



OUTOTEC HIGMILL – ENERGY-EFFICIENT HIGH-INTENSITY GRINDING

With global ore grades declining and the demand for commodities continuing to increase, mining companies require new ways to cost-effectively liberate minerals and maximize recovery levels. The Outotec HIGmill® is an advanced and energy-efficient fine and ultra-fine grinding solution that relies on proven technology. The mill takes advantage of gravitational forces and GrindForce™ rotor technology to produce a finer grind for mineral liberation.

BENEFITS

- High energy efficiency with patented GrindForce rotor technology
- Reduced CAPEX with small footprint and simple flow sheet
- Simple operation with multiple control modes
- High availability with long intervals between maintenance shutdowns

AN INTRODUCTION TO THE OUTOTEC HIGMILL

The Outotec HIGmill comprises a mill body, a shaft with grinding discs, shell-mounted counter rings, and a gearbox and drive. Grinding beads fill approximately 70% of the grinding chamber, with rotating discs stirring the charge and grinding taking place between the beads by attrition. Depending on the application, there can be up to 30 discs or grinding stages.

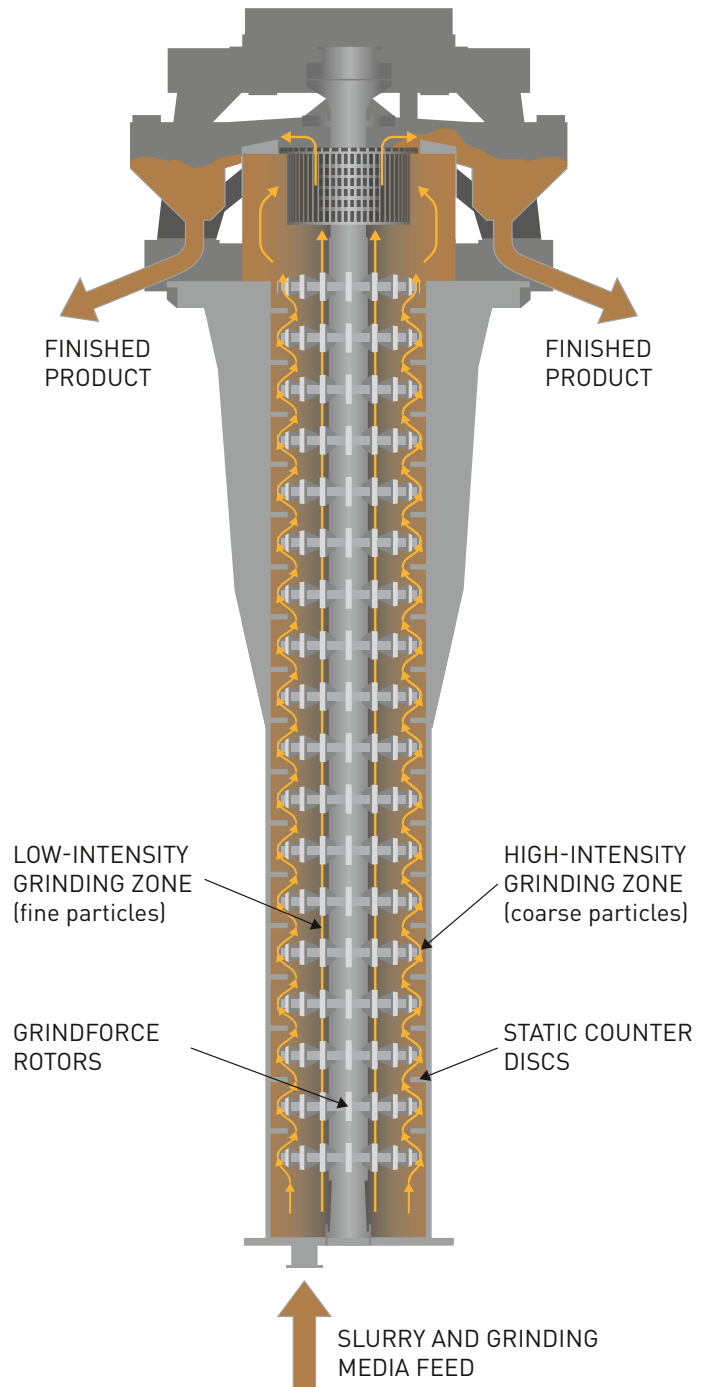
Feed slurry is pumped into the mill via a bottom connection, and as the flow transfers upwards it passes through each consecutive grinding stage. The final product discharges in an open atmosphere at the top of the mill. The open design lowers costs and enables a simpler control, valving, and instrumentation system compared to pressurized vessels. The tall, narrow mill body arrangement significantly increases grinding efficiency by ensuring that the grinding media is evenly distributed and that mineral particles remain in constant contact.

Classification is performed automatically at each stage of the grinding process. Larger particles are forced to the periphery, where the highest-intensity grinding occurs, while smaller particles travel up the mill to the next grinding stage, preventing overgrinding. This multi-stage arrangement eliminates the need for external classification and recirculation, providing a very steep particle size distribution after a single pass.

Applications

The HIGmill is suitable for a wide range of fine and ultra-fine grinding applications, including:

- Concentrate regrinding, including gold, copper, moly, platinum, lead, and zinc
- Iron ore fine grinding
- Tailings regrinding
- Slag and fly ash grinding for recovery of recyclable metals
- Tertiary grinding



The HIGmill's tall, narrow mill body arrangement ensures that the grinding media is evenly distributed and that mineral particles remain in constant contact.

The multistage arrangement of the HIGmill eliminates the need for external classification and recirculation, providing a very steep particle size distribution after a single pass.

ENERGY EFFICIENT AND PROVEN TECHNOLOGY

Proven technology

Since its introduction more than 50 years ago, HIGmill has been used in a broad range of applications including the ceramics, pigment, paint, paper, and pharmaceuticals industries. More than 200 units have been installed around the world, including several 5000 kW units that have been in operation for over 20 years. These are the largest fine-grinding mills in the world.

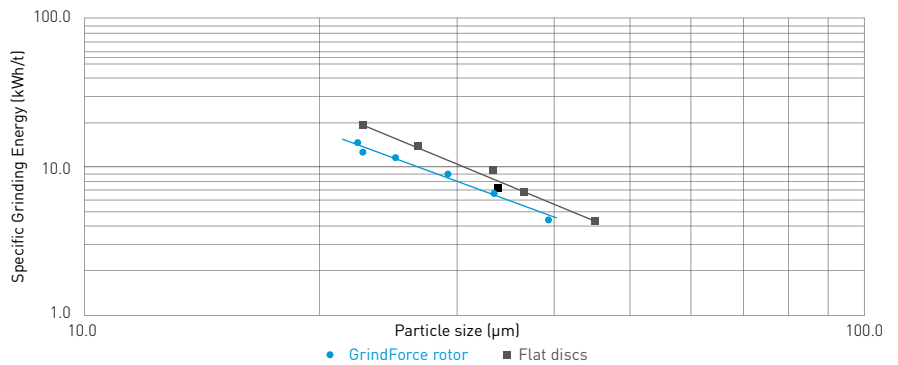
Efficient GrindForce technology

Invented for hard-rock applications, the patented GrindForce system is unique to the HIGmill and allows for optimal shear-force mixing and volume utilization – leading to more efficient grinding. Vanes on the GrindForce rotor surface ensure that the velocity of the rotating rotors and the media bed they are in contact with is approximately equivalent, eliminating any shear or slippage between the media bed and the rotor surface, reducing wear.

Compared to conventional flat-surface discs, the vaned rotors also enable a significant improvement in grinding efficiency to the target grind size thanks to the improved media agitation and improved power transfer between the rotor surface and media bead mass.



GrindForce’s vaned rotors enable a significant improvement in grinding efficiency to the target grind size.



Specific Grinding Energy (kWh/t) versus the particle size (P80, µm) showing consistent reduction in energy consumption of approximately 30% for the GrindForce rotors compared to flat discs.



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COMPACT LAYOUT AND EASY OPERATION

A compact, simple installation and process

The typical HIGmill flow sheet for regrind circuits is simple and straightforward. Regrind feed from flotation goes to a scalping cyclone. The cyclone overflow bypasses the HIGmill and the cyclone underflow is pumped into the mill, where the target product size is produced in a single pass. As there are no recirculating loads, the pumps, piping, and mill cylinder volume can be significantly reduced. The layout of the plant is optimized through the HIGmill's small footprint with a vertical orientation and high power intensity.

Quick maintenance with long service intervals

The HIGmill has been specifically designed for quick and safe maintenance. A significant cost benefit is that an overhead crane is not required during routine maintenance. With the mill installed on structural supports, the main shaft and shell liners are lowered and lifted using specially designed tools, including a maintenance trailer.

For maintenance purposes, the grinding media can be drained from the mill without opening the grinding chamber, reducing manual handling and minimizing safety risks for maintenance personnel. Media is removed safely by opening a drain valve at the base of the closed grinding chamber and allowing it to flow into collection bags or a transfer hopper for reuse.

Open-circuit configuration

Because it has multiple grinding stages in a single unit, the HIGmill operates in an open-circuit configuration and without recirculating loads. A pre-scalping cyclone prior to the mill can remove the fines from the feed so only the coarse particles are passed to the HIGmill. The mill feeds in one end and discharges at the other end, with slurry passing through the multiple grinding zones with no particle short-circuiting and no requirement for recycle streams. The HIGmill discharge is the final correct particle size for the downstream process. Since the mill can achieve the target product particle size in an open, single pass, this results in significant total installed Capex cost savings.

Maximized process efficiency with on-line particle-size control

Outotec HIGmill offers a unique on-line control solution which utilizes an Outotec PSI® on-line particle size analyzer to automatically measure the product particle size. The particle size measurement is then used to adjust the target for the Specific Grinding Energy (the amount of energy per unit of material needed to achieve the final product size). This control scheme will provide an extremely consistent product particle size to downstream processes regardless of variability in the feed particle size.

Variable-speed drive system for precise control

HIGmills are powered by squirrel cage induction motors and a variable speed drive (VSD) system. The VSD system is used for starting the mill under load as well as for speed adjustment during operation. The system allows precise control over product size. This in turn enables greater stability for downstream processing downstream processing by adjusting for upstream variability such as feed rate or feed size. The VSD system also allows for a reduction in operating costs by optimizing the rotor speed.

Grinding media addition

A fully incorporated grinding media handling and storage system is included. The media is added automatically to the grinding chamber to maintain the required filling set point and specific energy input.

Stirred milling for particle-size reduction utilizes an abrasive-type grinding mechanism. Ceramic grinding media is resistant to abrasion and is an ideal media for stirred milling, especially when compared with steel.



Ceramic grinding media is resistant to abrasion and ideal for stirred milling.

TESTING, SCALE-UP, AND DELIVERY

Testing

Outotec operates several mobile and stationary HIGmill test units with different mill sizes, and these testing services are available globally. Baseline test work with the HIG5 (5 kW/6-liter) test mill requires a minimum of 4 kg of dry test material. On-site testing is possible with the HIG25 (25 kW/25-liter) containerized mobile test unit or HIG75 (75 kW/200-liter) pilot mill.

The stationary test units are located at the Outotec Research Center in Finland. Additional testing can be performed at our research center, which develops metal processing technologies, processes, and equipment. Our expertise covers the entire processing chain from ore to metal, starting with mineralogical analysis.

Scale-up

Outotec utilizes proven 1:1 scale-up methodology from laboratory to production mills, backed by experience of sizing more than 200 mills in the range of 75 to 5000 kW. The exact same grinding mechanism, power intensity, tip speed, media size and type, slurry density, and continuous relative flow rate are used in the test work. This results in the same Specific Grinding Energy (SGE, kWh/t) to achieve the target grind size (P80, μm) as is achieved in full scale.

Delivery

HIGmills are typically pre-assembled in the factory and shipped in standard shipping containers where applicable. The mill sections are preassembled and prepared for installation on site. This design concept reduces site labor costs and ensures quick installation.

A typical delivery includes:

- Scalping cyclone with feed pump
- Feed, mixing, and storage tanks
- Feed pump
- Media addition systems for grinding media
- Motor and drive components
- Gearbox and oil supply system
- All instrumentation and controls, as well as motor control center
- PLC control with human machine interface (HMI)
- Vertical process package engineering and plant model





On-site testing is possible with the containerized mobile test unit.

SERVICES AND SOLUTIONS THAT BOOST YOUR PERFORMANCE AND PRODUCTIVITY

Maintaining the efficiency of your operations and protecting your profitability with the right technology is critical to staying ahead of the competition. As your service partner, Outotec ensures that our solutions have the maximum impact on performance and productivity throughout your plant's life cycle.

We are committed to understanding the unique business needs of your mineral processing operation. We collaborate with you to develop a safe, sustainable, and reliable service solution based on our deep process knowledge, leading technologies, and operational and maintenance expertise.

Full service portfolio

Our extensive service portfolio and customized solutions cover all phases of your equipment's life cycle – from maintenance inspections and spare parts to modernization and upgrades. Your tailored performance solution will be delivered with mutually agreed targets and shared responsibilities to meet your long-term goals. We can build solutions for individual projects or ones based on broader service agreements.

Outotec has locally available and experienced operation and maintenance (O&M) support personnel. Outotec O&M support services is a complete solution package under which we take extended responsibility for the condition and performance of the equipment after project delivery.

Outotec services

- Maintenance Services
- Spare and Wear Parts
- Upgrades
- Advisory Services
- Operations Services
- Remote Services
- Training Services

BENEFITS

- Improved health and safety
- Improved environmental efficiency
- Improved equipment and process efficiency
- Decreased operating cost
- Improved capital efficiency



Outotec provides leading technologies and services for the sustainable use of Earth's natural resources. As the global leader in minerals and metals processing technology, we have developed many breakthrough technologies over the decades for our customers in metals and mining industry. We also provide innovative solutions for industrial water treatment, the utilization of alternative energy sources and the chemical industry. Outotec shares are listed on NASDAQ OMX Helsinki. www.outotec.com