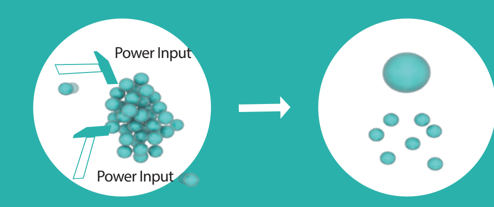
Particle Characteristics Preservation

Re-agglomeration Suppression

Reduced Dispersant Dosage

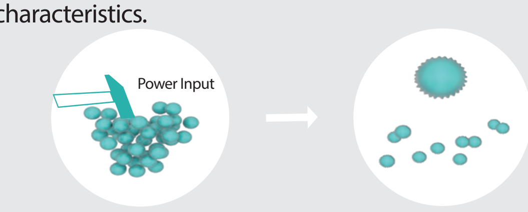
Gentle Dispersion

Prevents over-dispersion and particle damage, enabling high-quality and high-precision



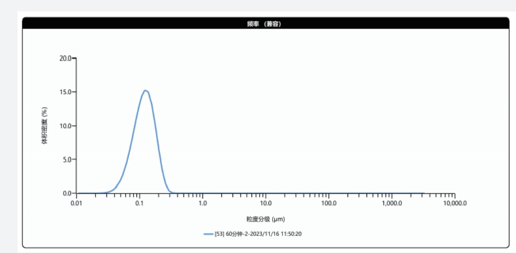
Traditional Dispersion

Excessive dispersion can easily damage particles and cause agglomeration, potentially compromising the product's characteristics.

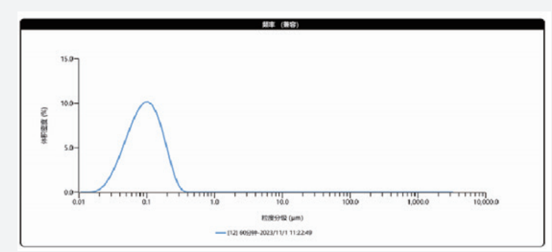


Gentle Dispersion Case Study (Barium Sulfate)

Raw Material Particle Size: D50=118nm



Gentle Dispersion with Particle Size: D50=92.8nm

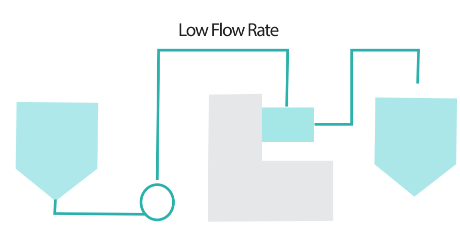


Efficient and Refined High-Flow Circulation Operation

Traditional Circulation Method

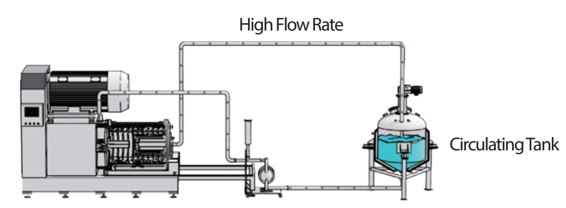
Conventional bead mills typically employ either single-unit circulation or dual-tank serial circulation, where material flows back and forth between the feed tank and grinding chamber, with screens separating the grinding media from the slurry.

Disadvantages：Flow rate limitationsPoor particle size control



Boyee High Flow Circulation Operation Method

Through the synergy of dynamic separation and high-flow forced circulation, this method achieves continuous and efficient deagglomeration of high-viscosity/high-solid-content slurries in a nanoscale grinding media field. Combined with closed-loop temperature control and real-time particle size monitoring, it enables high-flow micronization and clog-free continuous dispersion.



*Based on target particle size (nano/submicron level), material characteristics (viscosity, solid content, hardness,thermal sensitivity), and process requirements (R&D/production), this guide systematically outlines key selection criteria for reference.

Key Selection Criteria 1 Prerequisite Confirmation

Parameter	Technical Key Points	Impact on Micronization
Bead Specification	Particle Size selection: Target particle size ≈1/1000 of bead diameter (e.g.,0.05mm beads for 50nm target)	Smaller targets require finer beads; higher bead hardness improves grinding efficiency but increases wear rate
	Material: Yttria-stabilized zirconia (high hardness)	
Linear Velocity	Standard range: 10-15m/s	Higher velocity ↑ → Increased shear force ↑ →Smaller particles ↓ but energy consumption and temperature rise
	High shear (>15m/s): Nanoscale dispersion	
	Low shear (<10m/s): Overheat protection	
Material Compatibility	Silicon carbide ceramic: Corrosion-resistant, zero contamination	Material determines corrosion resistance, contamination risk, and service life; full ceramic design required for pharmaceutical/semiconductor applications
	Stainless steel: Cost-effective (general chemical use)	
Cooling Systemv	Jacketed kettle water cooling: ±1 ℃ temperature control	Prevents material property degradation and reduces solvent evaporation
	Nitrogen protection: For thermally sensitive materials (e.g., PVDF binders)	
	Real-time temperature control: Dynamically adjusts cooling power	

Key Selection Criteria 2 Selection Logic: Lab-Scale vs. Production-Scale

Machine Type	Core Features	Core Features	Representative Models
Lab-Scale	Small capacity Adjustable parameters (speed, circulation cycles)	New material R&D, process validation	NMM Lab Machine, 0.3L Self-Circulation Bead Mill, GPM Dry Sand Mill
Production-Scale	High stability (24/7 continuous operation) Modular expansion (multi-unitparallel operation)	Large-scale production (10,000-ton level): • Anode/Cathode materials • Conductive slurries • Pharmaceutical raw materials	NMM High-Flow Model, LMM Centrifugal Model, SW Series, BYZR Series

Selection Decision Flowchart

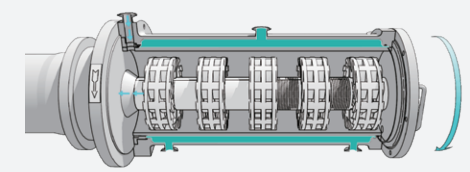
→ Confirm requirements (target particle size,solid content, etc.) → Lab testing
→ Matchmachine capacity→ Select rotor type/material → Choose beaddiameter
→ Scale-up to production

Key Selection Criteria 3 Selection Based on Structural Differences

Grinding & Dispersion Rotor Structures

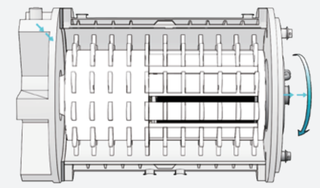
(Specific selection should consider material viscosity, target fineness, and energy consumption costs)

Turbine Rotor



Features a large-volume grinding chamber design combined with recirculation-capable beads. The turbine rotor structure precisely controls bead movement, creating a unique "spiral laminar flow" for damage-free, high-quality material refinement and dispersion.

Pin Rotor



Utilizes densely arranged pins between the rotor and grinding chamber to narrow the grinding zone, forming a uniform high-intensity shear field. Through powerful impact and shear forces, it achieves efficient grinding and fine dispersion of strongly cohesive particles, producing materials with narrow particle size distribution.

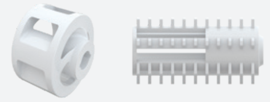
Comparison of Turbine and Pin Construction Features

Feature	Turbine Rotor	Pin Rotor
Particle Size Distribution	Narrow	Broad
Material Morphology & Structure	Intact morphology & structure	Significant structural damage
Heat Generation	Low	High
Wear Degree of Grinder	Low (long lifespan)	Significant (short lifespan)
Zirconia Bead Wear	Low breakage & wear	High breakage & wear
Price	High	Low
Suitable Viscosity	High viscosity	Low viscosity

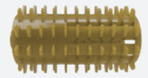
Rotor Materials (Zirconia, Silicon Nitride, Polyurethane, Alumina, Tungsten Carbide, PU+Tungsten Carbide Alloy)

- ✓ Zirconia (ZrO_2): Ideal for battery materials, MLCO, inks, and pharmaceutical ingredients. Features high hardness, heat resistance, corrosion resistance, wear resistance, and low contamination.
- ✓ Silicon Nitride (Si_3N_4): Suitable for semiconductor ceramics and chemical materials. Offers exceptional heat resistance, oxidation resistance, corrosion resistance, and wear resistance.
- ✓ Polyurethane (PU): Compatible with battery materials, ceramics, chemicals, inks, and coatings. Provides high elasticity, wear resistance, lightweight properties, and corrosion resistance.
- ✓ Alumina (Al_2O_3): Used for ceramics, pharmaceuticals, and food additives. Exhibits high hardness, heat resistance, excellent electrical insulation, and chemical stability.
- ✓ Tungsten Carbide (WC): Designed for processing high-hardness, high-toughness materials. Delivers extreme hardness, wear resistance, heat resistance, and corrosion resistance.
- ✓ PU+Tungsten Carbide Alloy: Combines high hardness, wear resistance, heat resistance, and corrosion resistance, making it ideal for machining ultra-hard materials.

Zirconia (ZrO_2) Material

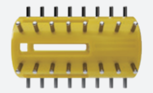


Polyurethane (PU) Material



Silicon Nitride (Si_3N_4), Silicon Carbide (SiC) Materials

PU + Tungsten Carbide (Alloy)



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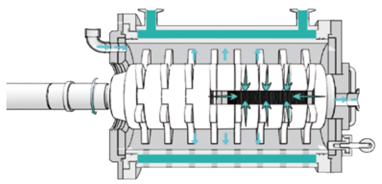
Separation Method

(Select based on material characteristics (particle size, viscosity) and separation accuracy requirements)



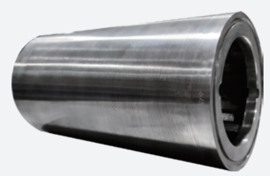
Screen Separation Working Principle

Screen separation operates on mesh filtration principles. Under pressure, material passes through the screen while oversized particles and grinding media are retained. Qualified material exits through the screen. Available in zirconia ceramic or wedge-wire stainless steel variants to suit different operational needs.

Screen Structures: Ceramic Disc Stack/Wedge Shape Screen

Ceramic Stacks

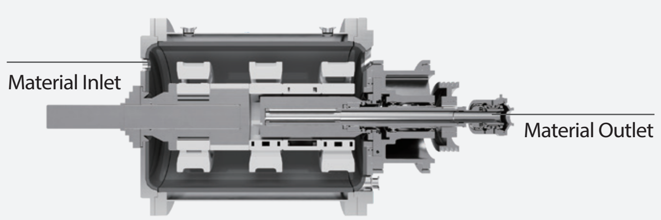
Multiple thin discs form a 3D filtration structure. Impurities are captured between disc walls and grooves for high efficiency filtration.



Wedge Shape Screen

Features trapezoidal wire cross-sections with tapered slots (narrow top/wide bottom). Constructed from corrosion-resistant materials (e.g., stainless steel) to minimize clogging. During operation: Grinding beads/ oversized particles larger than mesh openings are retained Material flows through the wedge shaped gaps.

Centrifugal Separator



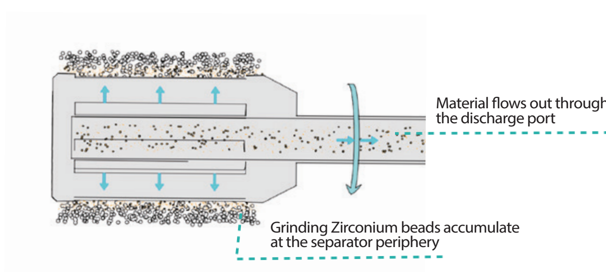
Picture: Schematic Diagram of Centrifugal Separation

Separator Structure

The separator consists of a cylindrical separation chamber and a control system. Its internal structure is designed to retain grinding media while allowing processed slurry to pass through.

Centrifugal Separation Principle

During the grinding phase, the bead mill refines materials through the action of grinding beads and the rotor. Subsequently, centrifugal force separates the ground material from the media, ensuring uniform product fineness.



Workflow

1. Grinding Phase: Processed material and media enter the separator.
2. Separation: The separator structure retains grinding beads while material flows out through the discharge port.
3. Recycling: Retained beads and residual material return to the grinding chamber for reprocessing.

Shaft Seal (Boyee's Proprietary Mechanical Seal Technology)

Boyee double-face design represents a significant technological innovation in mechanical seals. Compared to single-face seals, it demonstrates superior performance in maintaining precise alignment between rotating and stationary seal faces.

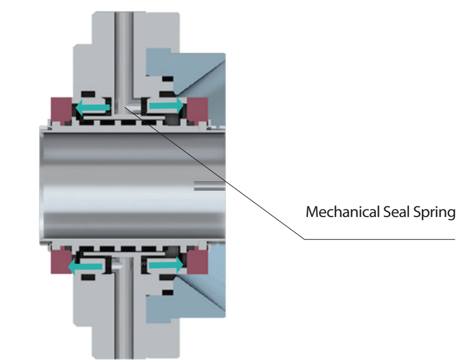
Core Advantages of Mechanical Seals

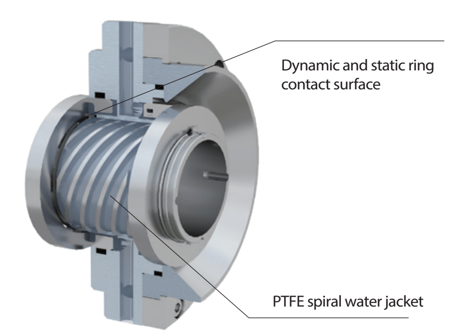
Material Leakage Prevention

During shaft eccentric operation, the double-face design utilizes precisely positioned stationary rings on both sides to effectively limit spiral sleeve displacement, thereby enhancing leak-proof performance.

Elastic Components Create "Zero-Gap" Sealing Defense

The seal spring pre-tensions the stationary and rotating face seals. Under combined action of medium pressure and elastic component force, the sealing pair is further compressed to achieve complete axial face sealing.





PTFE Spiral Water Jacket: The "Intelligent Temperature Control Assistant" for Mechanical Seals

Boyee's PTFE spiral water jacket features an ingenious design.
Passive Cooling: Enables natural water flow for preliminary cooling when pumps are inactiveActive Cooling: Accelerates water circulation for enhanced heat dissipation when pumps operateThe spiral structure ensures uniform cooling across the seal area, maintaining optimal temperatures to extend seal lifespan and support equipment efficiency.

Grinding Chamber Structure

Protrude Inner Lined Chamber

The protrude lined chamber features strategically designed protrusions (regular/irregular patterns) on its inner wall. During rotation, these raised points:Create multi-angle collisions, compression, and shear between material and grinding media to enhance grinding efficiencyDisrupt material flow patterns to improve mixing and dispersion Eliminate grinding dead zones.

Smooth-Liner Chamber

The smooth-liner chamber employs a polished inner wall design that:Enables stable rolling/sliding of material and grinding media through centrifugal force and gravity. Offers low-friction operation with minimal residue for easy cleaning Reduces operational resistance and energy consumption

Grinding Chamber Materials (Zirconia, Silicon Carbide, Silicon Nitride, Polyurethane, Wear-Resistant Alloy)

Zirconia Chamber

Exceptional wear resistance. Zero contamination.
Low energy consumption.

Silicon Nitride (Si_3N_4) Chamber

Wear and corrosion resistant. Thermal shock resistant. High hardness & strength.

Silicon Carbide (SiC) Chamber

Extreme hardness. Superior wear resistance.
Rapid heat dissipation ability.

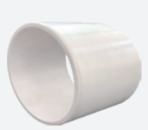
Polyurethane (PU) Chamber

Excellent wear resistance. High elasticity. Superior tear resistance.

Wear-Resistant Alloy Chamber

High wear resistance. Excellent mechanical strength. Corrosion & high-temperature resistance . Outstanding impact resistance.

Zirconia Chamber



Silicon Carbide Chamber

Silicon Carbide Chamber

Wear-Resistant Alloy Chamber

Grinding Media (Zirconia Beads)

Grinding media size should be selected based on material characteristics and processing requirements. Generally, smaller diameters deliver superior results. In high-speed sand mills, spherical or near-spherical beads are optimal as they maximize impact and shear forces. High-density beads further enhance these effects to improve.

Zirconia Bead Size Range(mm)

0. 03–0. 05	0. 8–1. 0
0. 05–0. 1	1. 0–1. 2
0. 1–0. 15	1. 2–1. 4
0. 15–0. 2	1. 4–1. 6
0. 2–0. 25	1. 6–1. 8
0. 25–0. 3	1. 8–2. 0
0. 3–0. 4	2. 0–2. 2
0. 4–0. 5	2. 2–2. 4
0. 6–0. 7	2. 4–2. 6
0. 7–0. 8	2. 8–3. 0

Properties of Grinding Zirconia Beads Density

Higher-density zirconia beads provide greater impact momentum and grinding efficiency, but increase wear on mill components. Proper matching of slurry viscosity and flow rate is critical:
Low-density beads: Optimal for low-viscosity slurries
High-density beads: Better suited for high-viscosity slurries

Properties of Grinding Zirconia Beads Density

While harder beads theoretically exhibit lower wear rates, they accelerate component wear. This can be mitigated by optimizing:

Bead filling ratio
Slurry viscosity
Flow rate parameters

Zirconia Beads Sphericity

The grinding efficiency is influenced by rotational dynamics:
Spherical beads: Higher angular velocity (ω) increases energy transfer
Non-spherical beads: Impede rotation, reducing energy efficiency

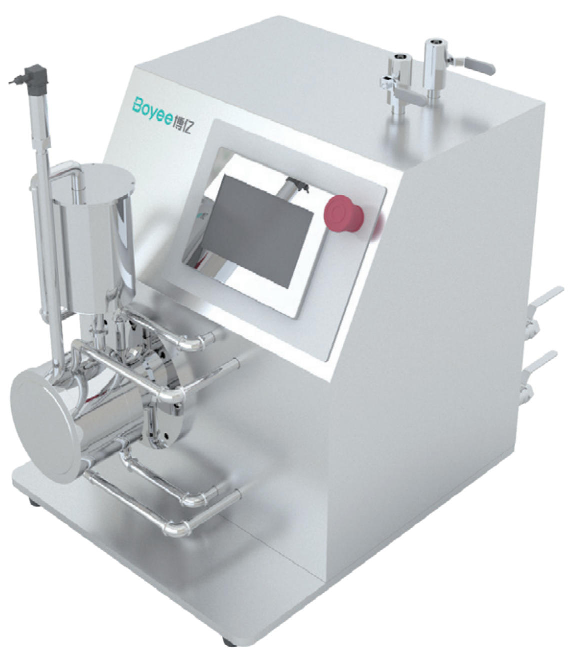
Reference Guidelines for Selecting Grinding Media Sizes for Bead Mills:

Bead Size(mm)	Target Particle Size(um)	Initial Particle Size(um)	Slurry Viscosity(cps)	Solid Content %（wt）	Linear Velocity(m/sec)	Screen Gap(mm)
0. 05	<0. 05	<5	<1000	<25	≤15	0. 02
0. 1	<0. 08	<10	<1000	<25	≤15	0. 05
0. 2	<0. 1	<20	<2000	<30	≤15	0. 1
0. 3–0. 4	<0. 1	<20	<10000	<35	≤15	0. 15–0. 1
0. 4–0. 6	<1	<40	<10000	<60	≤12	0. 22–0. 2
0. 7–0. 9	<2	<80	<20000	<70	≤12	0. 3–0. 35
0. 9– 1. 1	<10	<150	<20000	<70	≤8	0. 5
1. 75–2. 5	<20	<150	<20000	<70	≤8	0. 6

Note: The above data is for reference only. Actual parameters may vary depending on specific process conditions. For more detailed information, please contact us.

NMM-0.3L Self-Circulating Bead Mill

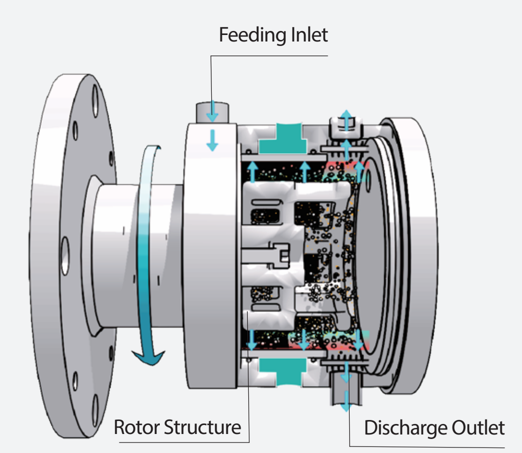
An efficient self-circulating sand mill specifically designed for university research and industrial pilot-scale development.



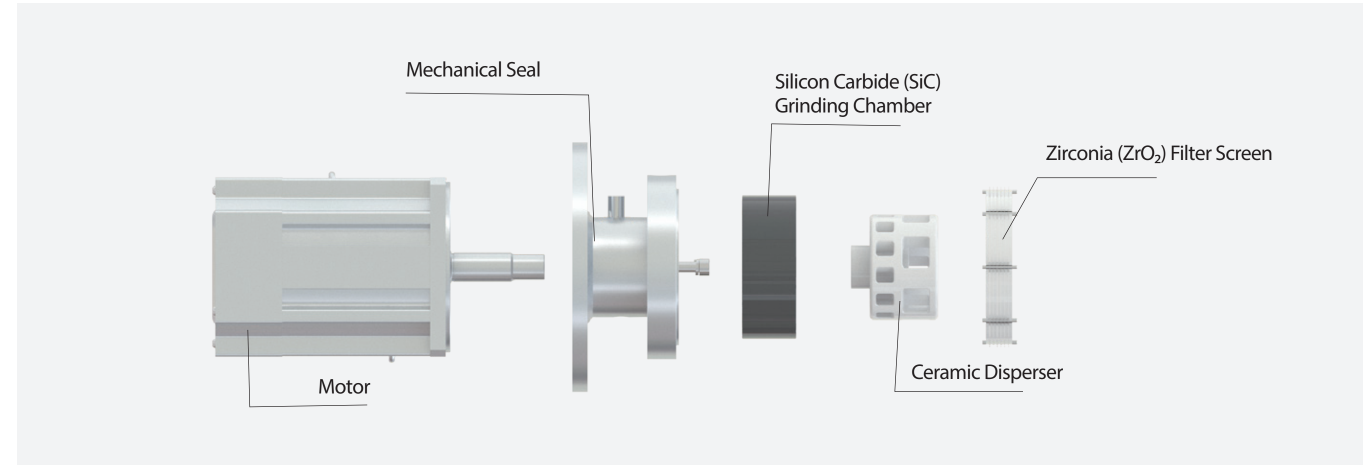
- **Patented Flow Channel Design**
  Silicon Carbide (SiC) Chamber Lining: Combined with guided flow channels to create axial vortex flow, enhancing grinding efficiency.
  Optimized Material Flow: Engineered channels direct slurry movement for maximum particle interaction.
- **Self-Circulating Operation (No External Pump Required)**
  Centrifugal Pumping Effect: Rotor-generated suction works with stack-disc filters to create autonomous circulation.
  Zero-Residue Advantage: Eliminates material retention and cross-batch contamination.
- **Stacked-Disc Static Separation**
  Zirconia (ZrO_2) Filter Design: 40% increased flow area.
  Clog-Free Operation: Combines rotor centrifugal force with static separation to prevent media blockage.

Working Principle

1. **Material Feeding:**
   Accepts powders, liquids, and solid-liquid mixtures. Compatible with multiple solvent and material systems. Loaded through the feeding inlet.
2. **Self-Circulation:**
   Ceramic disperser operates at high speeds3D chamber geometry enhances shear and impact forcesAchieves nano-level refinement with uniform particle distribution.
3. **High-Shear Grinding:**
   Ceramic disperser operates at high speeds3D chamber geometry enhances shear and impact forcesAchieves nano-level refinement with uniform particle distribution.
4. **Stacked-Disc Static Separation:**
   Zirconia (ZrO_2) disc filters separate material from media via centrifugal force40% larger flow area prevents cloggingEnsures efficient output of qualified material.
5. **Product Discharge:**
   Supports both continuous and batch modesDirect output meets both pilot-scale and production needs.



Internal Structure Schematic



Design Principles

Ceramic Disperser Design

Hydrodynamic Optimization: Blade angle and spacing engineered through fluid dynamics simulation3D. Grinding Zone: Creates multi-directional particle collisions for uniform size distribution.

Disperser-Chamber System

Material Synergy: ZrO_2 ceramic disperser + SiC chamber liningsuperior corrosion resistance vs. stainless steel. Chemical Compatibility: Handles strong acidic/alkaline solventsEliminates metal ion contamination risks.

Technical Specifications

Parameter	NMM-0.3L
Spindle Speed	0-4000r/min
Zirconia Bead Diameter	0.1-1.2mm
Bead Filling QTY	0.7-1.0KG
Energy Consumption	2.1kWh/次
Temperature Control	≤40℃（Enhanced cooling efficiency）
Batch Capacity	0.3-0.7Lslurry/batch
Flow Area	282.6/mm²
Screen Gap	0.15mm（Adjustable）

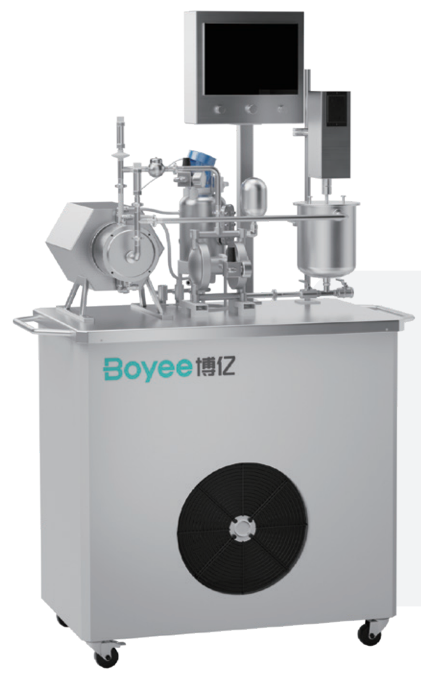
NMMMulti-Functional Laboratory Mill

An advanced device designed for small-scale R&D and production, featuring manually adjustable screen gaps.

- **Turbine + Pin Dual-Structure**
  High-frequency, high-intensity grinding for rapid material processingCombined shear/impact forces for efficient particle reduction.

- **Three Agitator Configurations**
  Frame-type: For high-viscosity materials
  Anchor-type: Optimal for suspension mixtures
  Dispersing disc: Ideal for nano-scale refinement
  (Interchangeable designs accommodate diverse experimental needs)

- **Scalable to Production**
  Seamless transition from lab testing to pilot-scale productionVerified scale-up protocols for industrial translation.

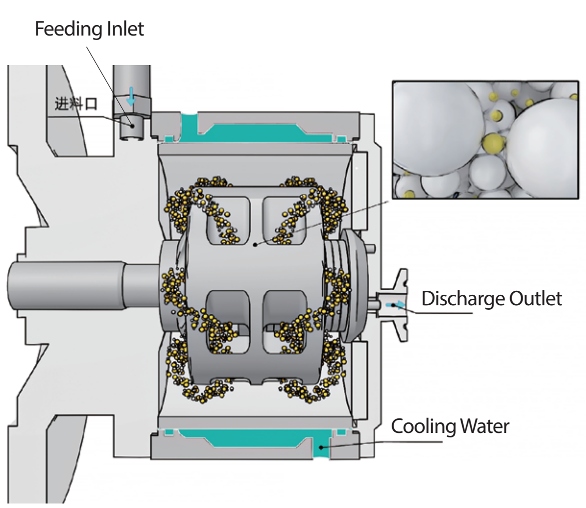


Bead Filling Rate: 70%-85%

Separation:Screen-based separation

Screen options:
Ceramic stacked-disc screen
(49 cm² flowarea)
Wedge shape screen
(65 cm² flow area)

Energy consumption:2.935/5.1025kwh



- **High-Intensity Shear Grinding**
  The grinding chamber utilizes powerful bead impact forces to create intensive particle collisions and shear, progressively reducing material particle size.

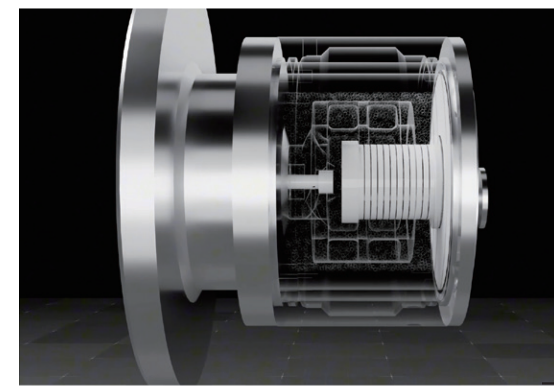
- **Dispersion Mechanism**
  Controlled-Intensity Processing: Optimized frequency prevents structural damage to particles.
  Non-Destructive Dispersion: Maintains original particle architecture while achieving uniform distribution.

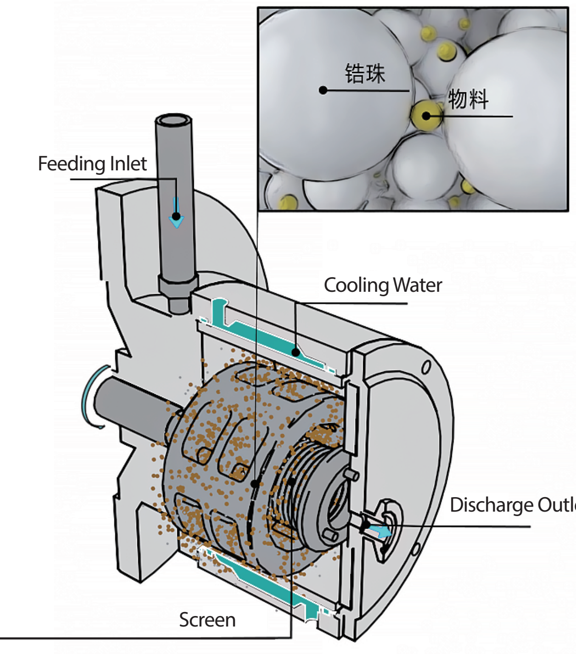
- **High-Energy-Density Grinding Chamber**
  Delivers maximum crushing forcePrevents over-dispersion
  Batch Processing Capability:Consistent micronization for both small and large batch volumes.

Ceramic Stacked-Disc Filter Screen

Flexible Adaptation to Experimental Needs

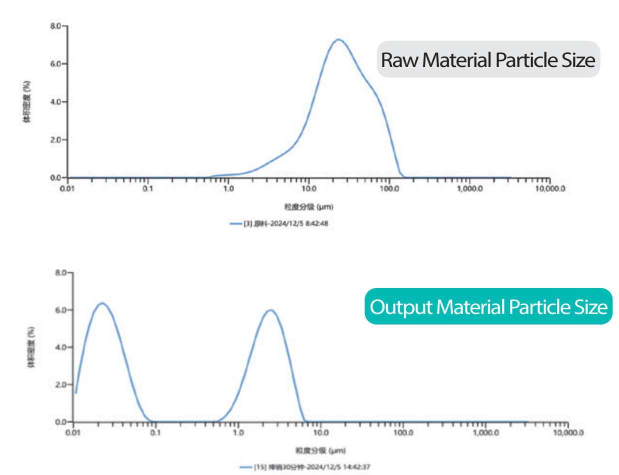
Large Flow Area: Optimized material throughput.
Adjustable Filtration: 0.1-2.0mm media diameter compatibility.
Universal Material Handling:
Single-machine adaptation for multiple materials.
Effective processing across viscosity ranges.





Specification

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter (mm)	Screen Gap (mm)	Batch Capacity (L)	Feed Rate (L/min)	Weight (KG)	Dimensions (mm)
NMM-1L	1	2.2	0.1-2	0.05-1	1.4-10	0.5-2	120	1000x580x1750
NMM-2L	2	4	0.1-2	0.05-1	2.4-20	0.5-2	140	1150x680x1850



Processing cases

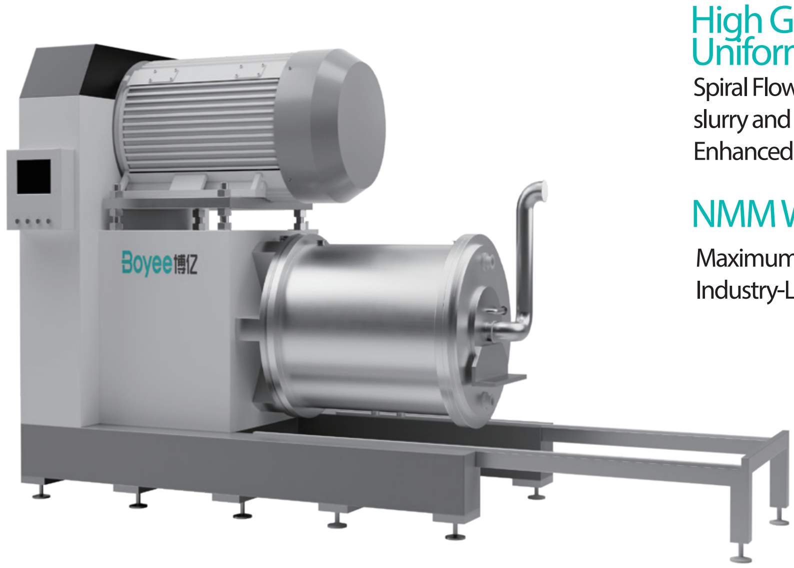
* Carbon Nanotubes (CNTs)

Particle Size	Innitial Material	Output Material
D50 μm	24.9	0.0555
D90 μm	71.8	3.39

NMMHigh-Flow Screen-Type Nano Bead Mill

Dual-function system supporting both grinding and nano-dispersion processes, achieving high-efficiency production through large-flow circulation.

Bead Filling Rate: 70%-85%
Separation Method: Screen separation
Energy Consumption: 9.205-443.2kwh
Flow Area: 162.7cm²-8849cm²
Screen Types: Ceramic stacked-disc, Wedge shape screen



High Grinding Efficiency with Uniform Particle Distribution

Spiral Flow Channel Design: Creates counter-current impact between slurry and grinding beads.
Enhanced Shear Forces: Optimized for nano-level refinement.

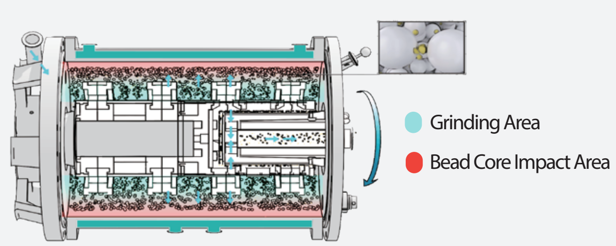
NMM Wedge-Wire Screen Structure

Maximum Flow Area: Enables large-volume circulation.
Industry-Leading Grinding Efficiency.

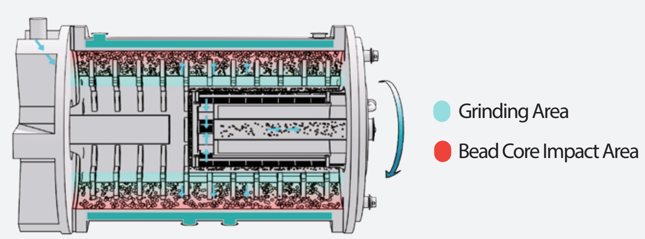
Patented Flow Channel Design (High-Viscosity Optimization)

Smart Discharge System: Eliminates traditional clogging issues.

Uniform Grinding Technology



High Energy Density Grinding Zone



- **Spiral Flow Channel Design:**
  Counter-current slurry/bead interaction
  Ultra-high shear intensity
- **Nano Precision Grinding**
  NMM Dynamic Distribution Technology Achieves:
  True nano-scale refinement
  Narrow particle size distribution (PSD)
- **High-Density Zirconia Bead**
  Nano-Impact Forces: Unmatched crushing efficiency
- **Dynamic Uniform Distribution:**
  Zero dead-zone bead distribution
  Precise particle size control (±5% variance)

Wedge Shape Screen Structure

Traditional Flat Screens

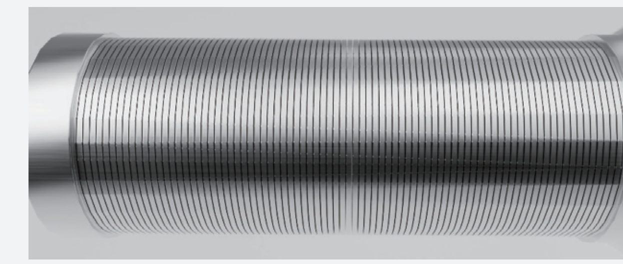
Planar Structure Limitations:
Restricted flow efficiency
Low throughput capacity

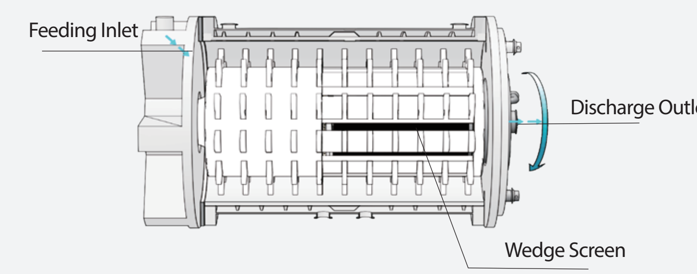
NMM Wedge Shape Screen Innovation

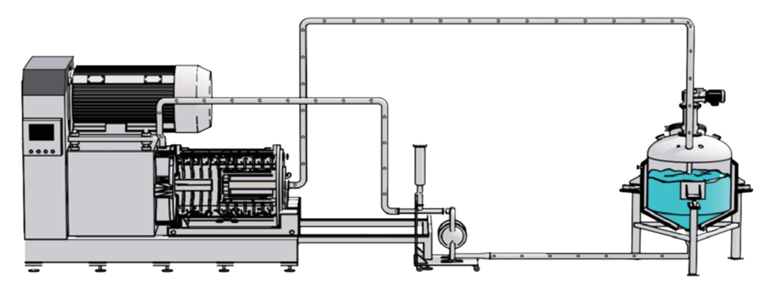
3D Expanded Design:
Increased flow area
Revolutionized processing capacity

Precision Gap Control

Accurate bead interception
Zero media leakage







High-Flow Circulation Mechanism

Continuous Operation:
High-speed slurry cycling
Full grinding media activation

Efficiency Breakthrough:
Multi-frequency crushing
Rapid dispersion
Closed-loop optimization

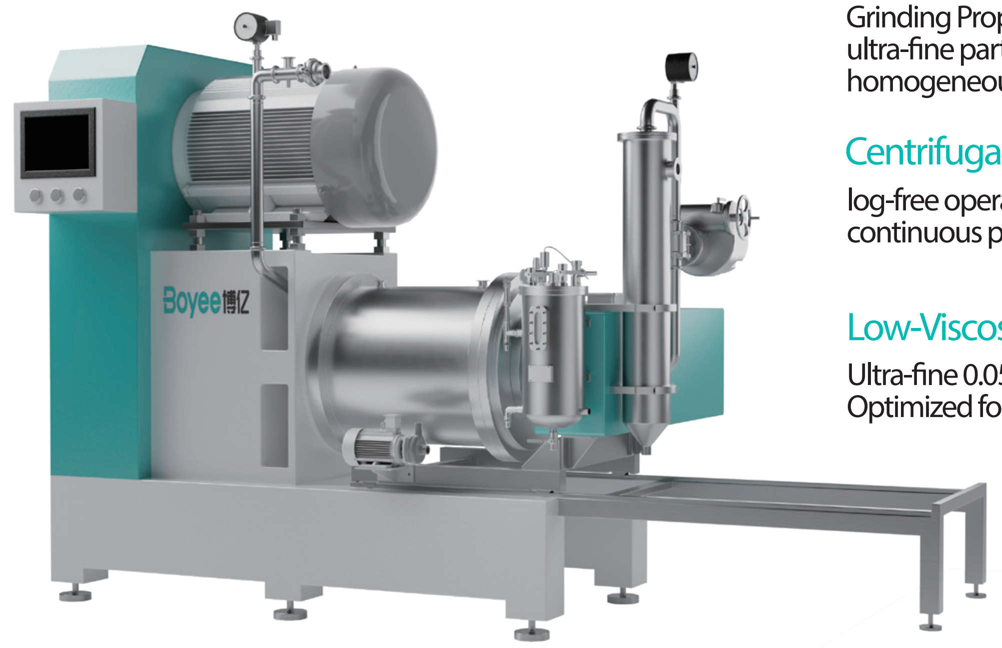
Speciafication

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter (mm)	Screen Gap (mm)	Batch Capacity (L)	Feed Rate (L/min)	Weight (KG)	Dimensions (mm)
NMM-3L	3	7. 5	0. 1-2	0. 05-1	7. 4-35	6-42	400	910x680x900
NMM-10L	10	18. 5	0. 1-2	0. 05-1	22. 6-100	6-42	1280	2223x1367x1870
NMM-30L	30	37-45	0. 1-2	0. 05-1	58-300	6-42	1700	2950x1220x1850
NMM-60L	60	75	0. 1-2	0. 05-1	126-500	25-50	2300	2985x1204x2240
NMM-90L	90	75-90	0. 1-2	0. 05-1	196-1000	41-65	2500	3320x1240x2140
NMM-150L	150	160-200	0. 3-1	0. 15-0. 5	325-3000	66-100	5200	4500x1500x2400
NMM-400L	400	315-355	0. 3-1	0. 15-0. 5	715-10000	100-300	8600	4900x1865x2750

LMM Ultrafine Centrifugal Nano Bead Mill

Innovative Dynamic Centrifugal Separation Technology Enables nano-scale gentle grinding without structural damage.

Optimal Bead Filling: 70%-85% Separation Method: Centrifugal separation Energy Consumption: 18.675- 443.2 kwh



Ultra-Precision

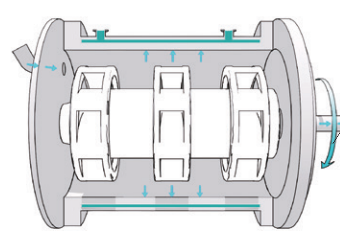
Grinding Proprietary system ensures both ultra-fine particle reduction and homogeneous dispersion.

Centrifugal Discharge System

log-free operation guarantees continuous production.

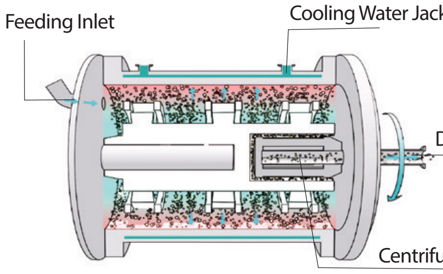
Low-Viscosity Material Specialization

Ultra-fine 0.05mm grinding media.
Optimized for delicate material processing.



Clog-Free Nano-Efficient Grinding Technology

High-Efficiency Nano-Grinding System.
High-Density Bead Loading: Maximizes impact frequency.
Patented Centrifugal Separator + Pump Synergy:
-Forces continuous media circulation.
-Prevents over-grinding while ensuring efficient dispersion.



Dynamic centrifugal force for precise separation of zirconium beads and material

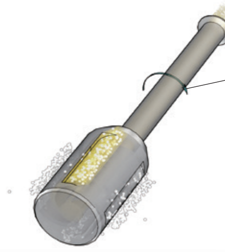
Centrifugal separators utilize the centrifugal force of the rotor to achieve efficient separation of microbeads for high speed, high flow circulation and small particle size media applications.

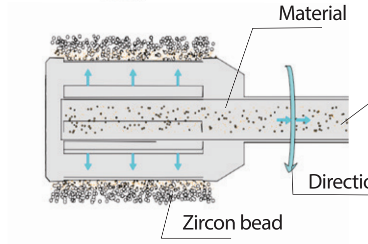
LMM Breakthrough: Eliminating Screen Limitations Ultra-fine media applications (down to 0.05mm beads)

Screenless Centrifugal Separation:

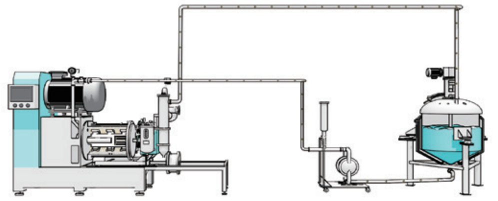
☐ Separates processed material from high-density beadswithout clogging

☐ Processes coarse particles without obstruction

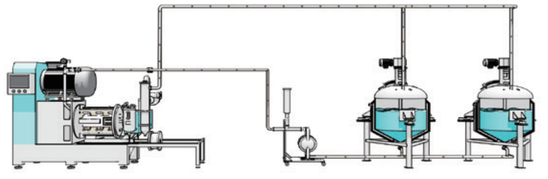




Single-Tank Circulation
Closed-loop system with grinding chamber and one processing tank



Dual-Tank Circulation Advanced system enabling:
☐ Alternating batch grinding
☐ Classified refinement processes



The sand mill with one tank for cyclic grinding forms a closed loop between the sand mill and a single tank, and the material is cycled and ground in it. The sand mill with two tanks for cyclic grinding builds a cyclic system with the two tanks, which can achieve different processes such as alternating grinding or graded grinding of the material between different tanks.

Speciafication

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter (mm)	Batch Capacity (L)	Feed Rate (L/min)	Weight (KG)	Dimensions (mm)
LMM-3L	3	7. 5/7. 5	0. 1-1	7. 4-35	6-42	800	1427x960x1711
LMM-10L	10	18. 5/7. 5	0. 05-1	24-100	6-42	1500	2223x1367x1870
LMM-30L	30	45/7. 5	0. 05-1	62-300	6-42	2300	2924x1287x1850
LMM-60L	60	75/11	0. 05-1	116-500	25-50	2800	3280x1368x2240
LMM-90L	90	75-90/11	0. 1-1	173-1000	41-65	3300	3300x1730x2140
LMM-150L	150	160/15	0. 1-1	300-3000	66-100	5800	4500x1700x2400
LMM-400L	400	315-355	0. 1-1	732-10000	100-300	10000	4600x1600x2400

SW Universal Nano Bead Mill

Dual-Function Innovation: Integrated Grinding & DispersionPrecision particle reduction and high-efficiency dispersion in a single processing step.

Enhanced Large-Flow Screen Design:
30% greater flow efficiency vs conventional mills
Optimized for nano-scale processing

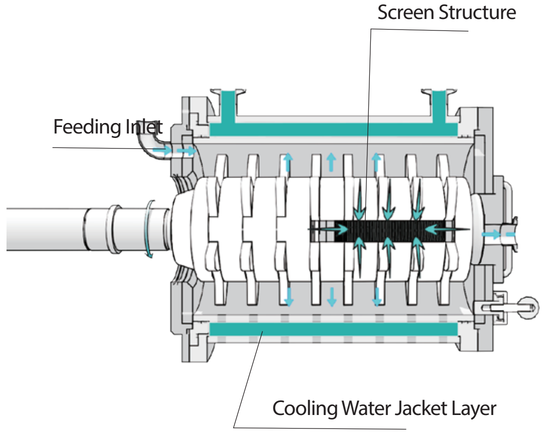
roprietary Dynamic Discharge System Clog-Free Operation:
Specialized high-viscosity material handling
Self-cleaning mechanism

Triple Discharge Solutions (Industry Pain Point Resolution)
Static High-Flow Mode
Dynamic Anti-Clog Mode
Hybrid Processing: Adaptive viscosity management

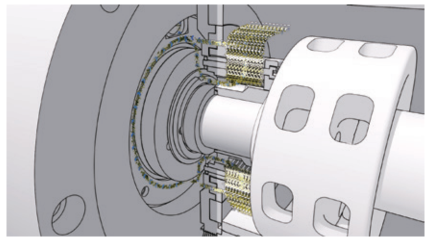
High Speed Bead&Material Interaction Dynamics

Grinding Zones
Primary Crushing Zone:
Zirconia beads perform high-frequency collisions in vortex flow.
Secondary Refining Zone:
Precision shear forces through dynamic gaps.

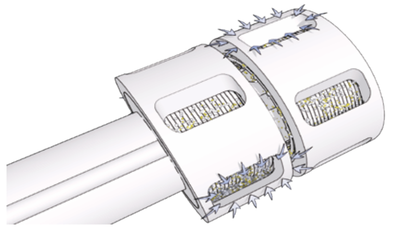
Uniform Bead Distribution System
Optimized Rotor Kinematics:
Maintains homogeneous bead dispersion.
Prevents over-crushing.
Damage-Free Processing:
Achieves micron/nano-scale refinement.
Preserves particle structure integrity.



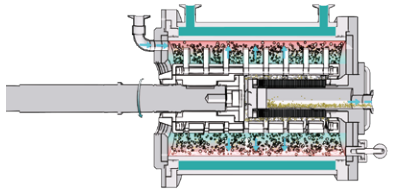
Discharge Methods Options



Rotating/Stationary Ring Discharge
Utilizes optimized seal ring contact pressure
Enables high-efficiency micro-gap discharge

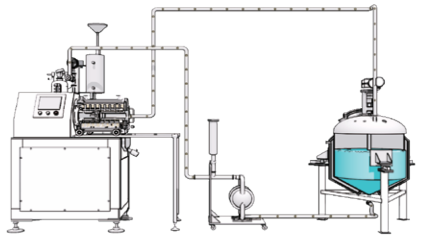


Axial Discharge
Hollow shaft design
Intelligent centrifugal force regulation
Achieves dynamic separation and axial material discharge



End Part Discharge
Static wedge-wire creen configuration
Optimized hydrodynamic flow paths
High-volume efficient discharge

Continuous Circulation Production



Pre-Dispersion: Homogenization in pre-mixing tank
Grinding Process:Coarse grinding → Precision refinement
PLC Control:Real-time parameter adjustment
Energy-efficient operationPrevents over-grinding

Beads Fill ing Rate: 70%-85%
Energy Consumption: 17.205-56.025kwh
Flow Area: 78.2cm^2-1156cm^2
Separation Method: Screen Type
Screen Type: Ceramic Disc/Wedge-Wire

Speciafication

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter (mm)	Screen Gap (mm)	Batch Capacity (L)	Feed Rate (L/min)	Weight (KG)	Dimensions (mm)
SW-5L	4.5	15	0.1-1.5	0.05-0.75	10-50	6-42	550	1430x748x2000
SW-10L	10	18.5-22	0.1-1.5	0.05-0.75	25.2-100	6-42	750	1467x863x1655
SW-30L	30	37-45	0.1-2	0.05-1	58-300	16.7-41.7	1700	2950x1220x1850

BYZR Ceramic Turbine Bead Mill

Full ceramic elongated chamber and turbine structure design, achieving gentle and efficient material dispersion and crushing.

Low-speed(flexible grinding)

Efficient and gentle dispersion/crushing of materials, avoiding structural damage to the material.

Coordinated axial and radial movement

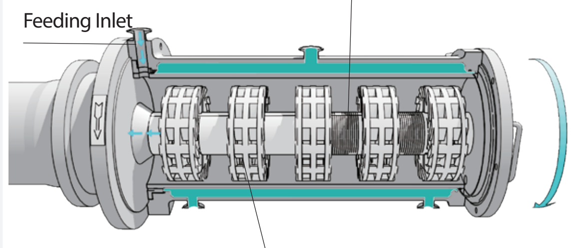
Enables highly efficient circulating grinding.

Axial discharge design

Allows precise separation of micro grinding beads.

Working Principle of Material and Grinding Beads Inside the Chamber

When the turbine structure operates, the material is axially drawn in and forms a spiral laminar flow along the curved blades. This subjects the material to repeated uniform shear and friction forces during laminar movement, achieving particle dispersion and refinement.

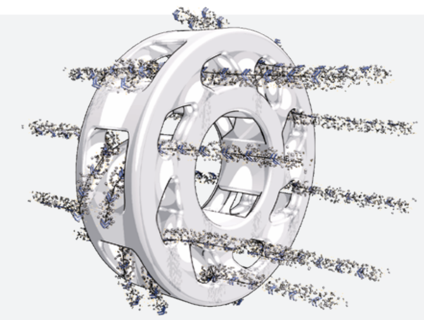


Gentle Dispersion and Grinding

1. Low-speed design: Compared to traditional high-speed grinding equipment, the turbine operates at a low rotational speed, reducing mechanical impact forces.

2. Soft contact: The blade surface's cushioning material minimizes direct collision intensity between particles.

3. Laminar-flow dispersion: Material is subjected to gradual forces within the laminar flow, avoiding localized stress concentration, enabling gentle fragmentation and dispersion.



Axial Motion Path

Material and grinding beads follow an axial motion path within the grinding zone drawn in and ejected, achieving material refinement.

Radial Motion Path

Unqualified material and grinding beads are drawn in and ejected along a radial motion path, re-entering the grinding zone for reprocessing.

Speciafication

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter (mm)	Screen Gap (mm)	Batch Capacity (L)	Feed Rate (L/min)	Weight (KG)	Dimensions (mm)
BYZr-3L	2. 8	7. 5	0. 2-1	0. 1-0. 5	5. 6-30	1-10	468	1200x1050x1450
BYZr-15L	15. 6	30	0. 3-1	0. 15-0. 5	31. 2-100	5-15	1205	1600x1350x1850
BYZr-30L	22. 5	45	0. 3-1	0. 15-0. 5	45-300	6-42	1425	1650x1305x2050

GFM Dry Bead Mill

Realization of powder particle refinement

The GFM-lL Dry Bead Mill is a highly efficient and precise hydration processing equipment, designed for laboratory and dry grinding applications.Its core advantages lie in refining or improving medium precision and particle refinement, making it suitable for processing high-temperature materials, ceramic fibers, metal oxides, and other wear-resistant applications.

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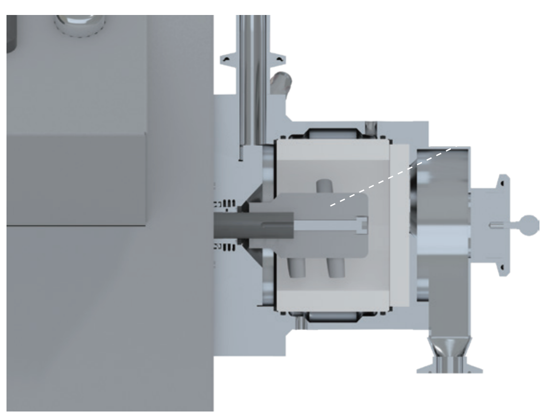
Spiral Counterflow Impeller



Turbine Rotor

Dynamic Gap Design Prevents Material Agglomeration

Asymmetric membrane design and plastic flow separation device; spindle speed: Φ590/1min; impeller speed: 4~6m/s; bidirectional vortex formed by counter-rotation.

Cooling via stirring; counter-vortex reduces blade pressure, enhances inter-blade friction, and improves lubrication efficiency.

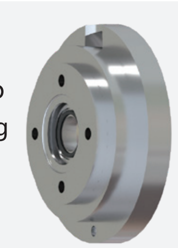
Static Screen and Labyrinth Seal System

Screen Structure

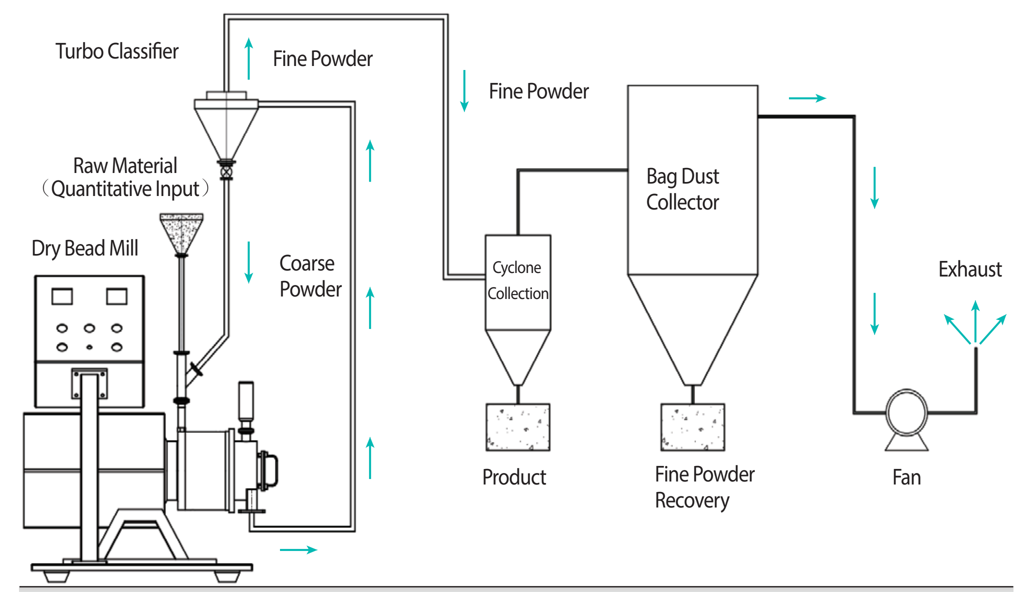
Oxidation filter (pore size gradient design) with maximum surface density processing and filling performance (>99.2%).

Labyrinth Seal

The labyrinth seal adopts precision axial radial gap control (0.05-0.1mm) and multi-stage meandering runner design, forming an efficient pneumatic barrier under 0.3MPa gas pressure.



Dry Grinding Process



① Quantitative Input of Raw Material
The raw material is measured by a high-precision quantitative feeder and transported to the GFM dry bead mill.

② Crushing Coarse Powder Particles
Coarse powder is sent to the crushing zone, where particles are broken by high-frequency collisions between the impeller and grinding beads in the grinding chamber.

③ Full Shear Crushing
Under the action of the grinding rotor, the beads and material fully collide and undergo shear crushing, then are sent to the classification zone.

④ Grinding and Classification
After crushing, the material is classified into coarse and fine powder by centrifugal force; coarse powder returns to the grinding zone.

⑤ Fine Powder Separation and Recovery
Fine powder is discharged from the GFM dry bead mill and recovered via a cyclone separator and bag filter.

Speciafication

Parameter Category	GFM-1L Dry Bead Mill
Spindle Speedv	0-950r/min
Bead Diameter	1- 8mm
Bead Loading	1.6-1.9KG
Energy Consumption	3KWh
Temperature Control	≤45℃
Optimal Batch Capacity	1.5-5kg powder/batch
Flow Area	740/mm²
Screen Gap	0.5-4 mm

GFM-1L Technological Innovations & Performance Comparison

Technology Module	Traditional Dry Bead Mill	GFM-1L Innovative Design	Performance Improvement
① Impeller Design	Unidirectional spiral	Reverse dual-spiral + TiN coating	Particle size CV value reduced by 42%
② Separation System	Single-stage metal screen	Ceramic segmented screen	Separation efficiency increased to 99.2%
③ Energy Control	Standard asynchronous motor	Permanent magnet synchronous motor + direct drive	Energy intensity reduced to 0.65kWh/kg
④ Temp. Control Precision	Air cooling	Multi-channel water cooling + PID control	Temperature fluctuation ≤±2℃

Mixing Tank

Material circulation volume is at least 2 times and maximum 15-20 times the tank capacity.

- Efficient and gentle mixing process prevents material damage from over-mixing
- Optional CIP (Clean-in-Place) and SIP (Sterilize-in-Place) functions
- Advanced shaft sealing technology effectively prevents leakage during operation
- All contact parts are made of high-quality stainless steel
- All mixing tanks come equipped with cooling water jackets

Frame-type Agitator

Suitable for processing high-viscosity materials or materials with sedimentation tendency.

1000-3000pcs

Anchor-type Agitator

Suitable for medium-low viscosity materials or materials prone to s edimentation

1000-3000pcs

Helical Ribbon Agitator

Suitable for high-viscosity, large-volume fluids and solid-liquid mixtures.

10000-100000pcs

Speciafication

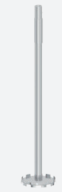
Volume (L)	Tank Diameter (mn)	Mixing Power (KW)	Mixing Speed (r/min)	Working Pressure (Mpa)	Jacket Pressure (Mpa)
20	300	0. 37	0-130	0. 08	≤0. 2
50	450	0. 75	0-130	0. 08	≤0. 2
100	500	1. 1	0-130	0. 08	≤0. 2
200	700	1. 5	0-130	0. 08	≤0. 2
300	900	3	0-130	0. 08	≤0. 2
500	1000	4/5. 5	0-130	0. 08	≤0. 2
1000	1200	5. 5-11	0-130	0. 08	≤0. 2
2000	1400	7. 5-15	0-130	0. 08	≤0. 2
3000	1500	11-18. 5	0-130	0. 08	≤0. 2
6000	2200	18. 5-37	0-130	0. 08	≤0. 2
10000	2400	22-37	0-130	0. 08	≤0. 2

Dispersion Tank

The disperser design ensures uniform material distribution within the tank for optimal mixing results.

- Adaptable to various material dispersion requirements
- Incorporates advanced dispersion technology for rapid, uniform material distribution
- Constructed with premium materials and precision engineering for durability and stability
- Supports automated module configuration for seamless integration with other production line equipment

Serrated Disc Type



When the serrated disc disperser rotates at high speed, its serrated edges generate intense shear forces and turbulence. This tears apart and disperses materials while creating circulatory flow, making it ideal for dispersing and mixing medium-low viscosity materials such as coatings, inks, and emulsions.

1000-50000pcs

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Services During Sale

Provide comprehensive technical support and solutions to ensure smooth project implementation and meet customer needs

- On-site investigation and technical support
- Equipment selection and matching
- Solution design and optimization
- All supporting equipment are independently produced
- Comprehensive project management

After-sales Service

Install service

Develop a Thorough Installation Plan and Implement It

After you purchase Boyee's equipm is ready to serve you at any time ent, our global service team When you start the equipment installation, we will start to develop a thorough plan, perform good installation, commissioning and startup Boyee 's professional installers will provide you with the following installation services based on their rich installation experience:

Installation & Assembly → Empty Machine Debugging → Debugging with Materials → Site Acceptance Test (SAT)

Repair

Ensure the Stable Operation of the Equipment to A Greater Extent

Malfunction Repair

Regardless of any problems such as interruption of operation or production stoppage of your machine, you can get professional advice through the new online support system or telephone. The Boyee service team will provide comprehensive professional support to minimize the impact/loss caused by the failure.

Regular Maintenance

In order to protect the service life of the equipment, we recommend that you perform regular maintenance inspections to prevent and detect abnormal operation as early as possible.

Partners

BUAA	FNU	HNU	HZU	ZZU	SYSU
SHU	SINANO	XJTU	HKU	SXDTU	CUST
BTR	Dynamonic	BYD	EVE	Gotion	IOPSILION
Weilan	SEMCORP	Shanshan	Qingtao	Hunan Yuneng	PUTAILAL
Sunwoda	BAK	SINUO	BRUNP	Haike	TOWSTONE
KTC	WANRUN	JINQUAN	HAOXIN	LENENG	KNANO
BYD Semicon	Omat	Gemch	CSOT	Shenglu	SUNWAY
AKZONOBEL	CLT	TOYOCOLOR	KB	MERLIA	INKBANK
SAVEN	SOKAN	INK	TJ Dongyang	TIAN WEI	Zhuhai JY