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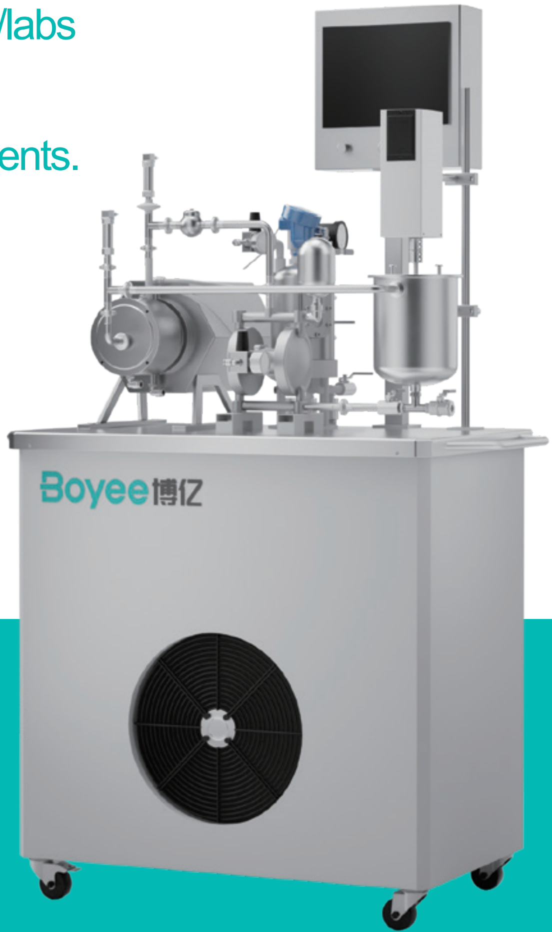
Stabler Equipment, Purer & Finer Outputs

NMM Multi-Functional Laboratory Mill

The preferred R&D equipment for universities/labs featuring manually adjustable screen gaps to accommodate diverse experimental requirements.



www.boyeemill.com

Equipment Introduction

The Boyi NMM Multi-Functional Testing Machine is an advanced device specifically designed for small-scale R&D and production. It accommodates diverse grinding requirements with versatile functionality and user-friendly operation. Constructed entirely from premium stainless steel, the machine exhibits exceptional resistance to acids and alkalis. Experimental data can be scaled proportionally to achieve production capacity and mass production.

Equipment Features

- Turbine + pin dual structure for high-frequency, high-intensity grinding
- Equipped with a pre-dispersion tank
- Adjustable cooling effect (temperature controllable)
- Double-ended mechanical seals effectively prevent material leakage
- Scaling from lab-scale to mass production
- Three mixer types to meet diverse experimental needs
- Sealed grinding circuit
- Ceramic laminated filter with self-adjusting clearance

Working Principle Introduction

01 Feeding and Grinding System Selection

The material to be processed enters the grinding zone of the NMM multifunctional laboratory machine through the feed inlet. Users may choose to equip it with either the patented TurboMax turbine-type or pin-type grinding system. Utilizing high-speed rotating grinding media, the system subjects the material to intense shearing, impact, and friction to achieve fine grinding.

02 Post-grinding Filtration

The ground material is filtered through a wedge-shaped screen structure, effectively intercepting grinding media and under-ground particles to ensure uniform and fine discharge particle size.

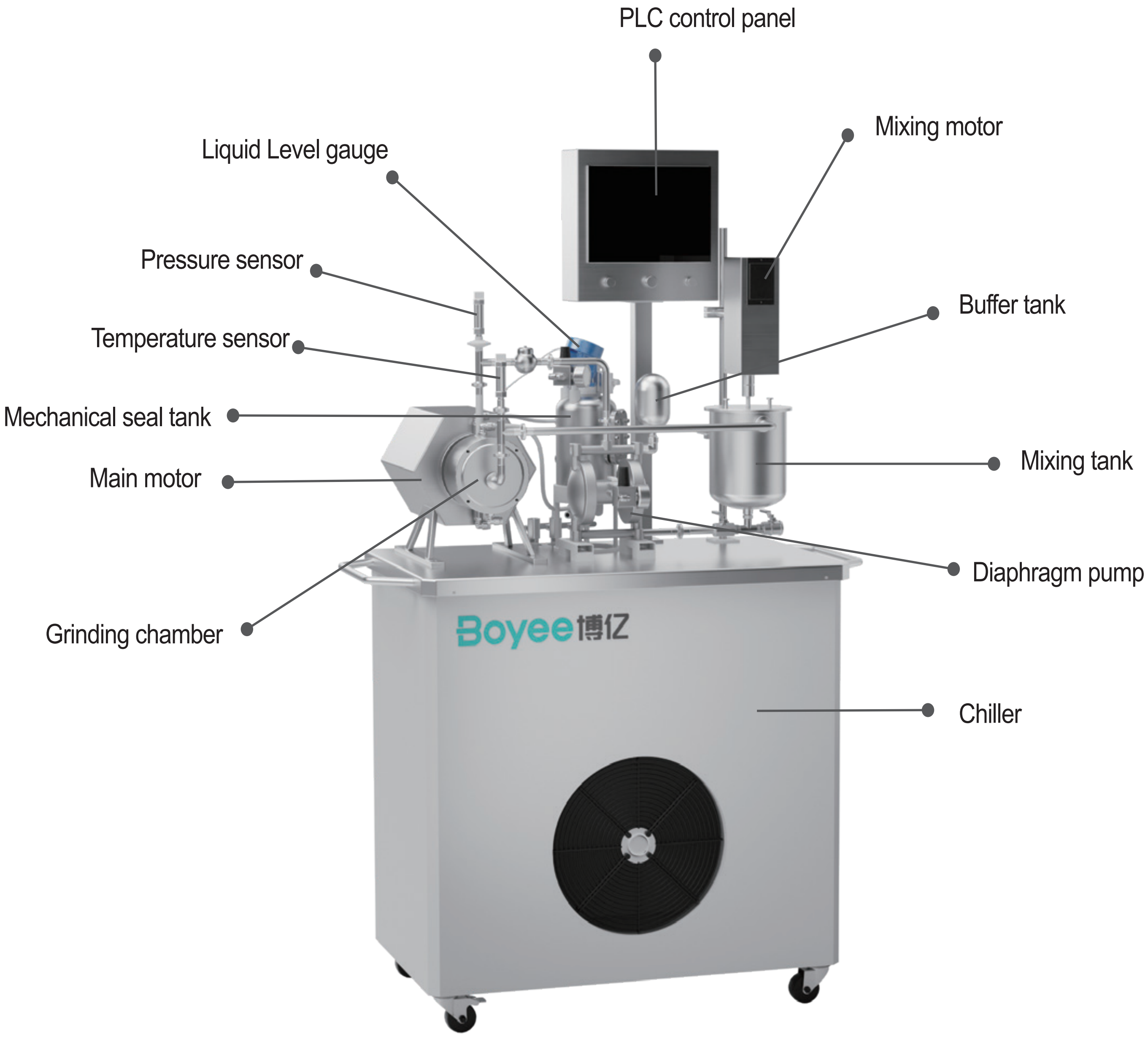
03 Cyclic Grinding

Material that does not pass through the filter screen is recycled back to the grinding zone for continued grinding until the desired particle size distribution is achieved.

04 Discharge

After being filtered through the screen and subjected to cyclic grinding, material meeting the particle size requirements is discharged through the outlet, completing the entire grinding process.

Overall Structure



The experimental data demonstrates excellent scalability, capable of processing 1.4L to 20L of slurry per batch to meet both laboratory and small-scale production requirements. Experimental results can be proportionally scaled up to production, enabling seamless transition from small-scale to large-scale manufacturing.

Parts Introduction

Pressure Sensor: Pressure sensors may be used to monitor internal equipment pressure or hydraulic system pressure, ensuring proper equipment operation and providing necessary safety protection.

PLC Control Panel: Serves as the equipment's control center, responsible for receiving and processing various input signals while controlling equipment operation according to preset programs. In bead mills, the PLC control panel is used to set and adjust grinding parameters, monitor equipment status, and handle malfunctions.

Agitator Motor: Provides power to the agitation mechanism, driving the agitator components to rotate at high speeds. This ensures thorough mixing, collision, and friction between the grinding media and the material, achieving grinding and dispersion.

Buffer Tank: StabilizThe performance and stability of the main motor significantly impact the grinding efficiency and operational reliability of the bead mill.

Temperature Sensor: Monitors the operating temperature of the equipment or the material temperature to ensure the device operates within safe temperature limits and prevent material degradation due to excessive heat.

Discharge Port: The pathway for material exiting the grinding chamber. In bead mills, the discharge port design must ensure smooth material discharge and prevent residue buildup that could compromise the grinding quality of subsequent batches.

Diaphragm Pump: Conveys material by reciprocating the diaphragm to alter the pump chamber volume for suction and discharge, offering excellent sealing performance. Chiller: Removes heat generated during grinding to maintain the equipment at an optimal temperature, preventing high temperatures from affecting material grinding efficiency and damaging the equipment.

Feed Inlet: The channel through which material enters the grinding chamber. In bead mills, the feed inlet design must ensure smooth and uniform material entry into the grinding chamber, preventing grinding inefficiencies caused by material blockages or uneven distribution.

Main Motor: The power source of the bead mill, responsible for driving the grinding media and material within the grinding chamber to achieve high-speed rotation and collision, thereby performing the grinding action. The performance and stability of the main motor significantly impact the grinding efficiency and operational reliability of the bead mill.

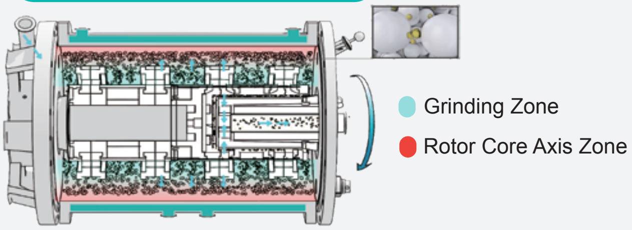
Temperature Sensor: Monitors the operating temperature of the equipment or the material temperature to ensure the device operates within safe temperature limits and prevent material degradation due to excessive heat.

Discharge Port: The pathway for material exiting the grinding chamber. In bead mills, the discharge port design must ensure smooth material discharge and prevent residue buildup that could compromise the grinding quality of subsequent batches.

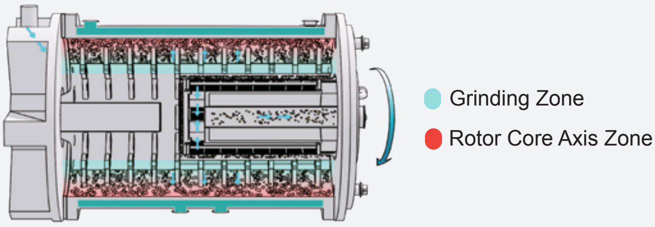
Grinding Chamber: The core component of the bead mill, housing the grinding media, material, and rotor assembly. During operation, the grinding media and rotor structure interact with the material within the chamber. Through high-speed rotation and collision, they perform the grinding action, achieving material refinement and homogenization.

Advantages of Rotor Structure Design

Uniform Grinding



High Energy Density



Helical Flow Channel Design

Slurry and grinding beads impact in counter-current flow, resulting in high shear intensity.

Nano-level Fine Grinding with Narrow Particle Size Distribution

NMM Model Dynamic Uniform Distribution Technology → Enables nano-level fine grinding.

High Energy Density Grinding Beads

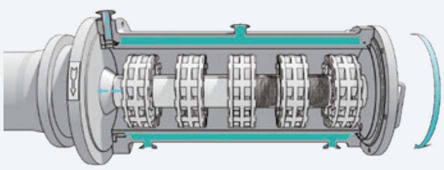
Delivers nano-level impact force for powerful crushing efficiency.

Dynamic Uniform Distribution Technology

Ensures zero dead-zone distribution of grinding beads for precise and controllable particle size.

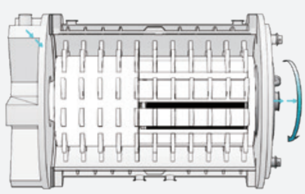
Principles of Rotor Structure

Turbo Rotor



The higher-standard turbine rotation generates a vortex within the chamber, propelling the grinding media into rotational motion. This continuous shear and dispersion of larger particles within the material is enhanced by the media's extensive range of motion and diverse movement patterns, resulting in higher capture rates for ground particles. The engineered turbine accelerator, combined with more wear-resistant materials, better meets stringent product requirements. This design delivers high efficiency, low energy consumption, and minimized pollution.

Pin Rotor



The rotating pin shaft drives the grinding media into motion. The grinding media continuously collide with each other, undergoing repeated opening and closing movements, thereby crushing large particles of the material being ground. However, the grinding media exhibit a limited range of motion, resulting in restricted capture efficiency for the grinding particles.

Advantages and Disadvantages of Turbine and Pin-type Structures

Advantages and Disadvantages of Turbine Rotors

Advantages

Particle size distribution is concentrated. Due to more thorough grinding between larger grinding media, the ground material exhibits a more uniform particle size distribution without structural damage. The centrifugal and shear forces generated by the turbine are distributed more evenly and gently, better ensuring material structure integrity and minimizing wear. The turbine primarily relies on centrifugal force to impart kinetic energy, thereby reducing bead breakage rates and minimizing grinding media loss. Low heat generation. The turbine rotor does not rely on collision or compression for grinding, resulting in relatively less physical friction and lower heat generation. Suitable for high viscosity: The turbine rotor also delivers superior grinding performance for high-viscosity materials.

Disadvantages

High cost: The turbine features a complex, integrated structure, resulting in high maintenance costs and complicated cleaning procedures. Its intricate design also makes routine maintenance relatively more cumbersome.

Advantages and Disadvantages of Pin Rotors

Advantages

Suitable for low-viscosity materials, pin-type rotors deliver superior grinding performance through greater impact force. Easy to operate, pin-type rotors feature a relatively simple structure and straightforward handling. This makes them particularly advantageous in applications requiring rapid rotor replacement or maintenance. Cost-effective, pin-type rotors offer a simpler structure and lower cost compared to turbine-type rotors.

Disadvantages

The particle size distribution is broader. Since pin mills primarily rely on the impact force of pins to grind materials, the contact area between grinding media and materials is smaller, leading to uneven grinding and an irregular particle size distribution. This results in high energy consumption, as pins require greater kinetic energy to achieve the target particle size, causing overall energy consumption to be elevated. When the pins of the pin-type rotor strike the material, the immense impact force may cause structural damage and excessive wear to the material. Similarly, when the pins strike the grinding media, they may fracture and damage the media, resulting in higher overall media loss and a higher rate of bead breakage. The pins require greater kinetic energy to impact both the material and the media. The high friction generates significant heat, necessitating a more robust cooling system.

Comparison of Turbine and Pin-type Features

Type	Turbine	Pin
Grinding impact force	Moderate	larger
Energy consumption	Low	High
Water consumption (chiller energy consumption)	Low	High
Grinder wear	Low wear (long service life)	High wear (short service life)
Zirconium ball wear	Minimal crumbling, low abrasion	High crumbling rate, high wear
Cavity pressure	Large	minor
Grinding efficiency	Low	High
Particle size distribution	Centralized	Broad
Material structure damage	Minor damage	Significant damage
Heat output	Low	High
Use viscosity	High viscosity	Low viscosity
Rotor structure	Simple, few components	Complex with numerous components
Grinding temperature	Low temperature (gentle grinding)	High temperature (gentle grinding)
Probability of material blockage	High flow rate, resistant to clogging	Broken beads clog nets easily
Particle size / Morphology	Particle size distribution extremely narrow / Shape smooth	Narrow particle size distribution / Sharp edges and corners
Dispersion uniformity	Excellent	Good
Price	High	Low

Turbine rotors and pin rotors function differently during the grinding process. Turbine rotors primarily achieve grinding effects through centrifugal and shear forces, making them suitable for high-speed grinding and dispersion of materials. Pin rotors, on the other hand, mix materials with grinding media through rotational and oscillating motions. The specific choice of rotor structure depends on the grinding mill's application requirements and material characteristics.

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The rotor structure material is selected based on the characteristics of the material being processed

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

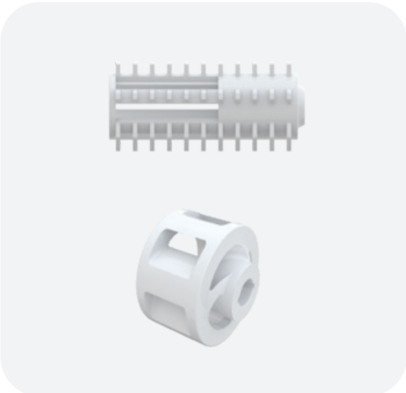
Zirconium Oxide, Aluminum Oxide

Function: Primarily used for grinding and dispersing tasks requiring wear resistance and corrosion resistance.

Advantages: High hardness, excellent wear resistance, strong chemical stability, suitable for grinding and dispersing high-viscosity, high-solids-content materials.

Material Characteristics: Features high hardness, high wear resistance, and good chemical stability, maintaining stable performance under harsh conditions such as high temperatures, strong acids, and strong alkalis.

Suitable Applications: Battery materials, MLCC, inks, pharmaceutical raw materials, food additives, etc.



Zirconia material

Silicon Nitride, Silicon Carbide Materials

Function: The grinding cylinder and rotor structure can withstand high temperatures, high pressures, and highly corrosive environments, making it suitable for grinding processes requiring exceptional wear resistance and corrosion resistance.

Advantages: High hardness, high strength, and excellent wear resistance ensure long-term precision grinding performance. It also exhibits superior thermal shock resistance and chemical stability.

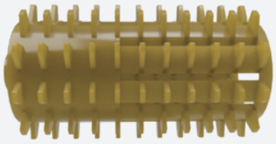
Material Characteristics: Outstanding mechanical properties and thermal stability. Its low density and excellent self-lubricating properties help reduce friction and wear during grinding.

Suitable Applications: Semiconductor ceramics, chemical materials, etc.

Silicon nitride, silicon carbide materials

Polyurethane (PU)

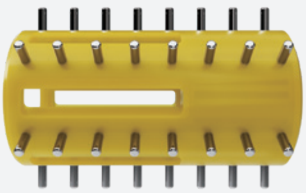
Function: Primarily used for low-speed, low-load grinding and dispersion tasks, especially involving soft materials.
Advantages: Excellent wear resistance, good elasticity, and strong impact resistance. Suitable for grinding and dispersing soft materials without causing damage.
Material Characteristics: Superior elasticity, wear resistance, oil resistance, and tear resistance, coupled with chemical corrosion resistance. Ideal for low-speed, low-load grinding and dispersion processes.
Suitable Applications: Battery materials, ceramic materials, chemical materials, inks, coatings, etc.



Polyurethane material

PU + Tungsten Carbide (Alloy)

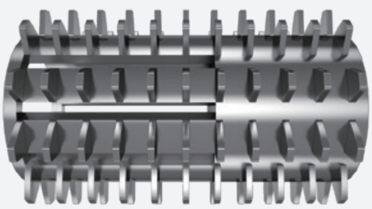
Function: Used for grinding high-hardness, high-wear-resistance materials.
Advantages: Extremely high hardness, excellent wear resistance, strong corrosion resistance, suitable for grinding high-hardness materials.
Material Characteristics: High hardness, high strength, and good wear resistance; maintains stable performance during high-load, high-speed grinding processes; offers extended service life and grinding efficiency.
Suitable Applications: High-hardness materials.



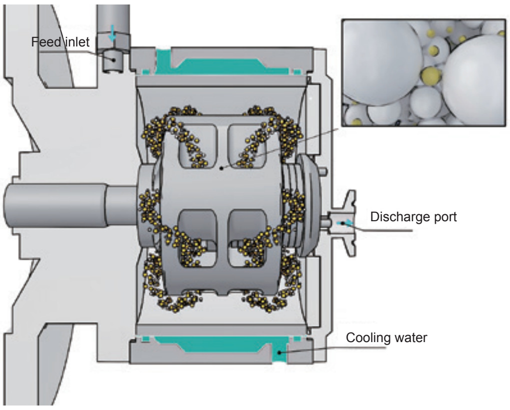
PU + tungsten carbide (alloy) material

Hard Alloy

Suitable for machining high-hardness, high-toughness materials, featuring high hardness, wear resistance, heat resistance, and corrosion resistance.



Adjustable Screen Gap



Ceramic stacked disc filter screens feature a large flow area and flexible adaptability to experimental requirements. They accommodate grinding media diameters ranging from 0.1 to 2.0 mm, enabling a single machine to process multiple materials and meet production demands for various viscosity levels.

Advantages of the 3 Types Mixer Designs

Combining multiple functions such as stirring and mixing, it accommodates various materials to meet diverse experimental requirements.

Box-type Agitator

Suitable for processing high-viscosity materials or those prone to sedimentation, it effectively pushes materials near the bottom and walls of the vessel toward the center of the liquid flow, thereby achieving uniform mixing.

Anchor-type Agitator

Suitable for low-to-medium viscosity or easily sedimenting materials, its shape allows it to reach deep into the bottom and corners of containers, ensuring thorough mixing with no dead spots.

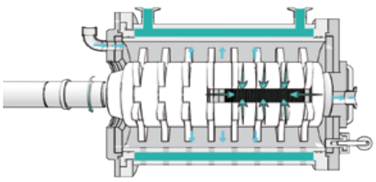
Dispersing Disc Agitator

The high-speed dispersion disc generates powerful vortexes, subjecting material particles to shear impact and friction within the annular flow to achieve rapid dispersion and dissolution.

1) Shear force: Relative motion between the dispersing disc or agitator paddle and the material thoroughly disperses solid particles, making them smaller and finer.
2) Impact force: High-speed rotation drives surrounding material, generating powerful centrifugal force that causes solid particles to continuously collide and impact each other.
3) Compressive force: The combined action of centrifugal and compressive forces deforms and fractures particles against grinding beads, progressively refining the material.

Separation Method

(Select the separation method based on material properties (particle size, viscosity) and separation precision requirements)



Working Principle of Filter Separation

The filter screen separation utilizes the principle of mesh screening. Material is forced through the filter screen under pressure, where larger particles and grinding media are intercepted. Qualified material passes through and is discharged. The filter screens are available in zirconia ceramic and wedge-shaped stainless steel materials to accommodate different operational requirements.

Filter Structure (Ceramic Disc/Wedge Shaped Filter)

Ceramic laminated disc

A three-dimensional filtration structure formed by stacking multiple thin sheets, which gathers and traps impurities through sheet walls and grooves to achieve high-efficiency filtration.

Wedge-shaped filter screen

A three-dimensional filtration structure formed by stacking multiple thin sheets, which gathers and traps impurities through sheet walls and grooves to achieve high-efficiency filtration.

Discharge and Separation Materials

Stainless Steel Filter Mesh

Filtration Function: Stainless steel mesh effectively removes impurities, particles, and suspended solids from liquids or gases, ensuring the purity of the output material. Corrosion Resistance: Due to the excellent corrosion resistance of stainless steel, this mesh operates stably in various corrosive environments, extending equipment lifespan. High-Temperature Stability: Stainless steel mesh maintains its filtration performance in high-temperature conditions, making it suitable for applications requiring high-temperature processing.

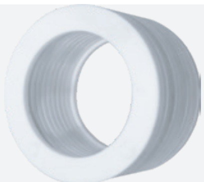
Separation Material: Ceramic/Stainless Steel Separator Plate

Note: 1L-5L models feature ceramic laminated separation material; larger capacities utilize stainless steel.

Ceramic Separator

Wear Resistance: Ceramic plates possess high hardness and wear resistance, effectively preventing damage to screening mesh.

Stability: Ceramic materials also exhibit excellent chemical stability, maintaining consistent performance across diverse environments.



Stainless Steel Separator Plate

Separation Effect: Stainless steel separator plates precisely separate particles of different sizes, ensuring the output particle size meets specifications.

Corrosion and High-Temperature Resistance: Stainless steel separator plates exhibit excellent corrosion resistance and high-temperature tolerance.

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Grinding Cylinder Structure

Raised Liner Cylinder

The inner wall of the protruding liner cylinder features regular or irregular protrusions. During rotation, these protrusions cause the material to undergo multi-angle collisions, compression, and shearing with the grinding media, thereby enhancing grinding force. Simultaneously, the protrusions disrupt the material flow pattern, promoting mixing and dispersion while eliminating grinding dead zones.

Smooth Inner Liner Cylinder

The smooth inner liner cylinder features a sleek inner wall design. Leveraging centrifugal force and gravity during cylinder rotation, it ensures stable rolling and sliding of materials and grinding media. Its low-friction, residue-free properties facilitate easy cleaning while reducing operational resistance and saving energy consumption.

Grinding Cylinder Material

Zirconia Cylinder

High wear resistance, zero pollution, low energy consumption

Silicon Nitride Cylinder

Wear resistance, corrosion resistance, thermal shock resistance, high hardness and strength

Silicon Carbide Cylinder

High hardness, wear resistance, and rapid heat dissipation

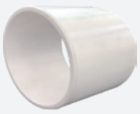
Polyurethane Cylinder

Abrasion resistance, excellent elasticity, and strong tear resistance

Wear-resistant Alloy

High wear resistance, high strength, excellent corrosion resistance and high-temperature resistance, as well as outstanding impact resistance

Zirconia Cylinder



Silicon Carbide Cylinder

Silicon Nitride Barrel

Wear-resistant Alloy

Grinding Media (Zirconia Beads)

The size of grinding media should be selected based on the material and grinding requirements, with smaller diameters typically yielding better results. In high-speed sand mills, spherical or near-spherical media are most suitable as they effectively leverage the mill's impact and shear forces. Additionally, high-density media can enhance both these forces, thereby improving grinding efficiency.

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

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Density of Zirconia Beads

The higher the specific gravity of zirconia grinding beads, the greater the impact force and grinding efficiency, but the greater the wear on the grinding mill's contact parts. Therefore, matching the slurry viscosity with the flow rate is crucial: low-density grinding beads are suitable for low-viscosity slurries, while high-density grinding beads are more suitable for high-viscosity slurries.

Hardness of Zirconia Grinding Beads

The greater the hardness of the grinding beads, the lower the theoretical wear rate, but this increases abrasion on the contact components. However, optimization can be achieved by adjusting parameters such as filler content, slurry viscosity, and flow rate.

Spherical Degree of Grinding Media

The higher the rotational angular velocity ω of spherical grinding media, the greater the additional energy. However, uneven spheres hinder rotation, reducing additional energy and adversely affecting grinding efficiency. Regarding uniformity: - From a kinetic perspective, consistent diameters result in equal momentum, where larger spheres impacting smaller ones reduces grinding efficiency. - From a geometric perspective, mixing media of different diameters fills voids, increases contact points, and thereby enhances grinding efficiency.

Selection Guidelines for Different Sizes of Grinding Media in Sand Mills

Grinding ball size mm	Final particle size um	Initial particle size um	Slurry viscosity cps	Solid content %（wt）	Linear velocity m/sec	Filter 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 figures may vary depending on specific processes. For further details, please contact us.

Double-Ended Mechanical Seal with Cooling Circuit (Boyee Exclusive Patent)

The double-ended design represents a significant technological innovation in Boyi mechanical seals. Compared to single-ended mechanical seals, it excels in ensuring the flatness of the mating surfaces between the rotating and stationary rings.

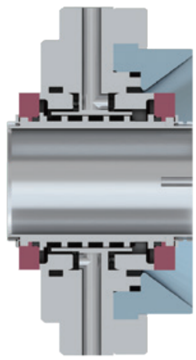
Core Advantages of Mechanical Seals

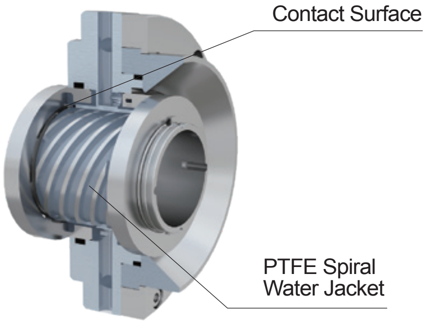
Prevent Material Leakage

Under eccentric shaft operation, the double-ended design achieves precise positioning through fixed static rings on both sides, effectively limiting displacement of the mechanical seal spiral sleeve and thereby enhancing leak prevention capabilities.

Elastic components form a “zero-gap” sealing barrier

The mechanical seal spring preloads the static and dynamic ring end faces. Under the combined action of medium pressure and spring force, the sealing pair is further compressed, achieving a tight axial seal.





PTFE Spiral Water Jacket:
The “Smart Temperature Control Assistant” for Mechanical Seals

The PTFE spiral water jacket of Boyi Mechanical Seals features an ingenious design. Without a pump, water flows naturally for preliminary cooling; with a pump, accelerated water flow enhances cooling efficiency. The spiral structure ensures uniform cooling across the sealing area, maintaining optimal temperatures for mechanical seals. This extends service life and supports efficient equipment operation.

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Introduction of PLC Control Systems

The BYZr sand mill is equipped with a comprehensive and advanced control system supporting manual, semi-automatic, or fully automatic operation modes to meet diverse user requirements. This system not only provides convenient mill status monitoring and an intuitive interface but, more importantly, comprehensively monitors and records all critical parameters related to the grinding process, ensuring production transparency and traceability.

The core of this control system lies in its PLC control module. This standardized component is not only highly functional but also exceptionally scalable, allowing for easy addition or optimization of features based on specific customer requirements. Furthermore, the module incorporates built-in automatic protection functions that respond promptly to abnormal conditions, effectively safeguarding the safe and stable operation of the grinding machine.

1) Process control achieved through product temperature or input power
2) Automation modules suitable for both batch and continuous operations
3) Data exchange via modems
4) Connectivity to computers or other optional control systems is included in our scope of supply

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Applications

Nano New Materials	Semiconductors	Pharmaceuticals
Silicon Carbon Anodes	Lithium Iron Phosphate	Biological Products
Conductive Slurries	Inkjet Ink	Electronic Ceramics
Lithium Iron Phosphate	Ceramic Ink	Cosmetics
Solid State Electrolytes	Ink and Coatings	Food/Chemicals

Specifications

Model	Chamber Volume (L)	Drive Power (KW)	Bead Diameter(mm)	Filter 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

Other Parameters

Model	Rotational speed (r/min)	Discharge particle size (μm)	Coolant consumption (㎡/s)	Ice water machine (P)	Zirconia sphere filling rate	Zirconia ball filling weight(KG)	Rotor diameter (mm)	Number of rotor groups	Standard diaphragm pump	Separation method	Filter type	Cross-sectional area	Energy consumption (kwh)
NMM-1L	2840	0.1-2	0.3-0.5	1	70%-80%	1.6-1.9	90	1	3 feet	Filter Separation	Ceramic Disc /Wedge-Shaped Filter	49cm^2	2.935
NMM-2L	2840	0.1-2	0.5-0.8	1.5	70%-80%	3.2-3.5	90	1		Filter Separation	Ceramic Disc /Wedge-Shaped Filter	65cm^2	5.1025