



Outotec HIGmill™

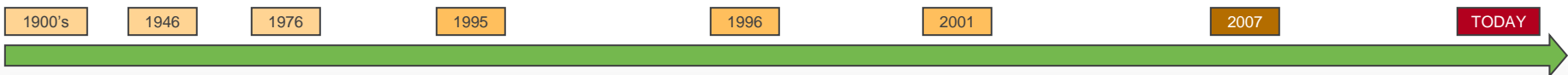
Outotec technology
for fine and ultra-fine grinding in minerals processing

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Outotec Comminution History

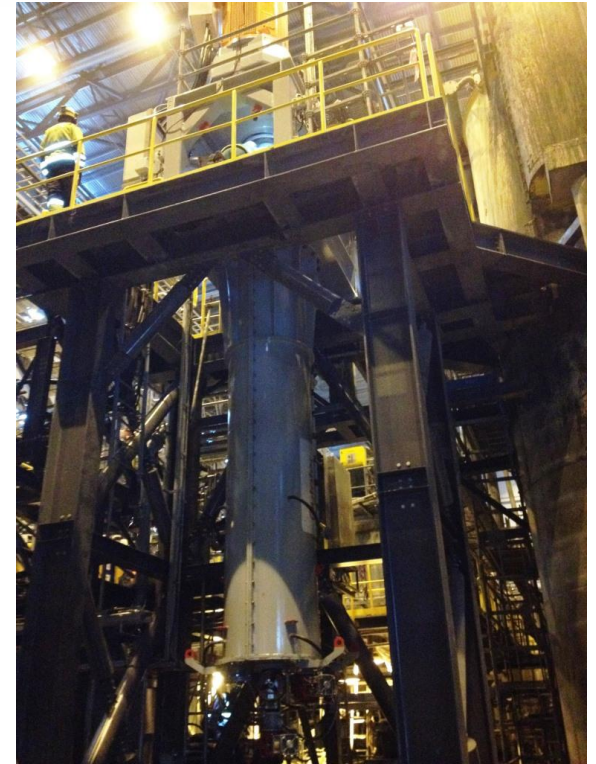
Over 1100 mills installed globally
More than 100 years of providing comminution solutions



3/18/2015

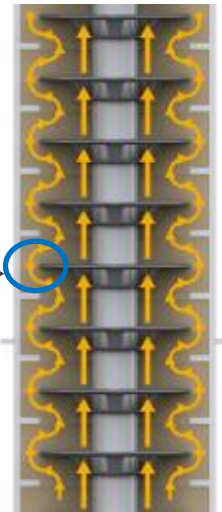
Outotec HIGmill™: Overview

- Mature grinding technology
 - Machine development & operation commenced more than 30 years ago.
- Over 200 mills installed
 - Including twenty (20) x 5MW units for 10+ years.
- Vertically arranged consisting:
 - centre drive shaft c/w grinding discs.
 - a static mill body c/w fixed counter-rings.
- Unique variable speed drive across full speed range
 - Providing control over product, size, feed rate, process fluctuations & energy efficiency.
- Ceramic or (steel media) can be utilized
- Open Circuit
 - Simplifying the flow sheet & process control.



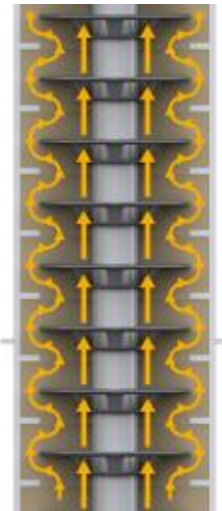
Energy efficient vertical design

- Developed and refined over years
- Unique concept rotating discs spaced between stationary counter discs
- Attrition grinding action is at a maximum at the rotating disc periphery in the clearance of mill shell and stationary rings of the mill
- Effective and efficient transferring energy
- Design inherently minimizes short-circuiting



Energy efficient vertical design

- Gravity ensures constant contact between grinding media & mineral particles
- Gravity ensures media to be spread across effective grinding zone.
- Due to centrifugal forces and open zone around the shaft the produced fines raise faster thus avoiding over grinding resulting in sharp size distribution curve
- Grinding media and large particles are retained in the mill by gravity.
- Open to atmosphere (no pressurized vessel)
- No bearing seals in slurry

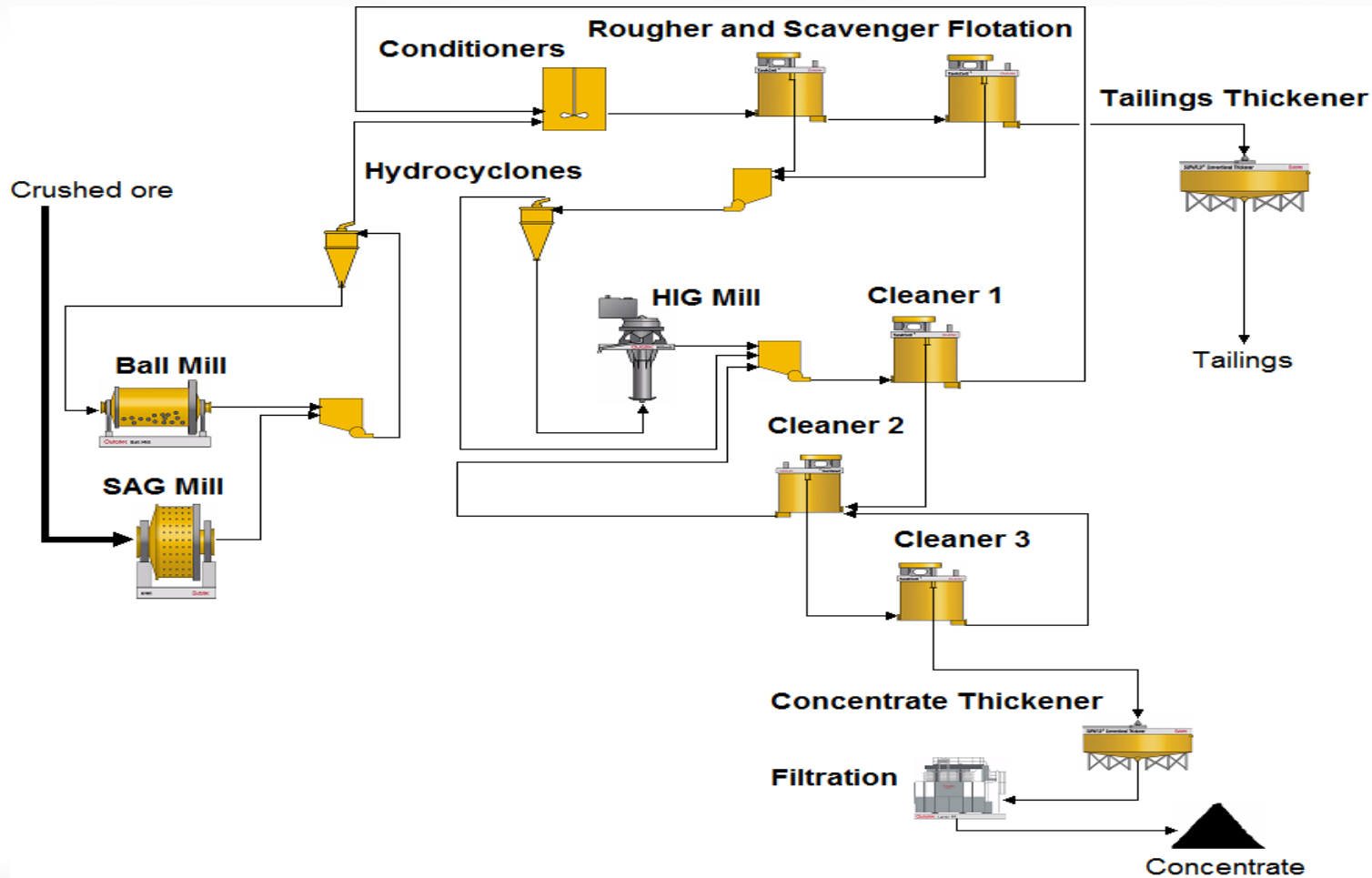


HIGmill™ types

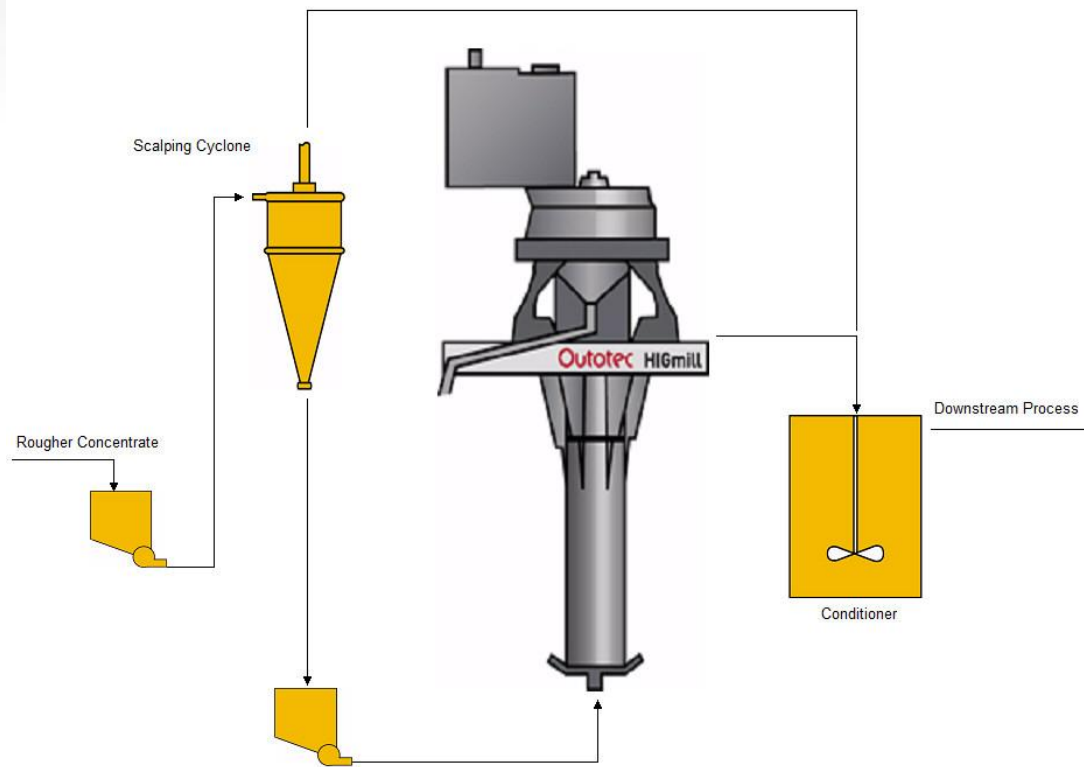
- Sizes available from 132 kW to 5000 kW
- Large units → less units installed = Lower capital costs
- Compact design compare to competition
- Competitive delivery time.



Process: Typical grinding flow sheet

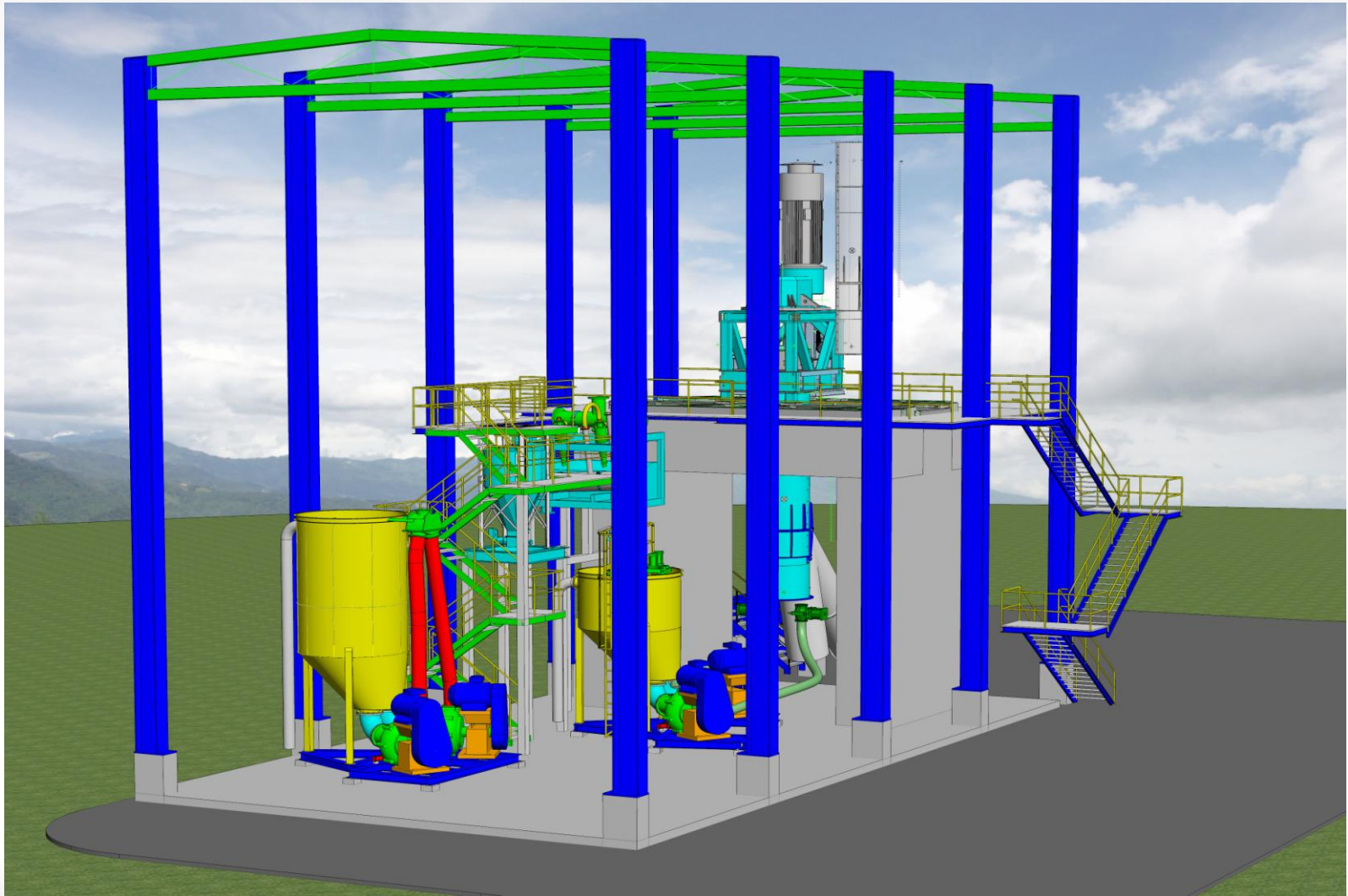


Simple process



- Internal classification
- Open circuit
- Flexible to adjust to fluctuating process conditions

HIGmill™ process solution



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HIGmill™ Overview

Examples: 5 MW 2.3 MW

Total height: 22 m 15.5 m

Mill height: 12.9m 9.0 m

Diameter: 1.6 m 1.3 m

Rotating discs

Stationary counter discs

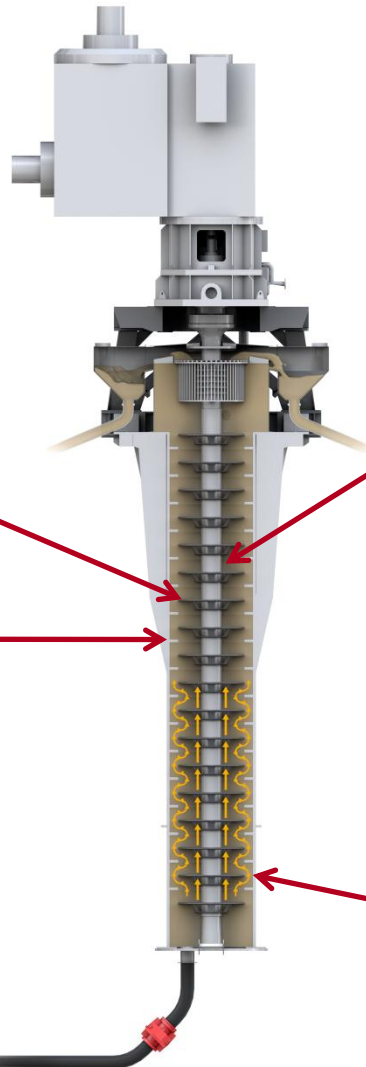
Lower intensity grinding zone

- Closer to the shaft
- More in the upper part of the mill

High intensity grinding zone

- At the disk shell clearance
- More in the lower part of the mill

Beads
addition
with feed



Outotec HIGmill™ : Test-work and sizing

- **Two mill sizes available for HIG pilot tests**
 - **HIG25 (30 kW)**
 - Available also for on-site campaigns (Container unit)
 - Net vol 18 L
 - +150 kg of samples
 - **HIG5 (5.5 kW)**
 - Min 50 kg of sample
 - Net vol 6 L
- **Semi continuous test runs**
- **Continuous test runs**
- **Performance graph**
 - **SGE vs. Particle size**



Outotec HIGmill™ Reference list

The following is a list of recent HIGmill orders in minerals processing:

Owner	Glencore	Confidential	Confidential	Confidential	Large Canadian Diversified Mining Company	Large Canadian Diversified Mining Company
Project	Mumi	Confidential	Confidential	Confidential	Confidential	Confidential
Location	DRC	Finland	Confidential	Panama	Chile	Chile
Model	HIG1600	HIG900	HIG75	HIG5000	HIG3500	HIG500
Installed Power	1,600 kW	700 kW	75 kW	5,000 kW	3,500 kW	300 kW
No. of Mills	1	1	1	3	2	1
Duty	Copper concentrate regrind	Copper rougher concentrate regrind	Platinum regrind (pilot plant)	Copper concentrate regrind	Copper concentrate bulk rougher regrind	Molybdenum concentrate rougher regrind
Feed Rate (mtph)	118	51	Various	Confidential	287	34
Feed Size (F₈₀)	212	50	Various	Confidential	75	50
Product Size (P₈₀)	35	20	Various	Confidential	30-40	40
Delivery	2014	2014	2014	2016	2017	2017

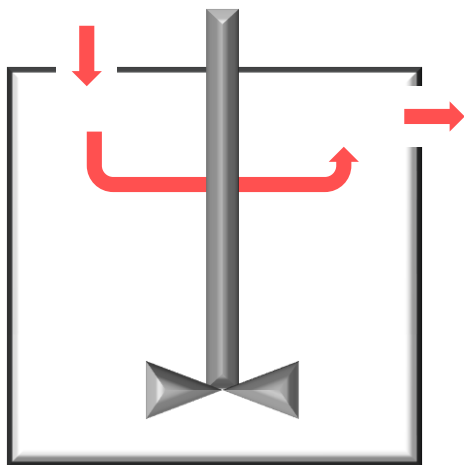
Updated: January: 2015



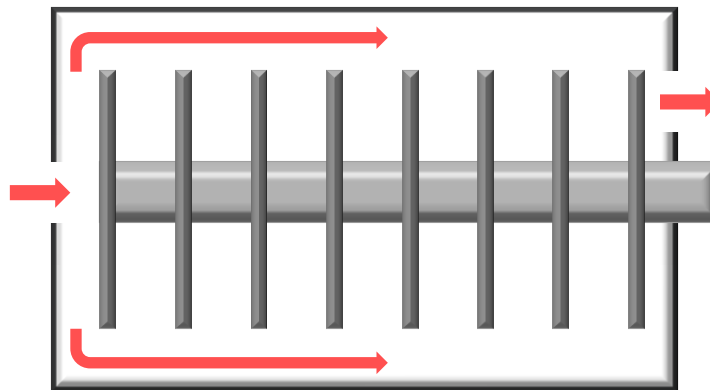
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Energy Efficiency – Physics of Operation

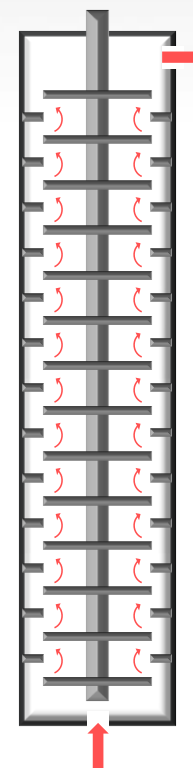
- Minimise short-circuiting → more media slurry contact → improve energy efficiency.
- How?
 - HIGmill greatest aspect ratio compared to other mills – Length (Height) / Diameter ratio.
 - Ideal grinding chamber design – tubular reactor/mixing vessel → plug flow.
 - As mills become larger greater likelihood of short-circuiting.
 - Multiple grinding chambers – HIGmill up to 30 grinding stages → most of all technologies.
 - Stator rings direct slurry and media to grinding zone – HIGmill only technology utilises.
 - Negative or positive gravity effect.
 - Feed inlet location opposite end mill to product outlet.



•Single stage grinding, vertical pin mill



•Multi stage grinding, horizontal disc mill



•High aspect ratio, multi-stage, vertical disc mill with stators



•Reduced chance of particle short-circuiting

•HIGmill

•→ no possible short-circuiting

Outotec

Benefit from HIGmill™ technology

- All mills are controlled by variable speed drive for maximum flexibility, energy efficiency and variable particle size.
- Optimum particle size controlled by shaft speed.
- Shaft sealing not needed due to vertical construction
- Grinding media and large particles are retained in the mill by gravity.
- Robust and simple design.
- Open circuit with multiple grinding stages (up to 30)
- Produces steep PSD without external classification
- Small footprint due to vertical design and high energy intensity.
- Grinding media (steel or ceramic) according to application to improve downstream process performance.
- Significant reduction of net carbon emissions compared to traditional milling circuits.

Thanks for your attention!



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