Stirred Milling

VERTIMILL® Grinding Mills & Stirred Media Detritor

metso
Expect results

Stirred Milling

Metso is the industry leader...

Metso has

- The most mature stirred milling technologies
- The largest installed base in terms of quantity of units and installed power
- Continuous development program

The stirred milling technologies currently available can be divided into two sub-categories: gravity-induced and fluidized. Gravity-induced stirred mills initiate a ball charge motion via rotational movement of a screw to provide a size reduction mechanism. In contrast, fluidized stirred mills use a rotational movement to fluidize a media-slurry mixture, resulting in a size reduction mechanism. The type of mill and the circuit configuration are intrinsic to maximizing the grade and recovery profile of an ore. Metso has both stirred milling technologies in the Vertimill and the Stirred Media Detritor (SMD), allowing Metso to offer the optimum equipment solution for the circuit.

The Vertimill

- 382 Units by Metso
- 230 MW Installed Power
- Standard Unit Sizes from 15 to 3000 HP
- Gravity Induced Stirred Mill
- Feed Size from 6 mm
- Product Sizes to sub 15 microns
- High Density media – steel or ceramic

Vertimills are globally recognized as energy efficient grinding machines and have been proven to grind more efficiently than ball mills with feeds as coarse as 6 mm to products finer than 20 microns. In addition to grind efficiency, reduced media consumption, lower installation cost, minimal maintenance, and minimal liner wear make the Metso Vertimill the lowest total cost of ownership in many applications, substantially improving the profitability of concentrators.

The Vertimill is a unique product offered exclusively by Metso that has a long history in the metallic mining industry. The technology was originally developed in the 1950's for industrial applications. Metso successfully developed and implemented the technology in the first large scale metallic operations in 1980. In the thirty years since, the Vertimill has built the largest installed base of any stirred milling technology.

Mechanically, the Vertimill is a very simple machine with an agitating screw suspended into the grinding chamber, supported by spherical roller bearings and driven by a fixed speed motor through a planetary gearbox. The figure above shows the Vertimill in its standard arrangement with all of its major components. The capacity of each unit size is relative to the required power input for the intended grind, however mills have been operated with throughputs exceeding 500 mtph.

Why Vertical Stirred Mills?

With any technology consideration, you want a solution that has the lowest total cost of ownership while meeting the product requirements. Vertically stirred mills have many advantages that make them the lowest total cost of ownership. These advantages include:

Lower Capital Cost
- Less Floor Space Required
- Simple, Smaller Foundation
- Faster Installation

Lower Operating Cost
- Energy Efficient Grinding
- Reduced Media Consumption
- Lower Maintenance

Additional Advantages:
- Quiet Operation
- High Availability
- Greater Operational Safety
- Easy to Control and Optimize

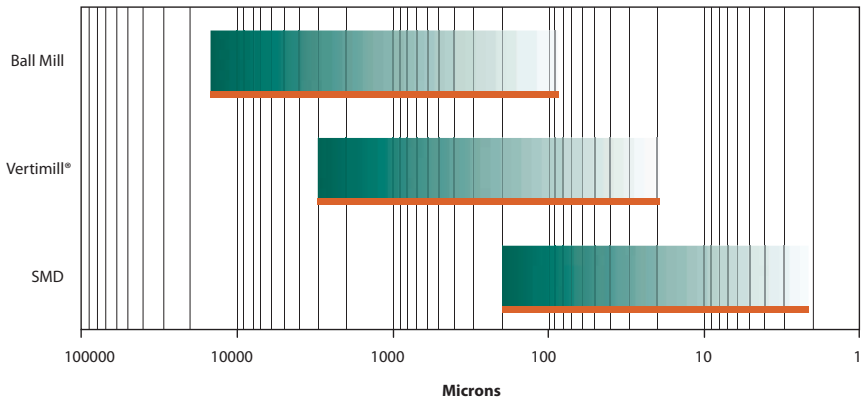
Stirred Media Detritor

- 170 Units by Metso
- 52 MW Installed Power
- Standard Units Sizes from 7.5 to 1100 kW
- Fluidize Media Mill
- Feed sizes from 250 microns
- Product to sub 5 microns
- Low density media: Sand or Ceramic

The Stirred Media Detritor (SMD) is a fluidized, vertical stirred mill designed for optimum grinding efficiency for fine and ultrafine grinding products. The SMD utilizes the rotational energy of the impeller arms to impart a high-energy motion to the media/slurry mixture inside the mill. This results in particle-to-particle shear and compressive forces which produce the desired grinding mechanism for fine grinding. The vertical arrangement allows the drive train to be entirely supported by the mill body which leads to a small foot print and simple foundation. Also, the vertical arrangement does not require any slurry seals or inlet feed pressure. The SMD is a fluidized media mill which means, the stirrer speed is high enough to distribute the media throughout the slurry regardless of media density, forcing particle and media contact.

The SMD power intensity is optimized to achieve efficient grinding, limit wear, and allow for heat dissipation in the case of a high energy grind. The power intensity (kW/m3) is relatively high compared with other mill types, but is required to generate a vortex of the media and slurry during operation and to bring the particles in contact with one another for efficient grinding. However, the power intensity is not so high that a cooling system would be required to dissipate the heat generated during a high energy grind. Also, limiting power intensity, limits the sheer force of the media/slurry on the liners, impellers and improves wear life.

Typical Grinding Ranges



Ball Mills and stirred mills are applied across a wide range of applications, but for each ore there is optimum efficient range. The figure to the left shows the typical application ranges for ball mills and stirred mill. The Vertimill is always more efficient than a ball mill with energy savings ranging from 30% to greater than 50%. The transition point from the Vertimill to an SMD varies depending on the ore properties but generally is in the range of 20 to 40 microns. A detailed test program can be carried out to determine the optimum energy efficient circuit.

Materials Successfully Ground in Stirred Mills

Aluminum Oxide
Aragonite
Barite
Blast Furnace Slag
Calcined Bauxite
Calcite
Calcium Carbonate
Clay
Coal – oil
Coal – water
Coal Tar Sludge
Coke – oil
Copper Molybdenum
Copper Concentrate
Copper Ore
Copper Slag
Copper-Lead-Zinc Ore
Decanter Tar Sludge
Ferrite
Ferro Alloy
Ferro Manganese
Gold Ore
Gold Tailings
Graphite
Hydrated Alumina
Iron Oxide
Iron Sand
Kaoline
Lead Concentrate
Lead Zinc Ore Lime (slaking)
Lime Powder
Limestone
Magnesium Oxide
Magnetite Concentrate
Manganese Dioxide
Manganese Ore
Marble
Molybdenite
Molybdenum Conc.
Oil Sludge
Petroleum Coke
Phosphate Rock
Pottery Stone
Pyrite
Red Phosphorous
Rock Salt
Salt
Sand Iron
Sericite
Silica
Silica Sand
Slag
Strontium Ferrite
Sulphur
Talc
Uranium
Zinc Concentrate
Zinc Lead Ore

Energy Efficiency

Stirred Mills have been proven to provide energy savings compared with traditional ball mills. The finer the product required, the more efficient stirred mills will be than a ball mill. The attrition grinding action, vertical arrangement, and the finer media size distribution contribute to make stirred mills more energy efficient grinding machines. The Vertimill energy savings range from 30% to greater than 50% compared with traditional ball mills and the SMD energy savings are far greater than 50% of ball mill energy in fine grinds.

Media Savings

Media consumption is directly related with energy efficiency. At a concentrator in Mexico, they experienced reduced media consumption from a previous average of 821 g/t to 429 g/t, or a 48% reduction by using Vertimills. The savings in media consumption is for two reasons. First, less energy is being consumed with grinding, so less grinding media will be consumed. Second, since the wasteful impact breakage of ball-to-ball or ball-to-liner is eliminated, there are fewer ball fractures and the media inside the mill can maintain its shape and usefulness.

Green Technology

Energy efficiency and environmental consciousness is very important today. A savings in energy usage not only means big savings in operational cost, but also a reduction in carbon emissions. Energy is also used to create grinding media, so a reduction in media consumption is also a reduction in net carbon emissions. Using energy efficient technology will not only decrease operating costs, but could also generate a more positive public opinion and ease the permitting process. In many cases, stirred mills can reduce the carbon footprint of a grinding circuit by 30 – 50%.

Fewer Moving Parts

	Ball Mill	SMD	Vertimill
Motor	√	√	√
Reducer	√	√	√
Couplings	√	√	√
Hyrostatic Bearing	√		
Bearing Lube Unit	√		
Gear Lube	√		
Trommel	√		

Additional Advantages

Flexibility in Feed Arrangement

- Multiple layout options can be optimized for specific process needs

Less Noise – Less than 85 dB

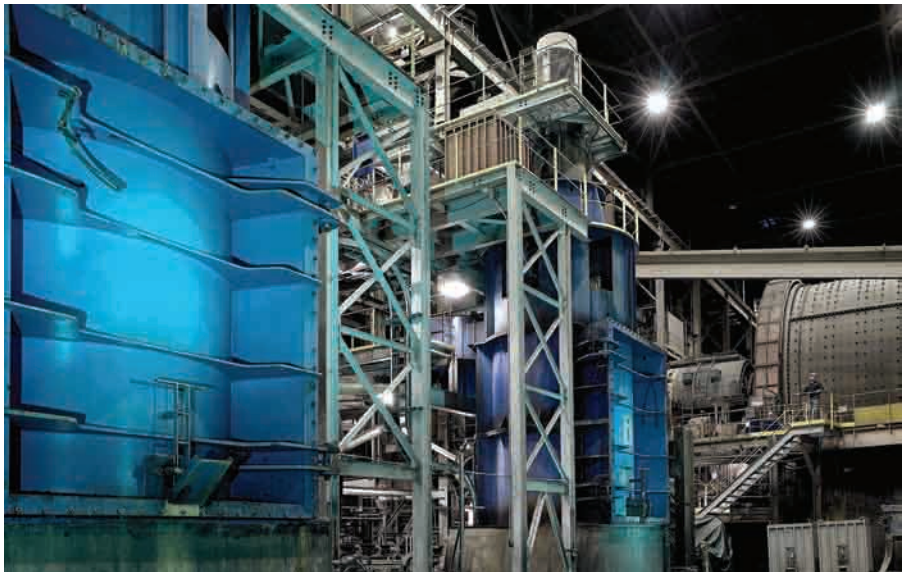
- If current ball mill acts as standby, building will be much quieter

Greater Operating Safety

- Moving parts are enclosed
- Easier, less frequent maintenance

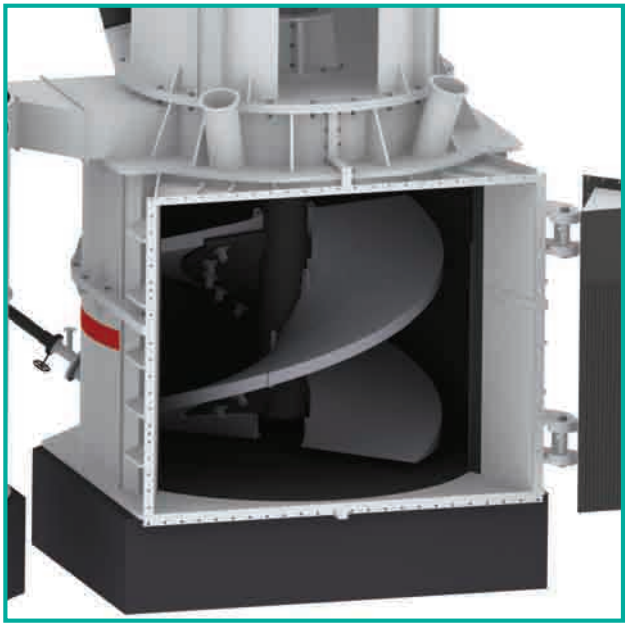
Operator Friendly

- More forgiving
- Easy to control and optimize



Vertimill Functional Description

The Vertimill is typically arranged in closed circuit and fed by the cyclone underflow. The motor power turns the Vertimill screw at constant speed to stir the grinding balls and slurry. As the particles are ground, they rise to the top of the mill and overflows into the separating tank. A change in the rotational direction of the slurry when it transitions from the mill to the separating tank causes turbulence which facilitates a settling of the coarser material. Product from the mill exits the tank through a stand pipe and then to the cyclone sump. The slightly coarser portion of the mill overflow is recycled back into the bottom of the Vertimill. The recycle system can reduce cyclone circulating load by allowing the mill to preferentially grind the coarser material. Also, the uprising velocity in the mill can be controlled by a recycle pump to affect the product size distribution, prevent over grinding, and reduce the circulating load from the cyclone.



Vertimill Operational Control

Final product size is a factor of applied grinding power, flow rate, and slurry density. The effective operation of the Vertimill requires these parameters to be accurately and constantly monitored and adjusted to meet the required product specifications.

Motor Power/Media Addition - The power drawn by the Vertimill motor is required to establish the grinding rate. Motor power should be measured using corrected power. Monitoring mill motor amperage is not an accurate method. As the grinding media wears fine enough to be carried out by the uprising velocity in the mill, the total media charge will diminish and the power draw will decrease. Consistent power draw is required in order to achieve the desired product size, so media should be added either manually or automatically periodically to maintain as consistent a power draw as possible. The Vertimill has an excellent turndown ratio and can be operated at lower than installed power with less effect on grind efficiency than horizontal ball mills.

Feed Flow-Rate - This parameter is used in conjunction with the feed density and motor power to establish the grinding rate in kWh/mt. The Vertimill can easily handle a fluctuating flow but it should be monitored and can be varied to achieve required product requirement.

Feed Density - The feed density is required, in conjunction with the feed flow-rate, to establish the feed rate of solids.

SMD Functional Description

The feed slurry enters through a feed spout in the top cover which directs the feed into the bottom of the vortex (bottom of the mill) without any inlet head. Grinding media is added either by the automatic Media Addition System through one of the unused feed ports or manually through the media feed chute. Final product leaves the SMD through the media retention screens, situated around the top of the body and is collected in an external launder and is then pumped, or flows under gravity, to the next stage in the process.

In operating a SMD, there is no set combination of parameters, because the different parameters have influence on each other. Experience and practice usually establish optimum operating conditions with the lab testing establishing the initial set points. The particle size distribution produced is governed primarily by the throughput and the amount of media and multiple mill arrangement. Primary mill control is by media addition to maintain the required power draw to achieve the desired product. Multiple SMDs can be arranged in parallel or series depending on the circuit requirements to affect the particle size distribution.

SMD Operational Control

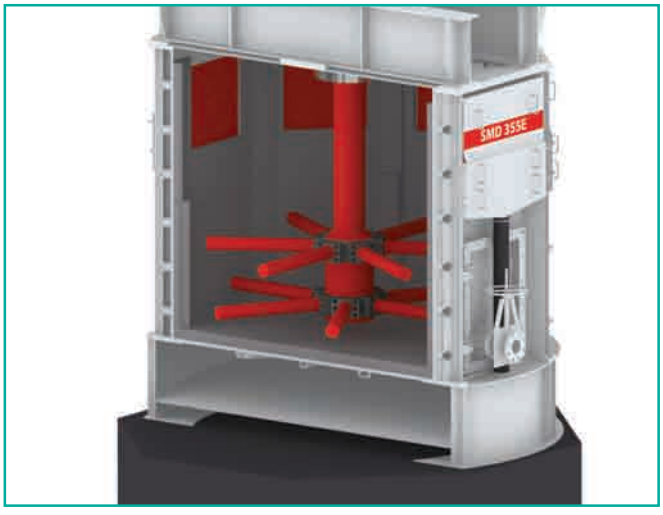
The effective operation of the SMD requires the following parameters to be accurately and constantly monitored:

Feed Flow-Rate - This parameter is used in conjunction with the feed density and motor power to establish the grinding rate in kWh/mt. Flow rate should be as steady as possible. If the whole stream is feeding direct to the mill, surge tanks should be considered. Feeding the SMD from a thickener or scalping cyclone regulates the flow very well and generates a suitable feed density.

Feed Density - The feed density is required, in conjunction with the feed flow-rate, to establish the feed rate of solids. Typical operational feed density range is 30-60% solids. Optimum grinding efficiency is usually in the range of 40-50% solids.

Motor Power/Media Addition - The power drawn by the SMD motor is required to establish the grinding rate. As the grinding media wears fine enough to exit through the mill screens, the total media charge will diminish and the power draw will decrease. So media should be added either manually or automatically to maintain as consistent a power draw as possible. The SMD is normally operated at 85-100% of full power.

Grinding Media - The grinding media can be varied with a wide range of alternatives, depending on the application and the process requirements. Grinding media plays an important role in grinding efficiency and mill liner wear life so a high quality media is beneficial, but an economical solution is also important.



Expect results

Expect results is our promise to our customers and the essence of our strategy. It is the attitude we share globally. Our business is to deliver results to our customers, to help them reach their goals.

Metso Minerals Industries, Inc., 2715 Pleasant Valley Road, York PA, 17402 USA, tel +1 717 849 7213, fax +1 717 849 7252, www.metso.com

2357-02-10-MBL/Pittsburgh