
Fundamentals on Grinding Workshops

GRINDING I – Training Session

Content

- **Fundamentals on grinding**
- **Different types of ball mills**
- **Vertical mills**
- **Roller press**
- **Horomill**

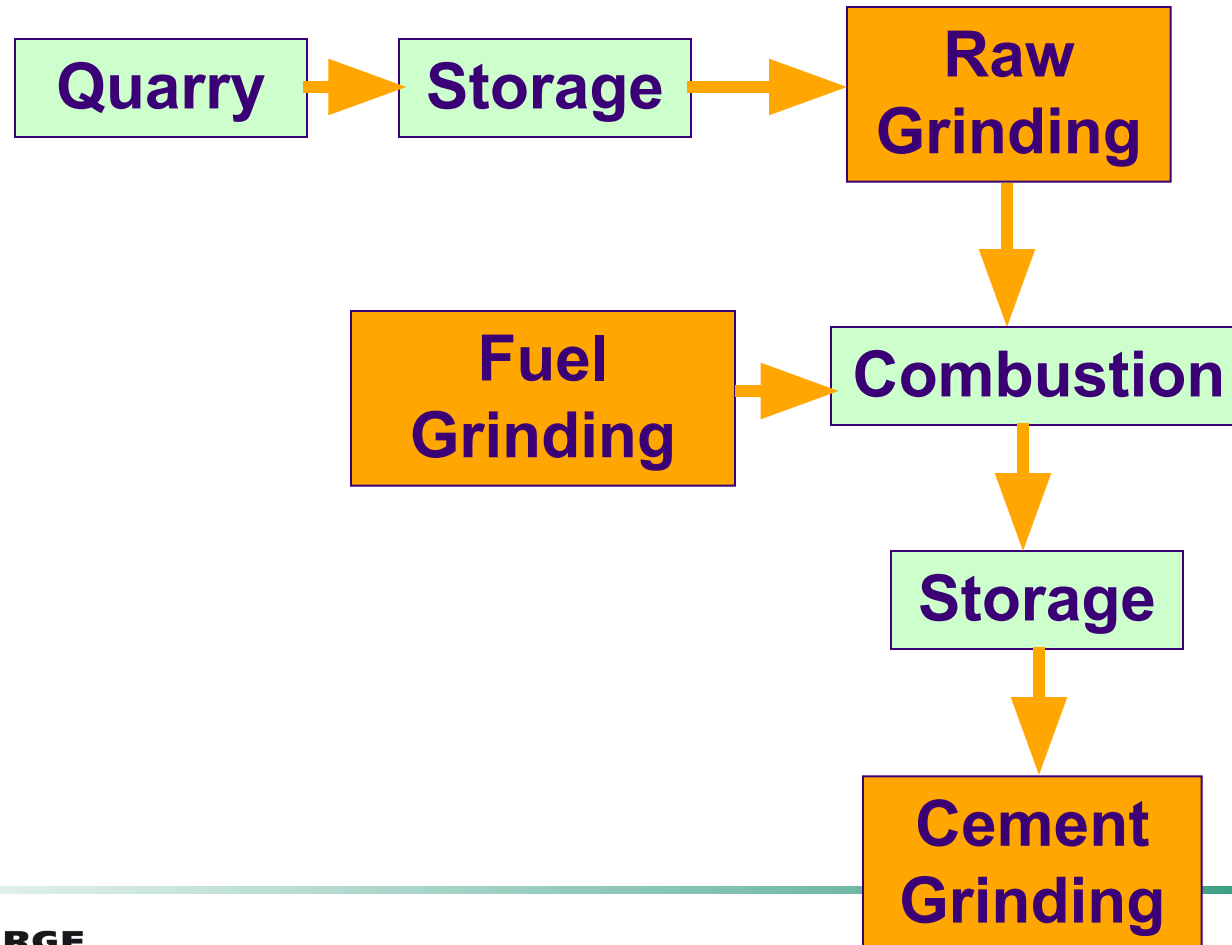
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- **Horomill**

Why do we grind in the cement business?

- **To create surface area for good chemical reactions to occur**
 - Combination in the kiln (Raw grinding)
 - Hydraulic reactions in the concrete (Cement grinding)
 - Good combustion in the kiln flame (Coal grinding)

Where do we grind in the overall cement manufacturing process

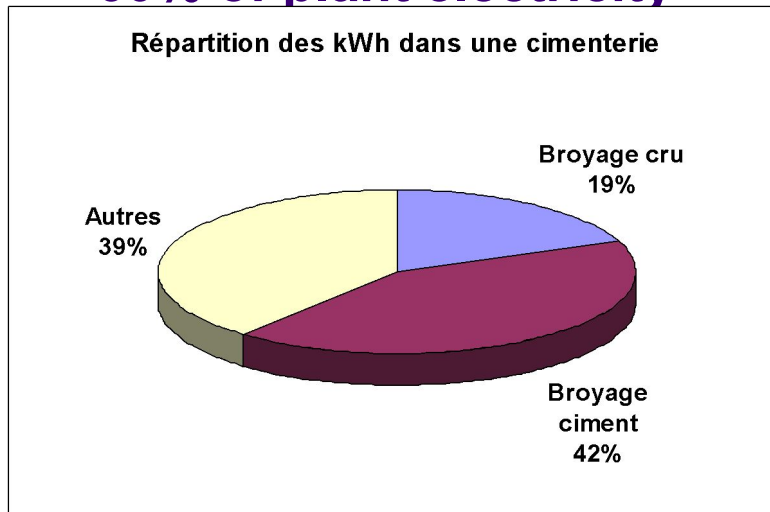


What are the main challenges for cement production

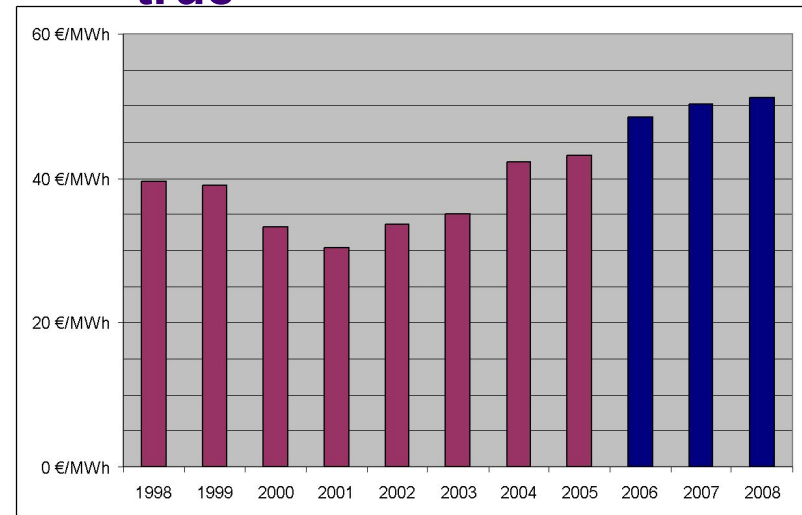
- Reduce power consumption
- Maximize production
- Optimize and improve product regularity
- Control maintenance costs

Grinding costs money

- Grinding uses approx. 60% of plant electricity



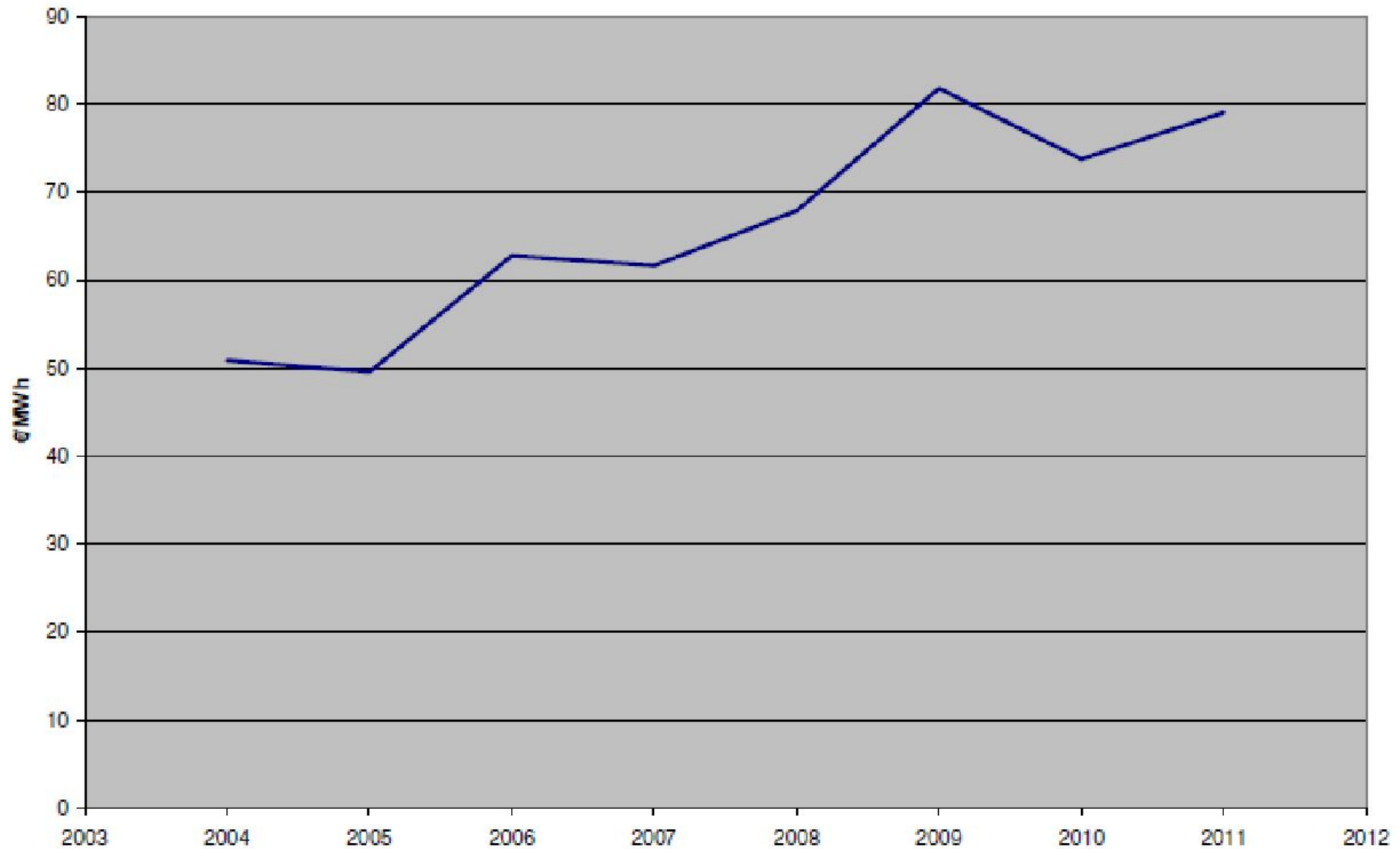
- Cheap power is no longer true



- Today plant electricity bill is more important than fuel bill

Specific power must be improved

WOS average power cost 2004 - 2011



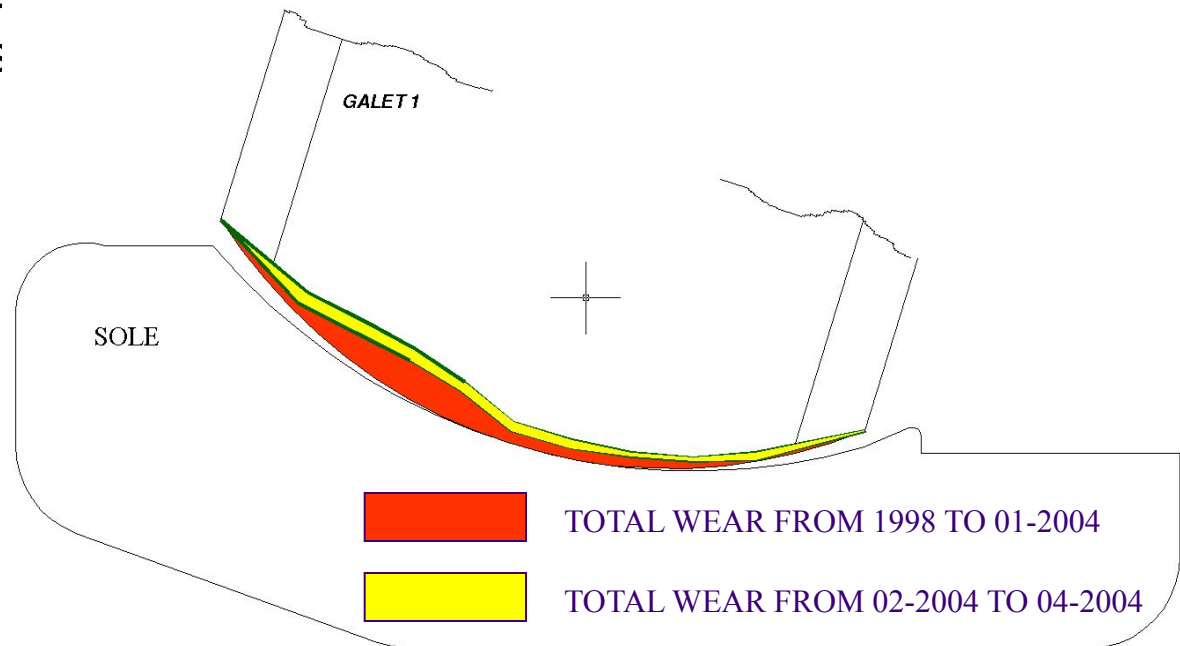
Grinding costs money

• Costs of wear parts increasing

- Joint visits between process and maintenance department the process

PLN raw mill example:

- Change of iron source
- Wear before and after use of this new raw material
- Material stays in the reject



The different types of mill

- **Three different mill types with specific purposes**
 - **Raw mills (for slag, shale, limestone...)**
 - Size reduction (targeted rejects at 90 and 200µm)
 - Drying the materials
 - **Cement mills (pure or compound cements)**
 - Size reduction (objectives in SSB)
 - Management of gypsum dehydration
 - **Fuel mills (coal and pet coke)**
 - Size reduction (targeted rejects at 90µm)
 - Drying the materials

Technologies and arrangements

- **Different mill technologies**

- Ball mills
 - Air swept mill = materials released by ventilation air
 - Compound mill = with end discharge
 - Bi rotator mill = with central discharge
- Vertical mill
- Roller press
- Horomill

- **Different architectures**

- In open circuit
- In closed circuit
- With pre-grinding, hybrid grinding...

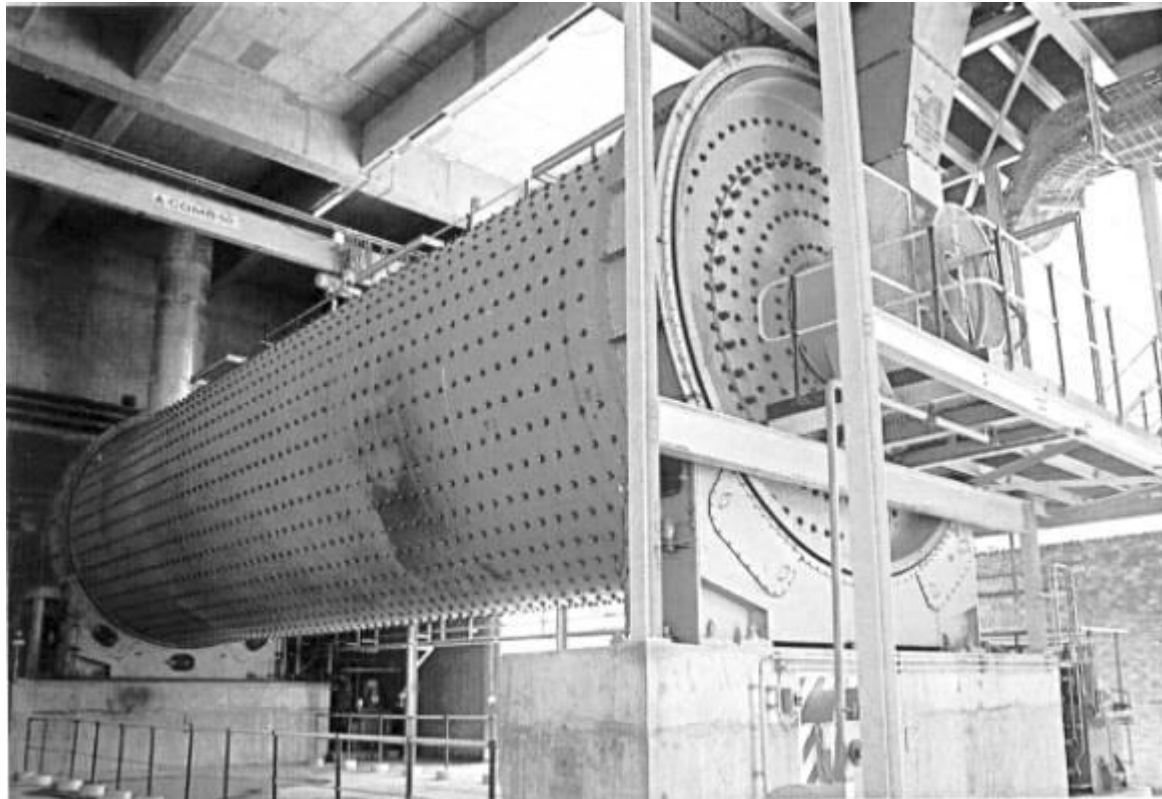
Origin of a current workshop

- **Existing workshop design depends on**
 - Material feed specifications
 - Feed size
 - Moisture
 - Outlet product specifications
 - Flow rate
 - Fineness target
 - History of the plant and workshop

Content

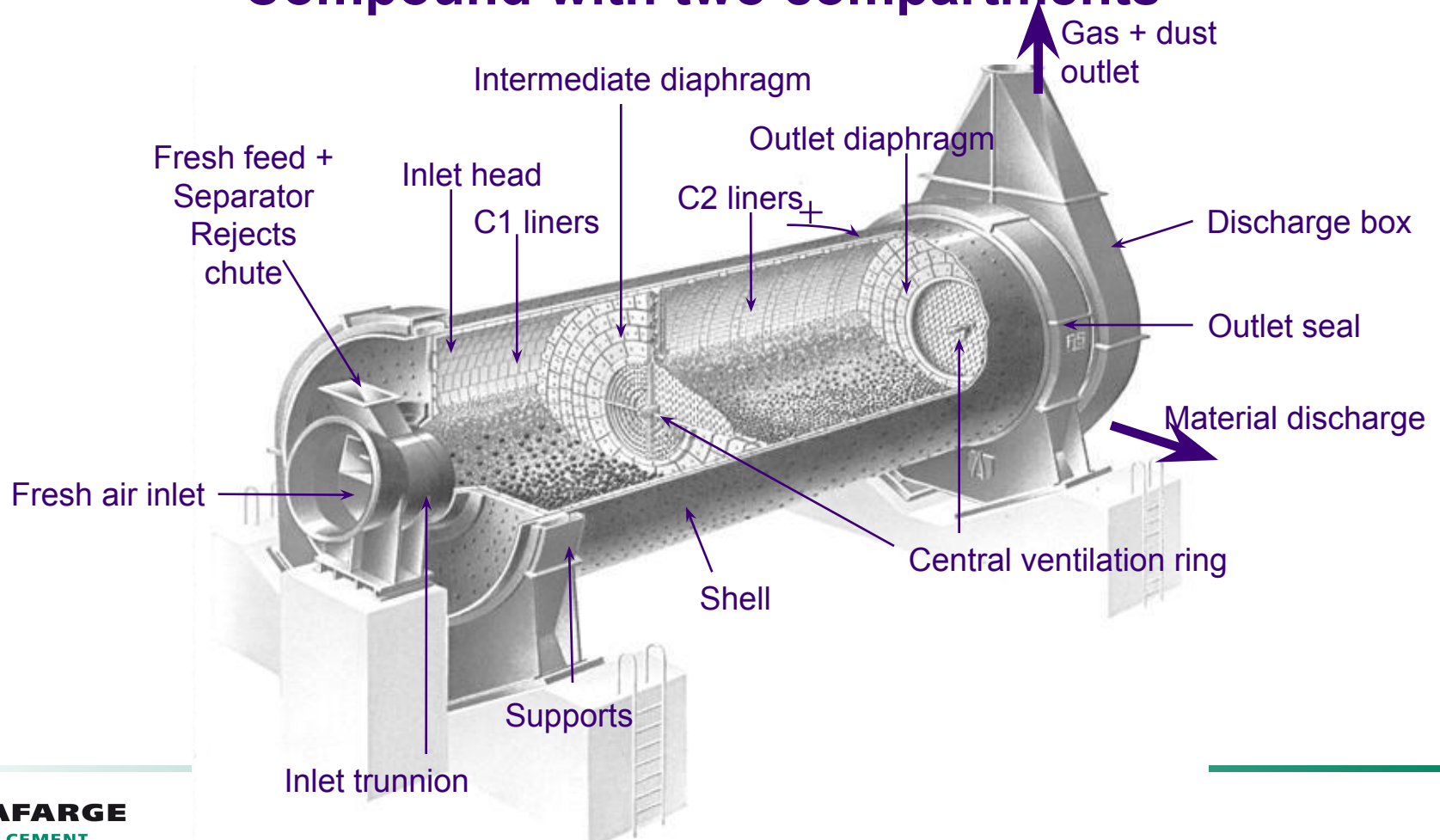
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The Ball Mill

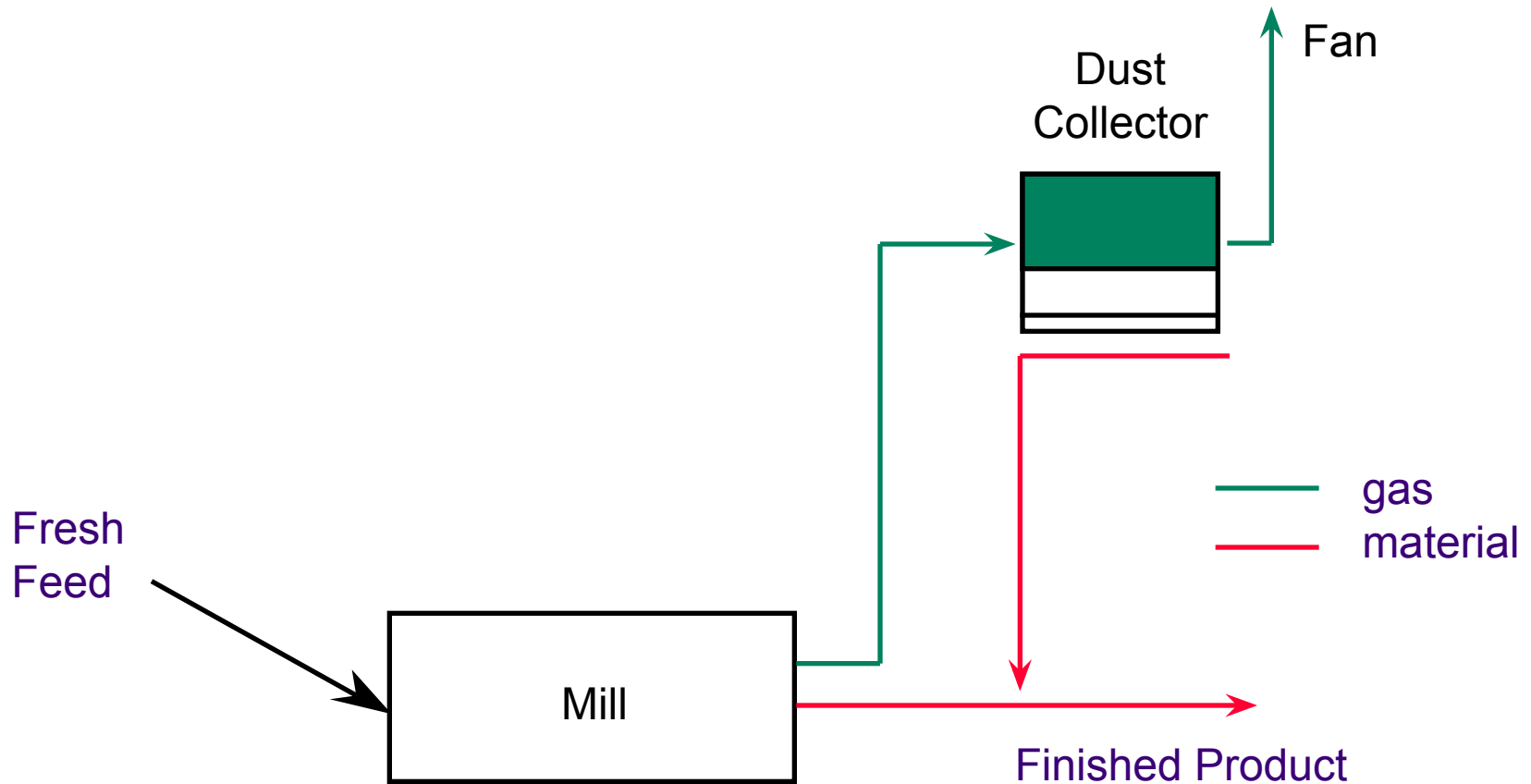


The Ball Mill

- **Compound with two compartments**



The ball mill in open circuit



The ball mill in open circuit

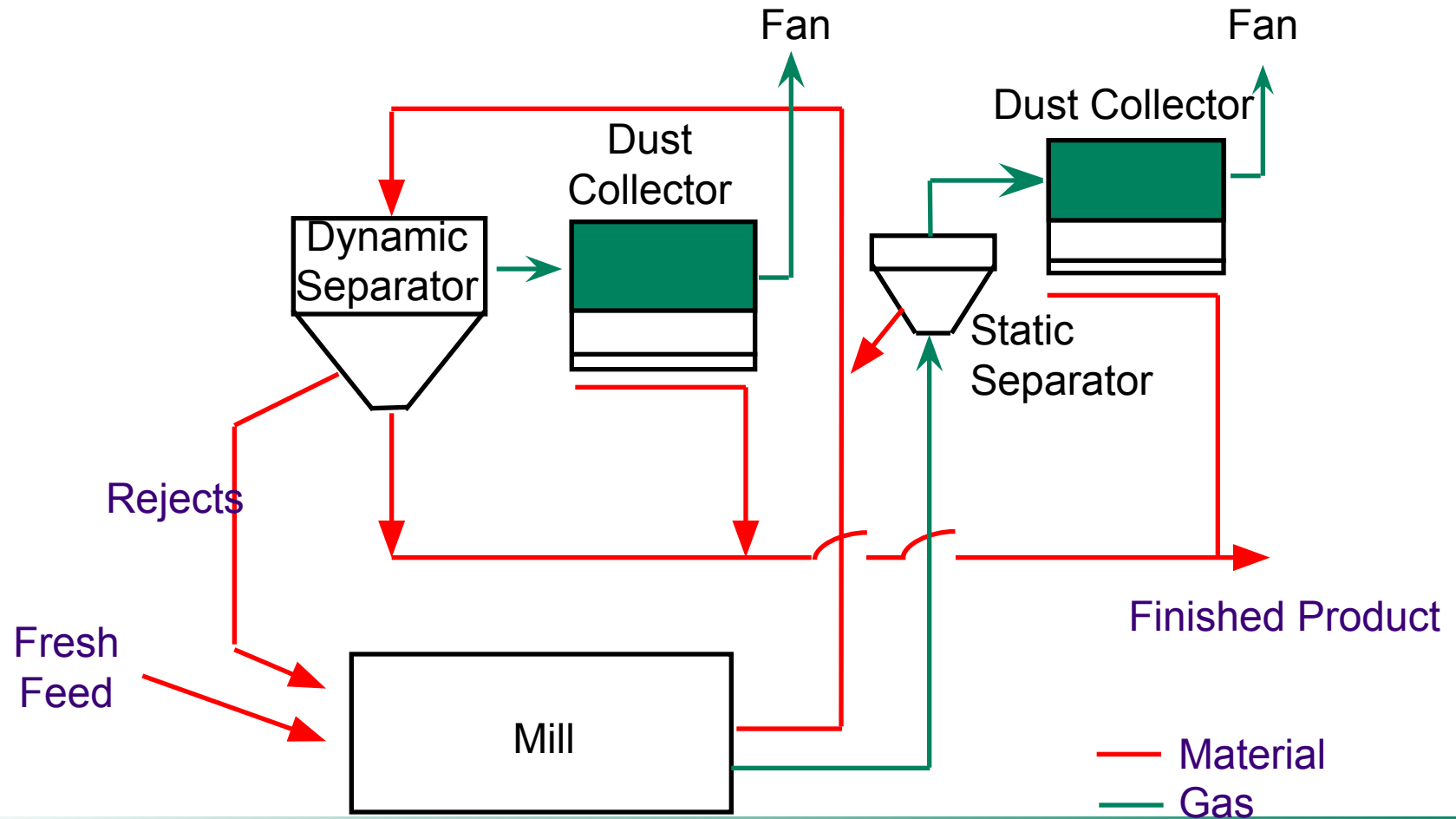
• Advantages

- Moderate investment costs
- Simple operation
- Simple maintenance
- Highest reliability

• Disadvantages

- little or no control of fineness
- not adapted to high fineness (possibility of overgrinding)
- broad particles size distribution
- higher temperature of products
- Limited drying capacity

The ball mill in closed circuit

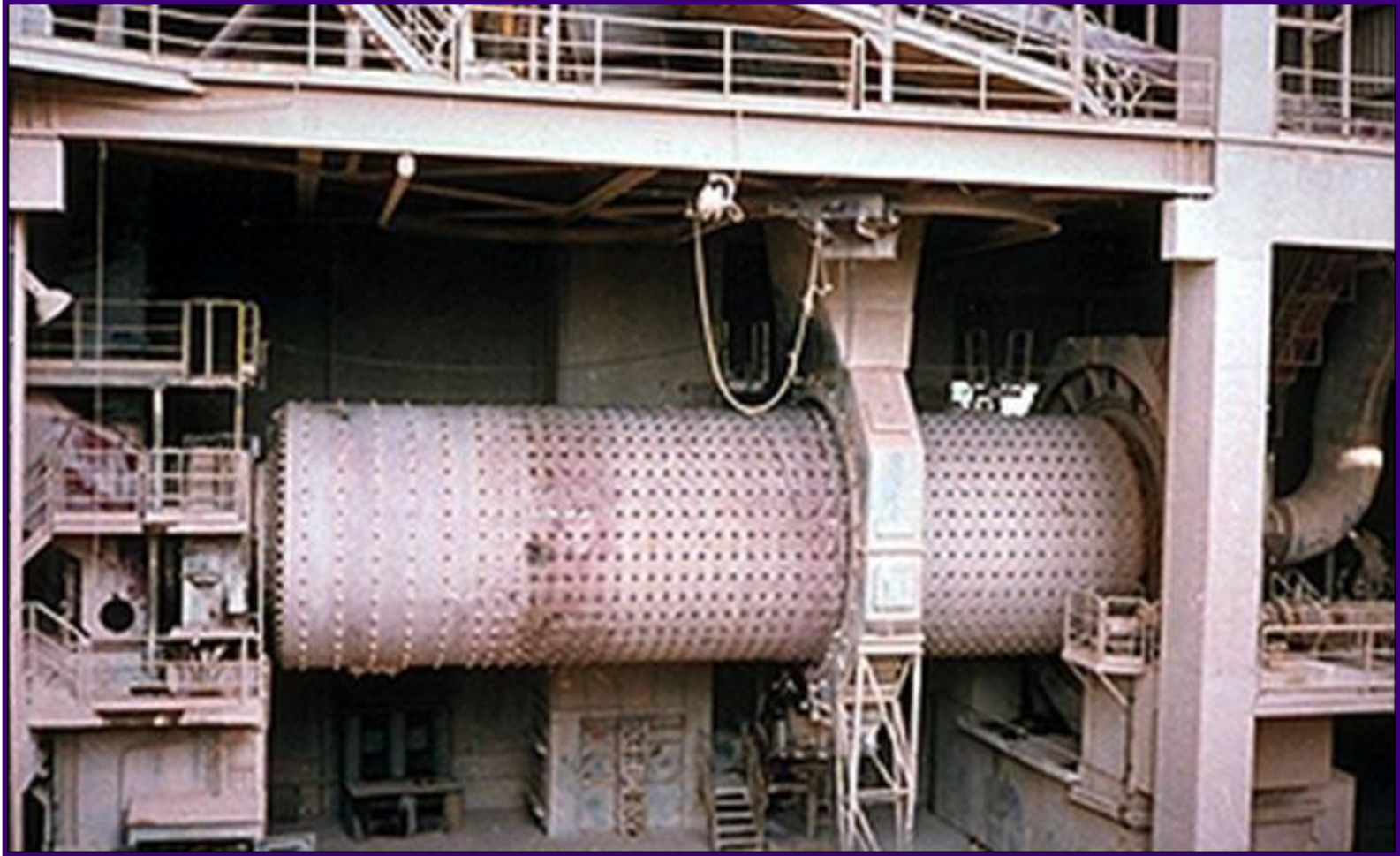


The ball mill in closed circuit

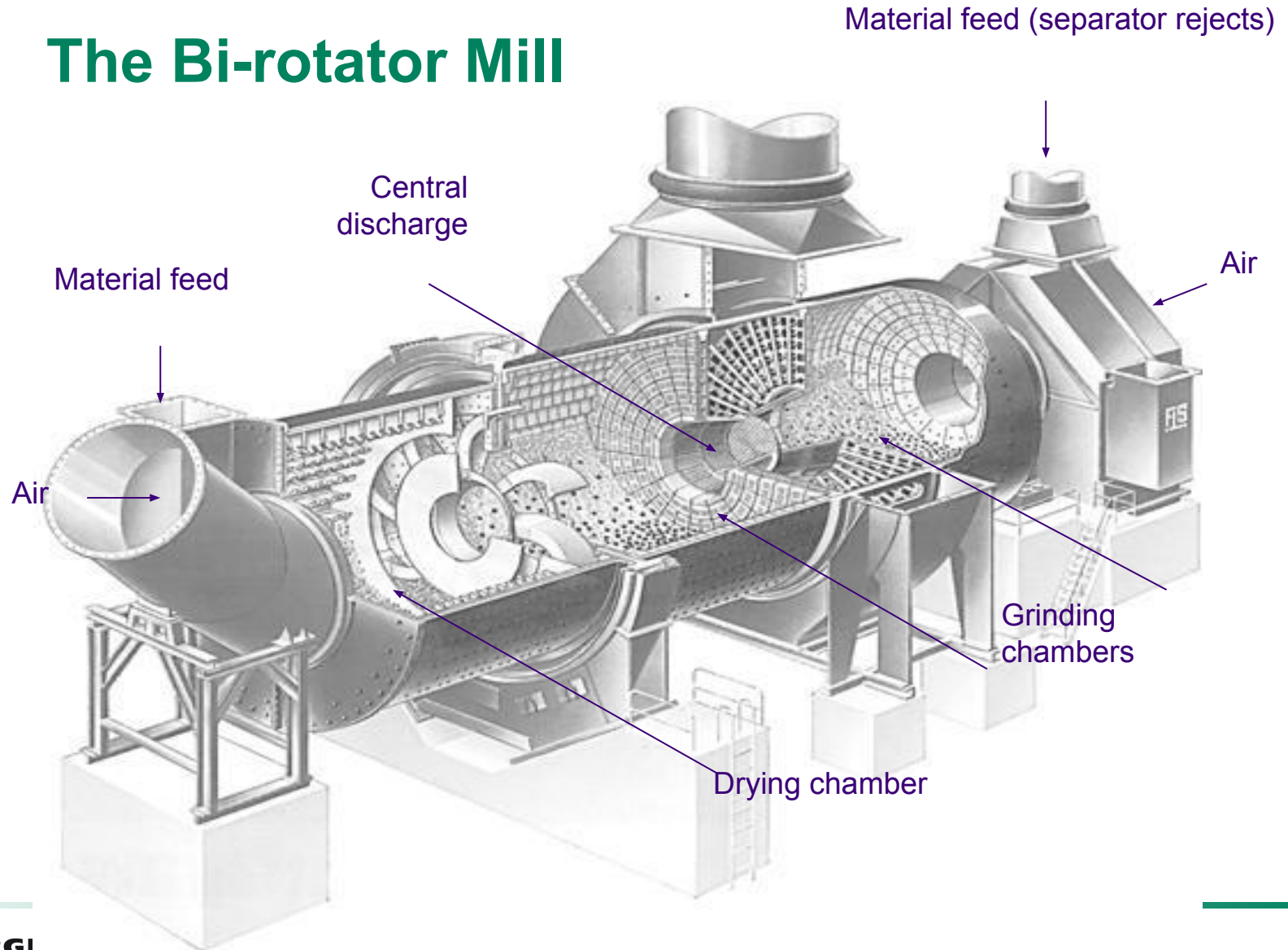
• General description

- Better regularity thanks to a real control of the fineness
- High fineness is possible
- Higher flexibility and possibility of optimisation by product
- Higher output, better efficiency
- Possibility of higher mill ventilation
- Better temperature control
 - High mill ventilation
 - Possibility to have a separated ventilation in the separator
- Narrow particle size distribution
- Higher investment costs

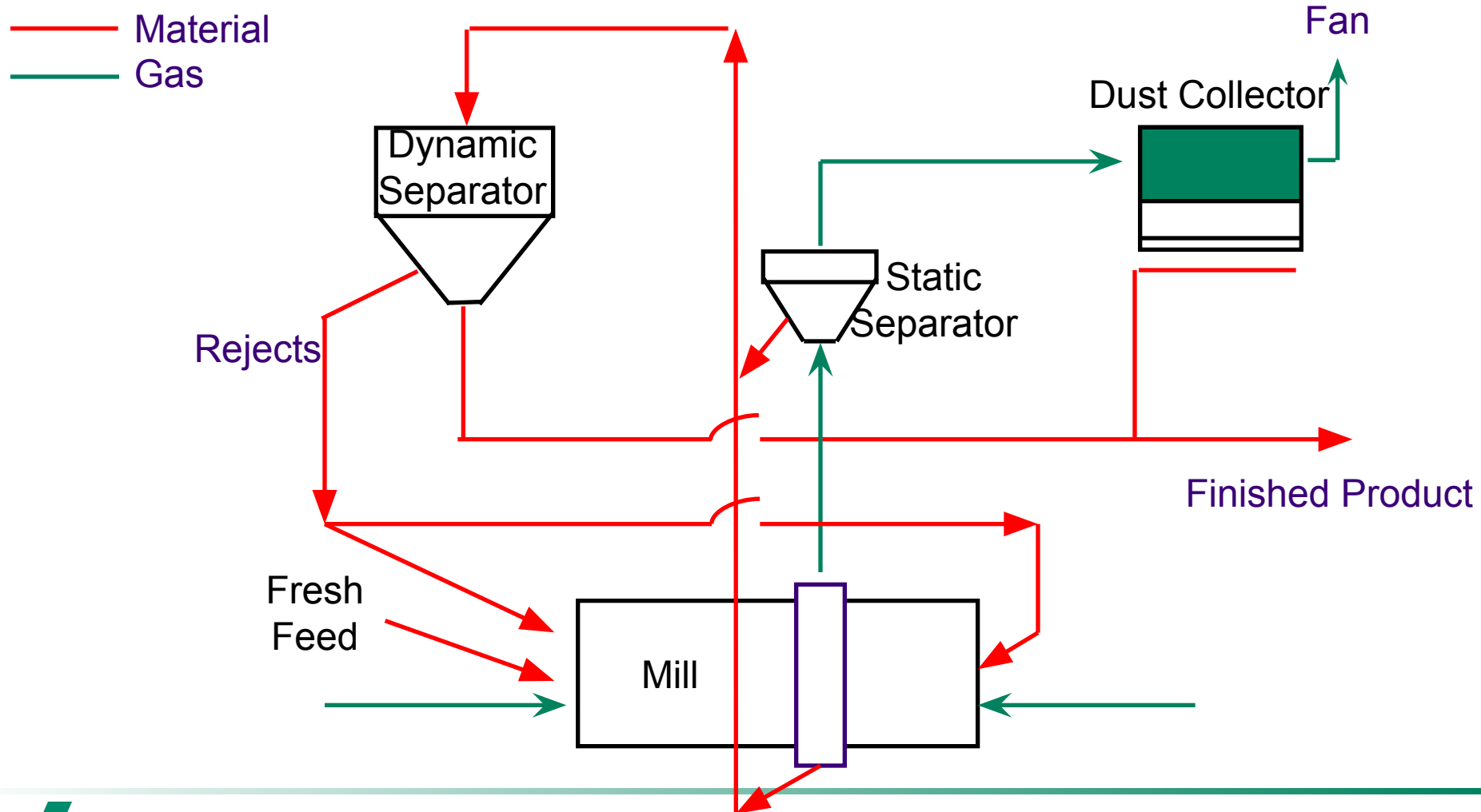
The Bi-rotator Mill



The Bi-rotator Mill



The Bi-rotator Mill in closed circuit



The Bi-rotator Mill

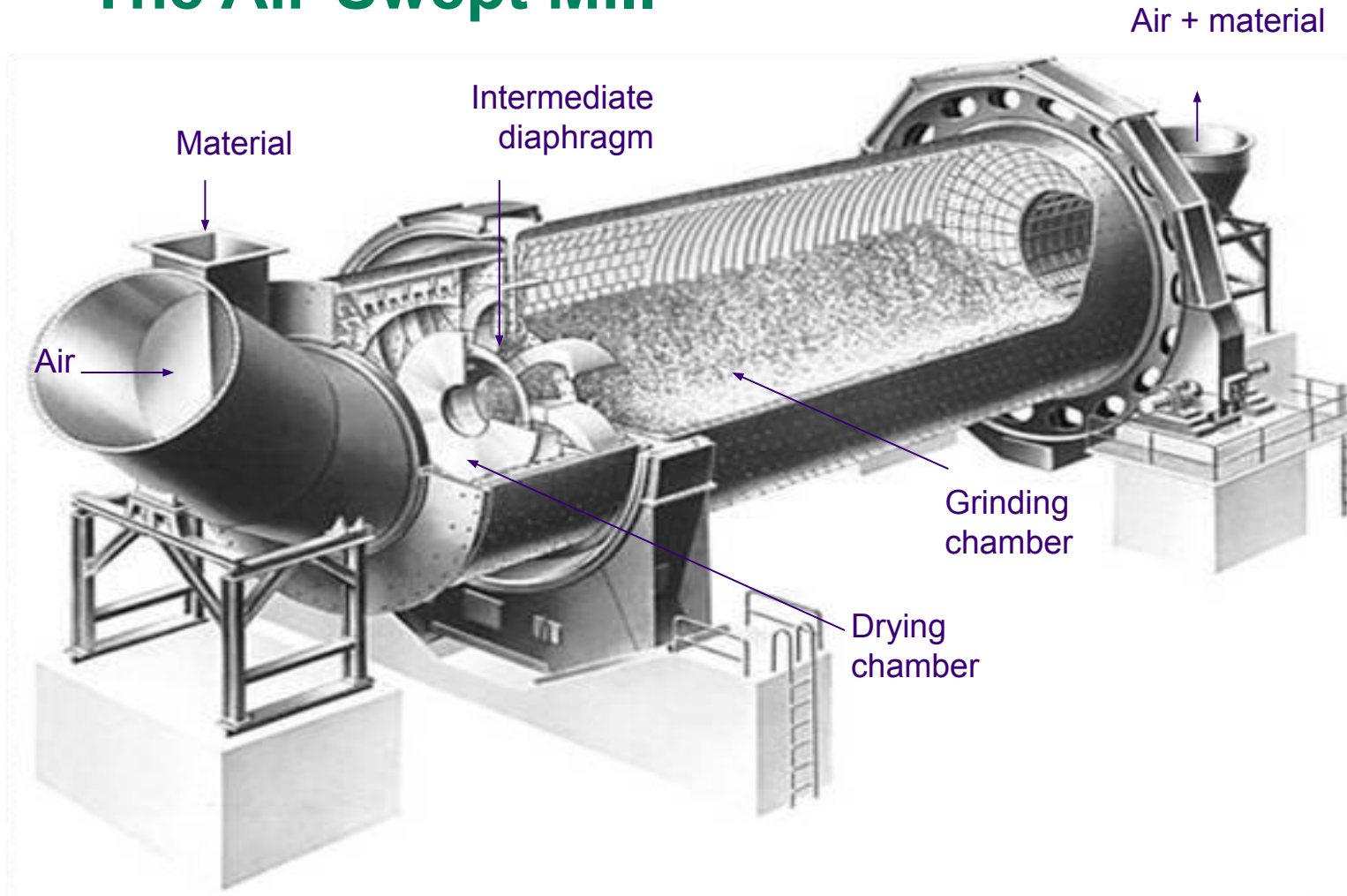
- **Advantages**

- High ventilation capacity for drying materials

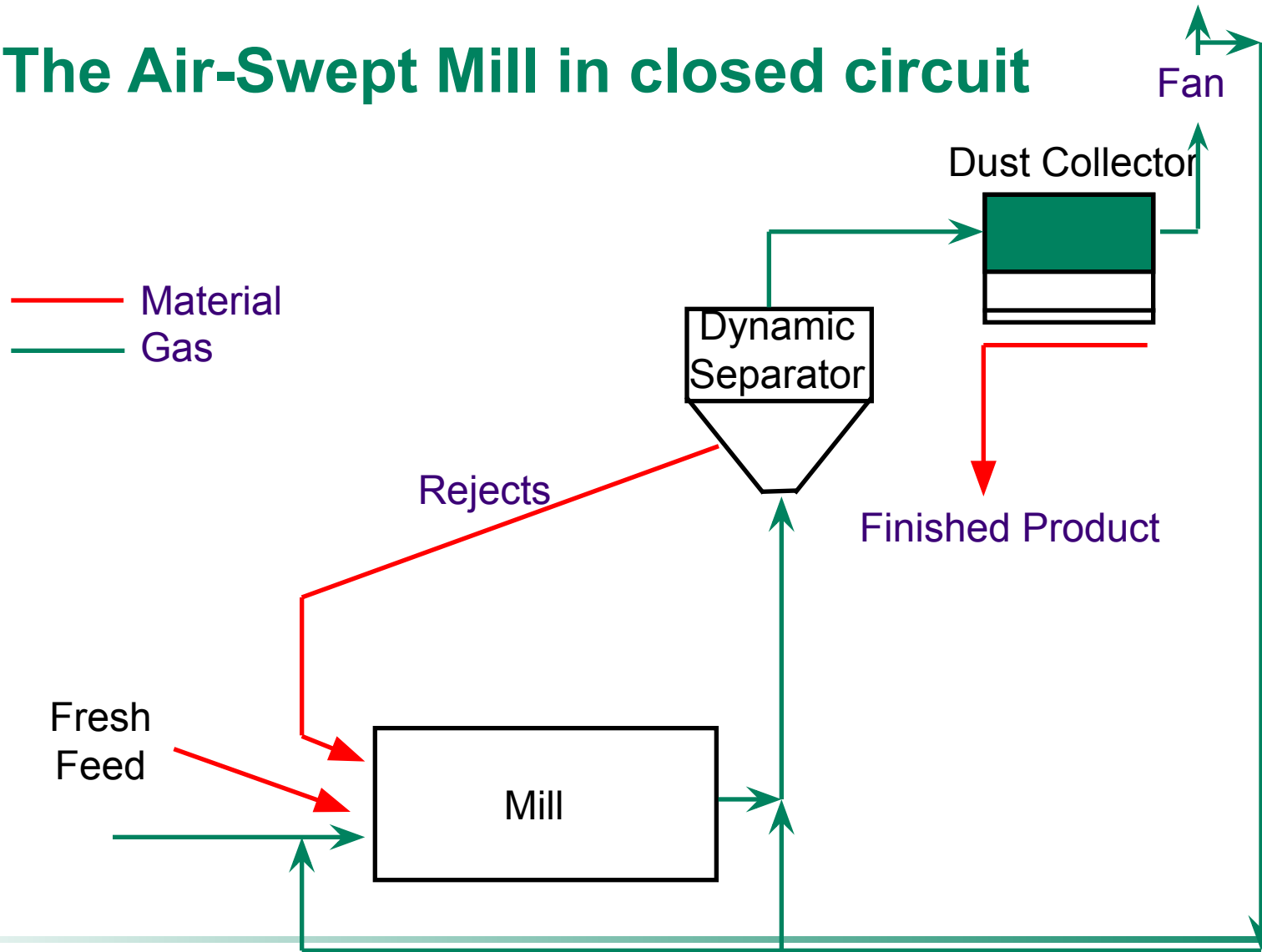
- **Disadvantages**

- False air

The Air-Swept Mill



The Air-Swept Mill in closed circuit



The Air-Swept Mill

- **Advantages**

- High ventilation capacity to dry materials

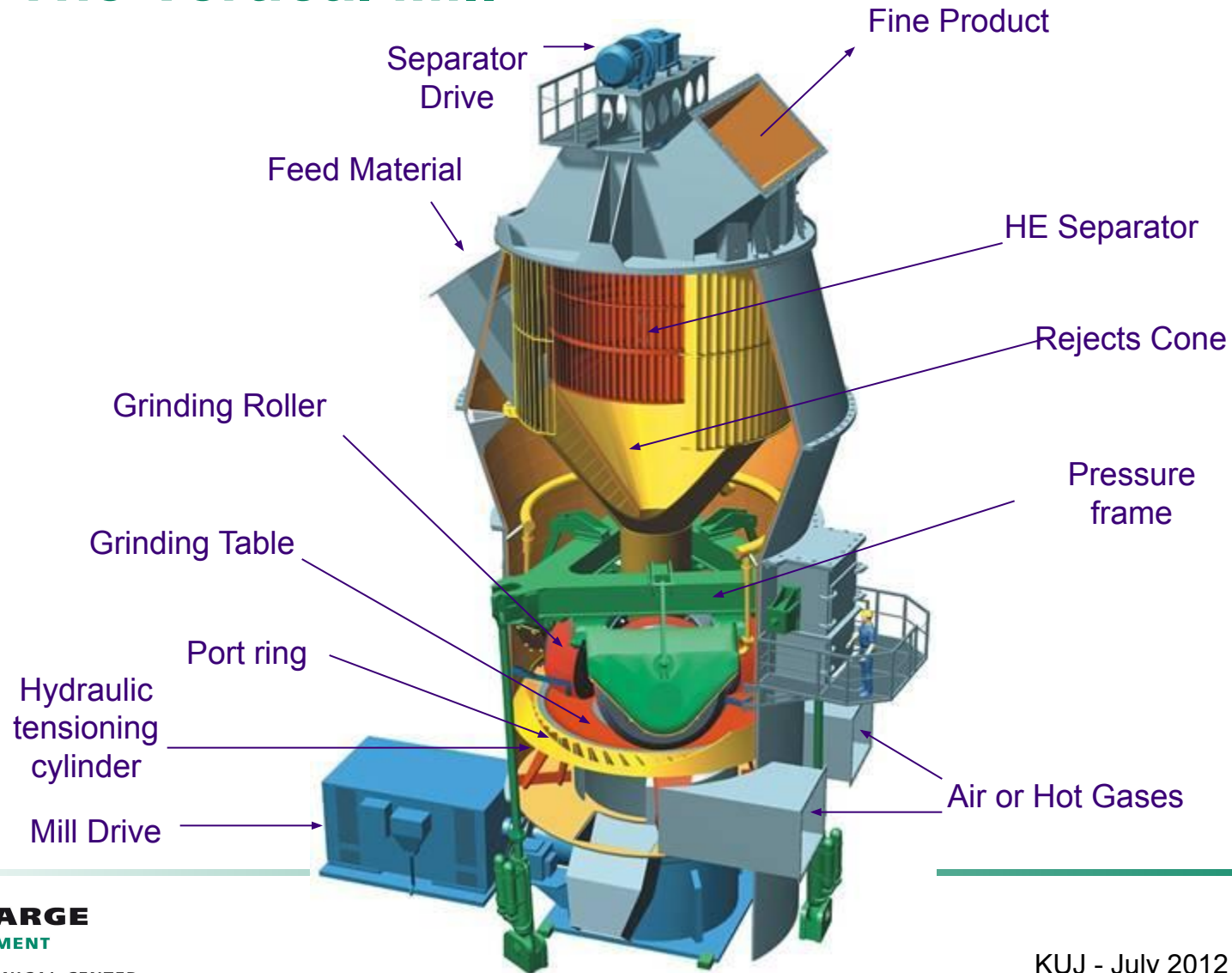
- **Disadvantages**

- High specific power consumption due to swept solution

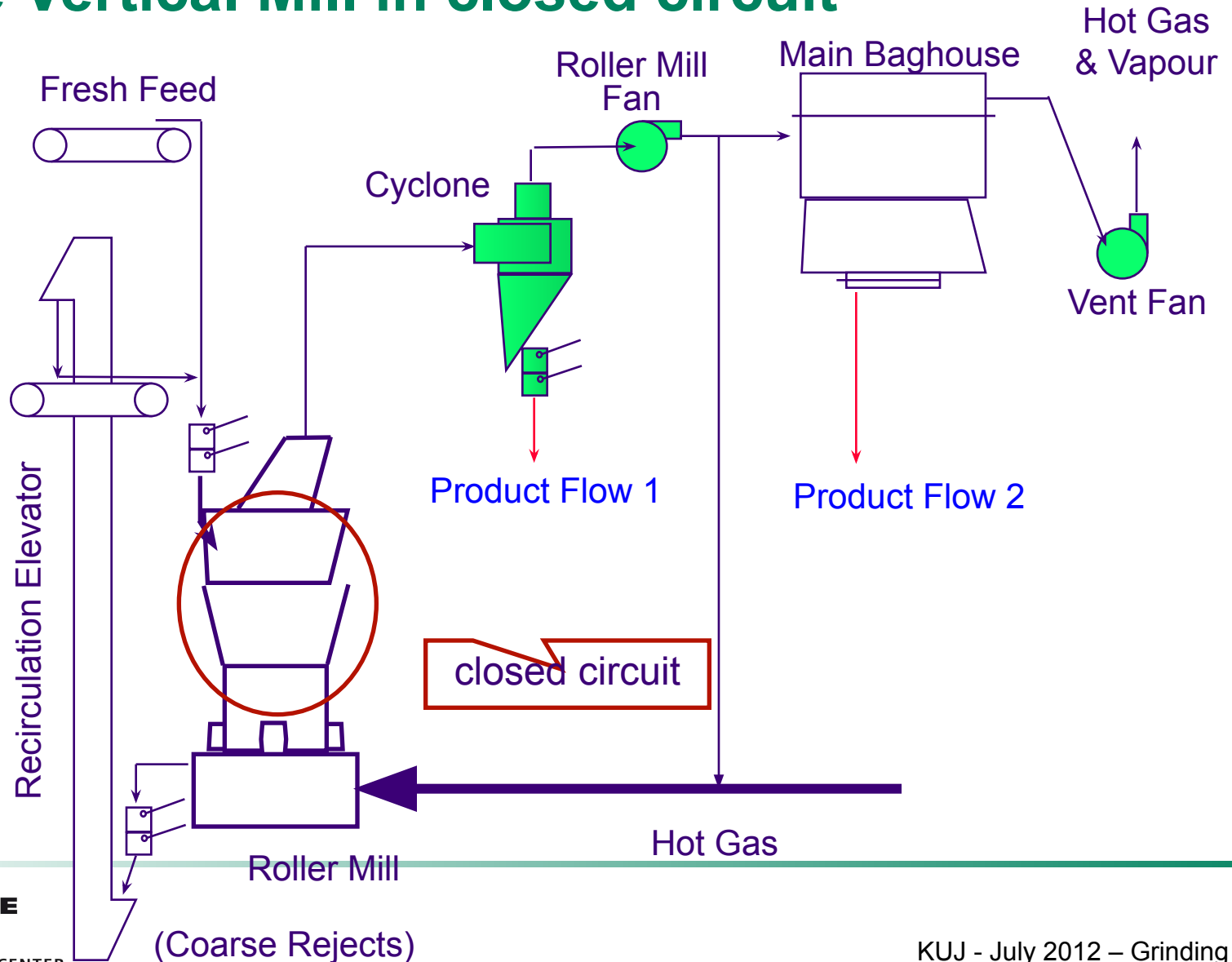
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- Roller press
- Horomill

The Vertical Mill



The Vertical Mill in closed circuit



The Vertical Mill

•Advantages

- Good efficiency factor
- High drying capacity
- Combined grinder, separator and dryer in one unit
- Popular for coal and raw material grinding with high moisture content

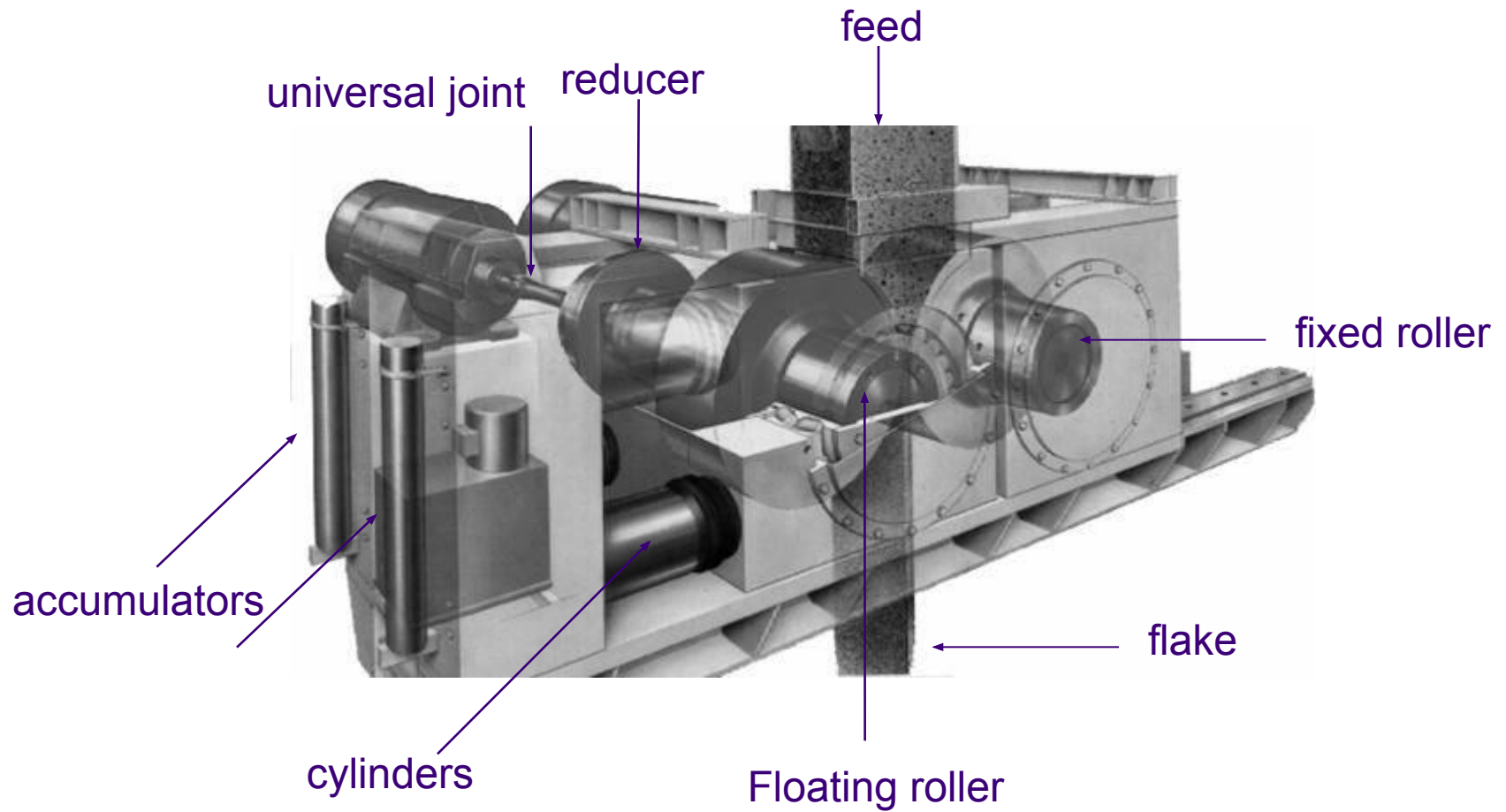
•Disadvantages

- Complex operation
- Reliability – maintenance costs
- Vibrations
- Management of gypsum dehydration in cement grinding

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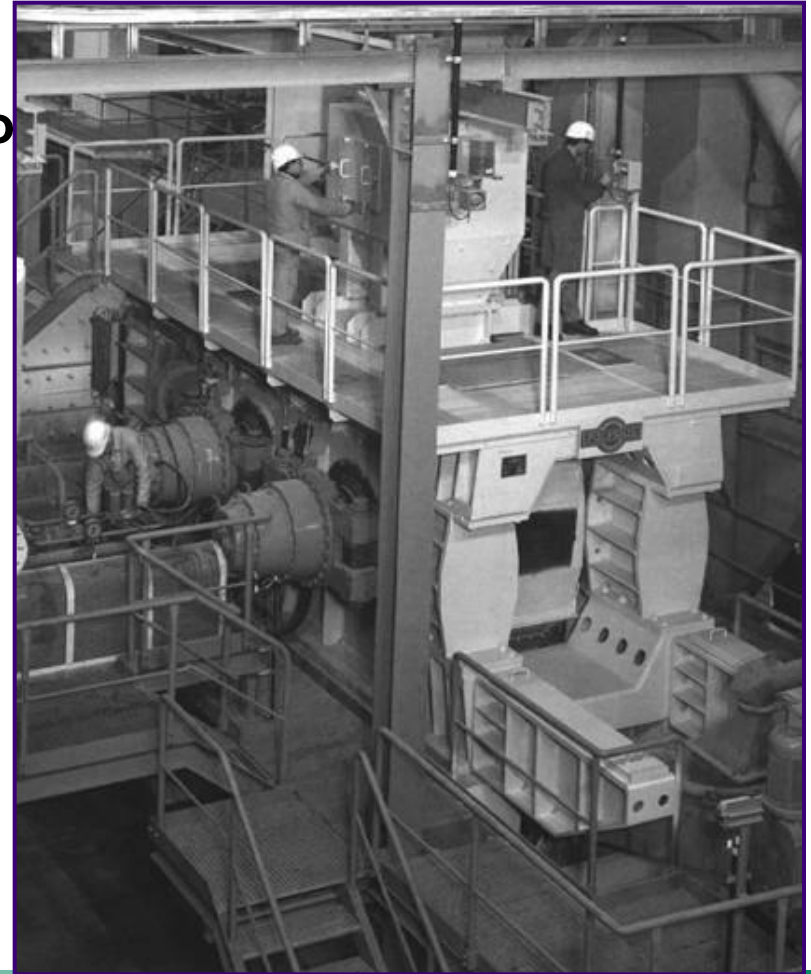
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Roller Press



Roller Press

- Pneumatic slide choke plates on both sides of feed hopper needed to control intake and therefore power.
- Low reliability typical, but very energy efficient.



Roller Press

• Advantages

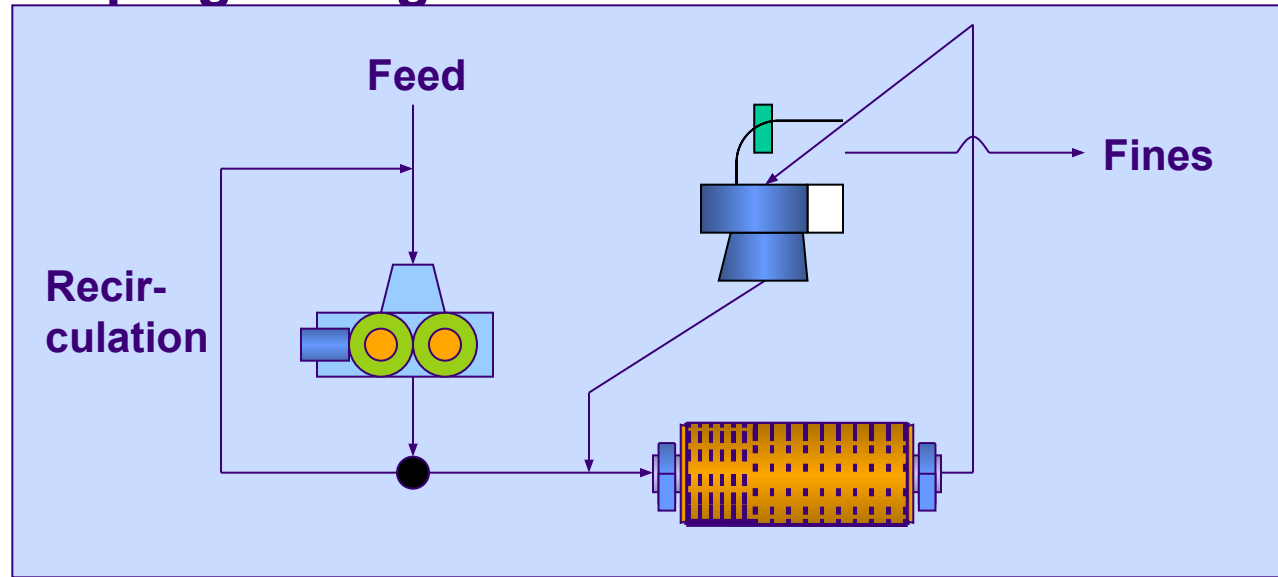
- High efficiency factor
- Compact installation
- High production increase when used as pregrinding

• Disadvantages

- High investment costs
- Complex operation
- Reliability
- Limited drying capacity

Pregrinding with Roller Press

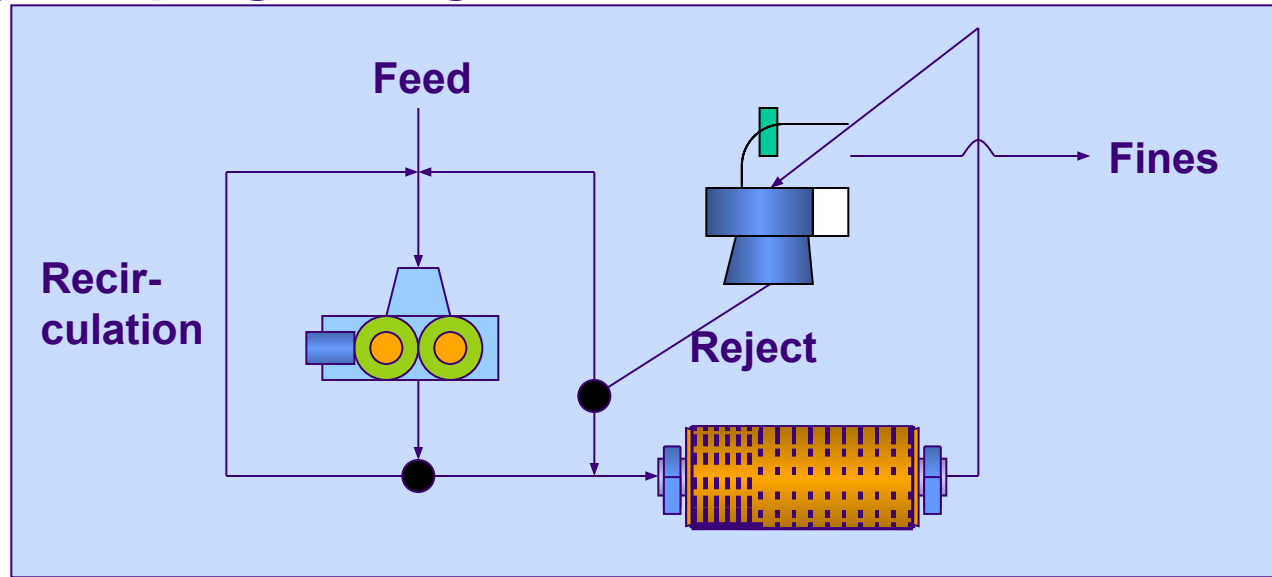
- **Basic pregrinding**



- Preground material could feed into an intermediate bin
- Approx. 30% increase of production
- Recirculation is required for pregrinder efficiency and stability

Pregrinding with Roller Press

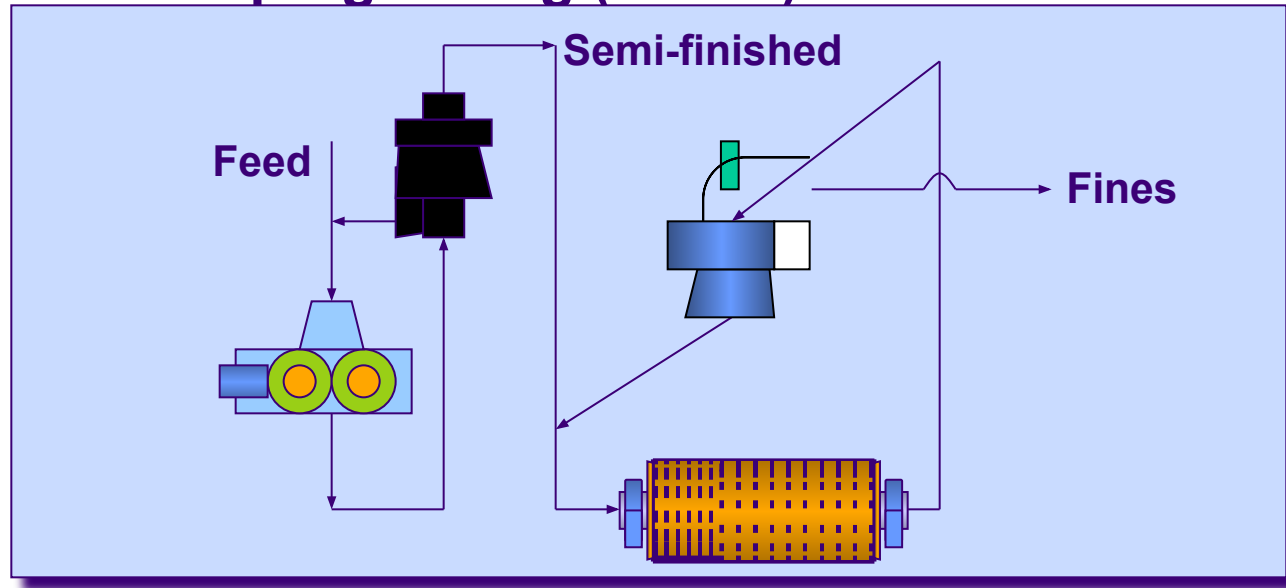
- **Hybrid pregrinding**



- Separator rejects are split (partly to ball mill and pregrinder)
- Approx. 50% increase of production
- Difficult to control

Pregrinding with Roller Press

- **Combined pregrinding (series)**



- Each grinding machine has its own separator
- Up to 100% increase of production is possible

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Horomill

• General description

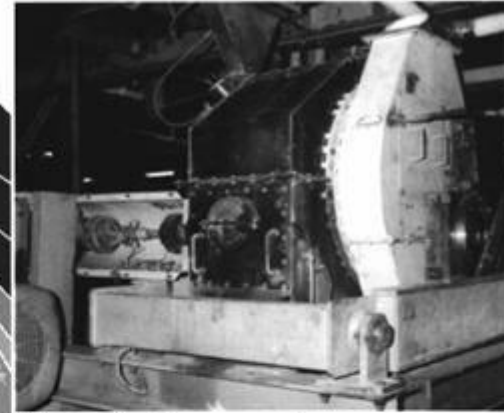
- Horizontal mill
- Single roller inside a motorized tube shell
- Slide shoe (thrust pad) bearings
- Girth gear and pinion drive
- Designed by FCB

Horomill

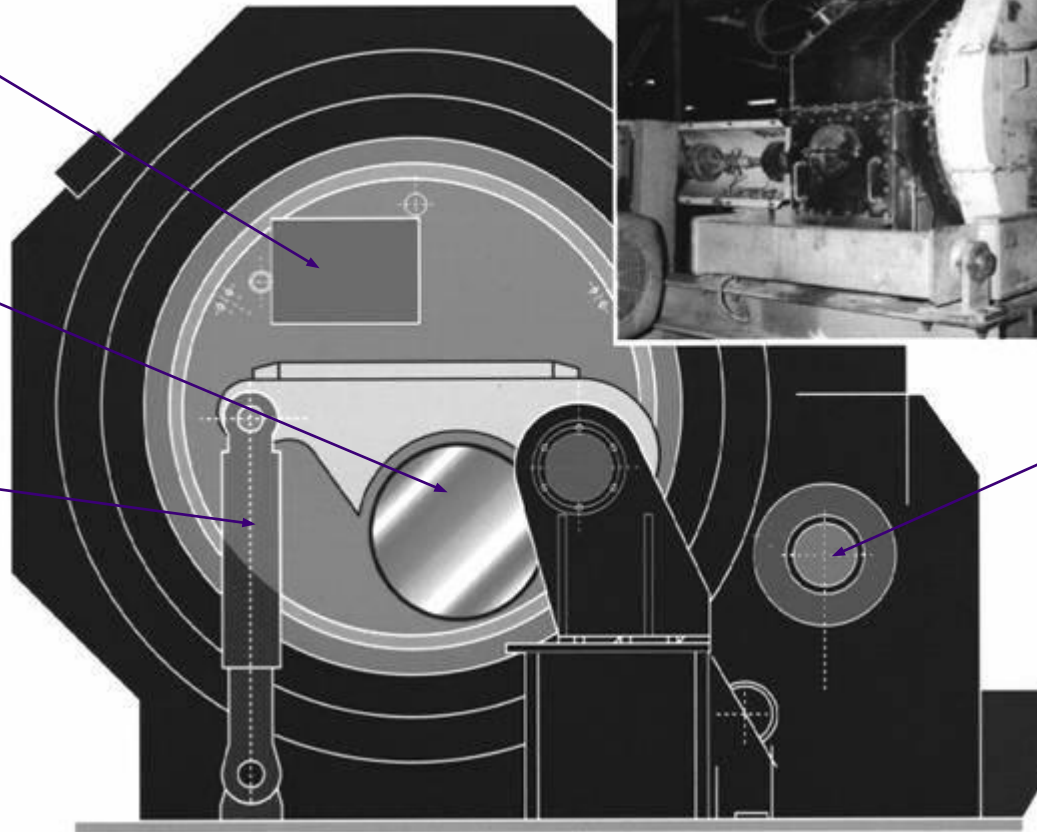
Scraper and feed
forward plate

roller

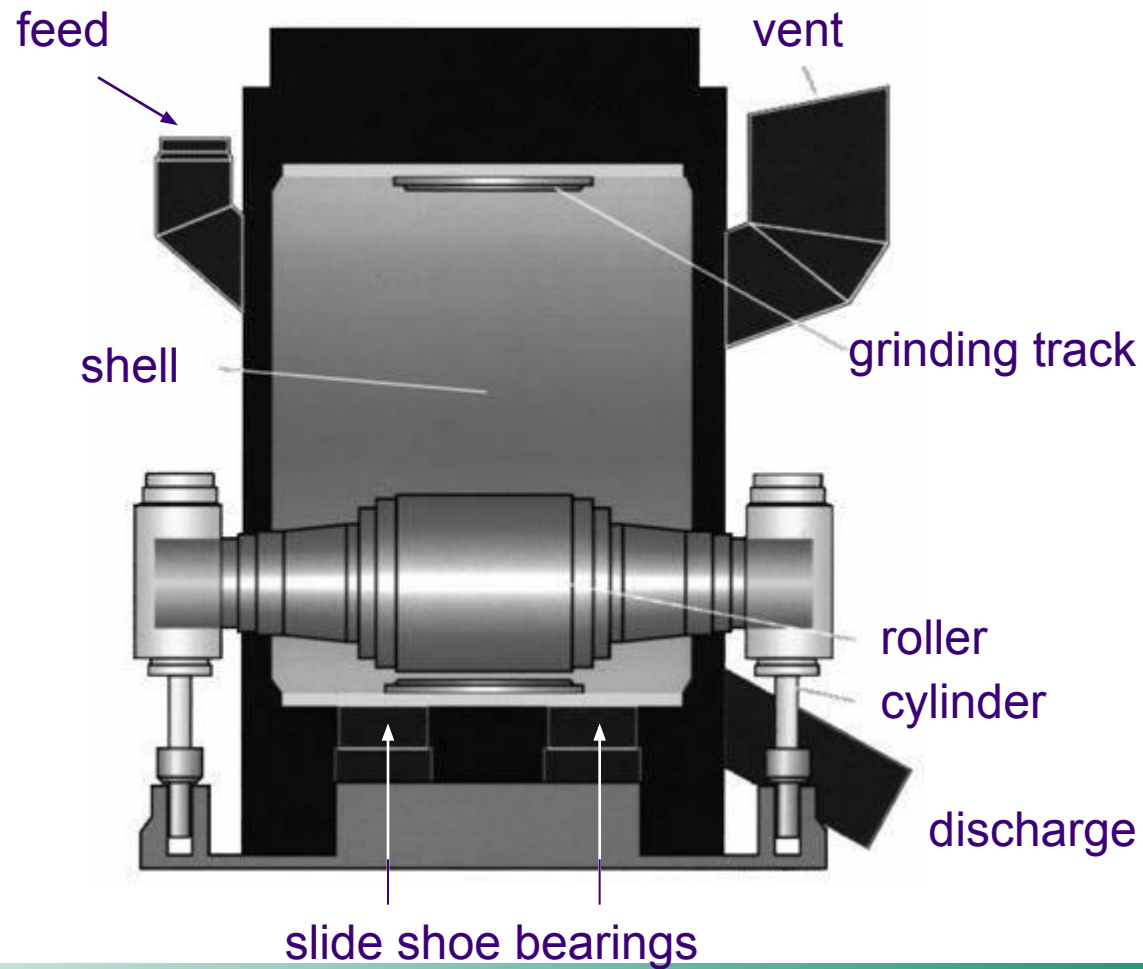
cylinder



pinion shaft



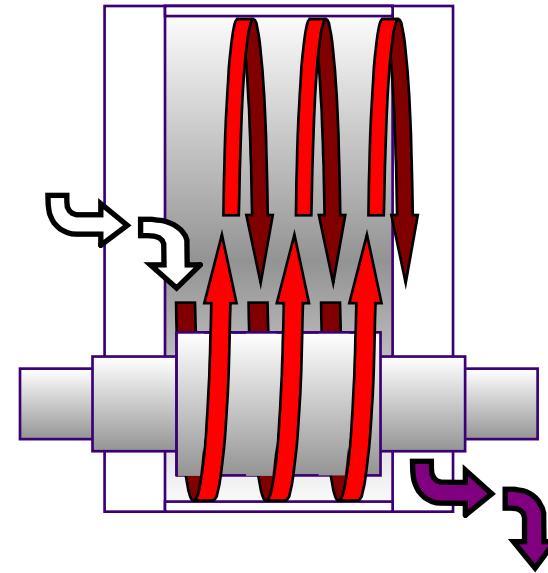
Horomill



Horomill



- Greatest nip angle (lowest amount of pressure)
- Virtually no shear - little wear claimed



- Patented device to control retention time
- $RPM > V$ critical
- Internal recirculation results in low vibration

Ways to upgrade a workshop

- **Optimisation of workshop operations**
 - Ball charge design
 - Ventilation balance
 - Circulating load
 - Increase of the ball mill speed (target of 75% V_{crit})
- **Replacement of the workshop separator with a third generation one**