Progressive grinding technology with Loesche VRM for the mining industry

Carsten Gerold, LOESCHE GmbH

Roadshow Cement & Minerals
Latin America, Lima 03-05-2013
LOESCHE – Innovative Engineering

⚠️ LOESCHE GmbH is a privately owned company
⚠️ Established 1906 in Berlin, Germany
⚠️ Certification DIN Standard EN ISO 9001

⚠️ Main Shareholder: Dr. Thomas Loesche
⚠️ Management: Dr. Thomas Loesche
               Dr. Joachim Kirchmann

⚠️ Employees in group 970
Loesche: comminution expertise since more than 106 years

- Minerals
- Pyro Products
- Recycling, Slag
- Global market leader in the cement industry
- 100 % market share in Peru and Chile since 2006
### References

#### Minerals

<table>
<thead>
<tr>
<th>Ore / Minerals</th>
<th>number of references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td>&gt; 1000</td>
</tr>
<tr>
<td>Coal</td>
<td>&gt; 800</td>
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<tr>
<td>Phosphate</td>
<td>36</td>
</tr>
<tr>
<td>Iron Ore</td>
<td>12</td>
</tr>
<tr>
<td>Bentonite</td>
<td>9</td>
</tr>
<tr>
<td>Barite</td>
<td>4</td>
</tr>
<tr>
<td>Colemanite</td>
<td>3</td>
</tr>
<tr>
<td>Manganese</td>
<td>1</td>
</tr>
<tr>
<td>Lithium Oxide</td>
<td>1</td>
</tr>
<tr>
<td>Lead / Zinc</td>
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</table>
## References

### Pyro Products

<table>
<thead>
<tr>
<th>Pyro Product</th>
<th>number of references</th>
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<tbody>
<tr>
<td>Clinker</td>
<td>202</td>
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<tr>
<td>Manganese Dioxide</td>
<td>6</td>
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<tr>
<td>Copper Matte</td>
<td>4</td>
</tr>
<tr>
<td>Titanium Dioxide</td>
<td>3</td>
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</tbody>
</table>
## References
### Recycling, Slag

<table>
<thead>
<tr>
<th>Slag</th>
<th>Number of References</th>
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<tbody>
<tr>
<td>Blast Furnace Slag</td>
<td>85</td>
</tr>
<tr>
<td>Steel Slag</td>
<td>2</td>
</tr>
<tr>
<td>Stainless Steel Slag</td>
<td>1</td>
</tr>
<tr>
<td>Tin Slag</td>
<td>1</td>
</tr>
</tbody>
</table>

LM 15.2 Minsur Tin Slag
LOESCHE Technology
Reference Minerals / Phosphate

- Phosphate ore grinding in Phalaborwa South Africa
- Pyroxenite Hard Rock
- Actual production capacity 520 t/h at P85=425µm
- Final product: Flotation Feed
LOESCHE Technology transfer

Cement Industry

- Varying production demands to be fulfilled in one Loesche VRM
- Energy savings of about 30%
- Reduced operating costs through lower wear rates
- Simplified Process Chain

Ore Industry

- Ore deposits are mostly heterogeneous and demand well adapted treatment
- Grinding is consuming over 50% of the energy in Mineral processing
- Most ores types are far more abrasive than cement or slag
Loesche Comminution Technology „More than just a mill“

„More than just a mill“

- 1 machine for crushing, grinding and classifying
- Efficient grinding system: compressive comminution with adjustable amount of shear forces
- Highly efficient air classifying: on-line adjustable product PSD, classifying directly after each grinding impact ➔ no over-grinding
- If necessary highly efficient drying possible: Drying just if necessary for classifying
LOESCHE Technology unique Arguments

- Small plant foot print
- Energy savings of up to 30%
- Water saving through dry grinding (evaporation in thickeners, spillage, process water recycling)
- Constant throughput through on-line adjustable grinding pressure
- Reduced operating costs through lower wear rates and lower energy consumption
- Increased mineral liberation ➔ increased recovery
LOESCHE Vertical Roller Mill

Working principle of VRM

- LM 69.6
- LM 60.6
LOESCHE Technology
Applications Raw Meal / Ore
LOESCHE Technology
Applications Minerals
Ore Processing

- Mining
- Crushing
- Grinding
- Beneficiation
- Pyro-Metallurgy
- Refining Electrolysis
LOESCHE Grinding Technology
Ore Industry

Crushing & Grinding

Benefication & Dewatering
Conventional grinding technology:

AG/SAG Mills

Quelle: www.im-mining.com

Ball Mills

Quelle: metalworkingmachine.net
LOESCHE Grinding Technology in Ore Industry

Crushing & Grinding

Benefication & Dewatering

Replacement through LM 150 – 0.020mm
Grinding Characteristic
Inter-particle comminution

One roller mill - Donkey driven
(fixed mill table - rotating roller system)
Grinding Characteristic
Inter-particle comminution

- Multiple points of contact as bed is compressed
- Fluid like allover stressing of the particle agglomerates
- Greatly improved breakage on the mineral boundaries → improved mineral liberation
- Compressive force is controllable

Quelle: Loesche
Loesche Grinding Technology „More than just a mill“

- Feeding system
- Air sealing
- Grit cone
- Mill table
- Mill gearbox
- Electric motor
- Product-/ air stream to dedusting system
- Classifier
- Commination zone between rollers and mill table
- Gas inlets
Loesche Grinding Technology

Online Controls

- Rotor rpm
- Grinding pressure
- Grinding table rpm
- Air temperature
- Differential pressure
- Volume Flow
Primary and secondary crushing
LOESCHE Grinding Technology, Airflow-Mode

ROM

Primary and secondary crushing

fresh air
loaded air
ore
Video
LOESCHE Grinding Technology
Ore Industry
Test work with 5 – 50 tones:

- Porphyry Copper ores
- Copper shale
- Copper slags
- Hematite and Magnetite Iron ores
- Hematite Iron ore concentrate
- Chromite ores
- Gold ore
- Platinum
- ...
LOESCHE Grinding Technology
Particle Size Distribution Loesche Mill vs. Ball Mill

UG2 Platinum Ore

- No oversize material
- Steeper particle size distribution
- Less fines
Test program with a sulfide Zinc Ore together with Anglo Research
LOESCHE Grinding Technology
Pilot Plant Work Zinc Ore / Test Results Airflow-Mode

![Graph showing kWh/t for Mill Power, Fan Power, and Total Power over a range of airflow modes.](image-url)
## Product size

<table>
<thead>
<tr>
<th>Product size</th>
<th>Circuit 1</th>
<th>Circuit 2</th>
<th>Circuit 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P80=65µm</td>
<td>AG/SAG Mill kWh/t</td>
<td>Ball Mill kWh/t</td>
<td>Cone Crusher kWh/t</td>
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<tr>
<td></td>
<td>11.26</td>
<td>x</td>
<td>x</td>
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<tr>
<td></td>
<td>Ball Mill kWh/t</td>
<td>8.85</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>11.17</td>
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<td>x</td>
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<td>x</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>1.14</td>
<td>0.57</td>
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<tr>
<td></td>
<td>x</td>
<td>2.56</td>
<td>2.56</td>
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<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>1.25</td>
<td>6.92</td>
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<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>5.69</td>
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<td>21.36</td>
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<td>14.22</td>
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</table>

* assumed value for classifying circuits

P80 = 65µm
The test work with the Chilean copper ore showed benefits in energy consumption grinding to P80=212µm and clear increase in the flotation recovery of:

- + 1.3% for Copper
- + 6.5% for Molybdenum

<table>
<thead>
<tr>
<th></th>
<th>Alimentación</th>
<th>Cobre</th>
<th>Molibdeno</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Cut</td>
<td>% Mo</td>
<td>% Cut</td>
</tr>
<tr>
<td></td>
<td>12 min.</td>
<td>12 min.</td>
<td>Rmax</td>
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<tr>
<td>Testigo en Chile</td>
<td>0.53</td>
<td>0.02</td>
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<tr>
<td>Mineral regreso Alemania</td>
<td>0.51</td>
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<tr>
<td>Muestra 7097-7</td>
<td>0.51</td>
<td>0.02</td>
<td>3.29</td>
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<tr>
<td>Muestra 7097-8</td>
<td>0.51</td>
<td>0.02</td>
<td>3.29</td>
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</tbody>
</table>
The test work with the Salvador copper ore showed benefits in energy consumption when grinding to P80=212µm and an increase in the flotation recovery of:

+ 1,3% for Copper
+ 6,5% for Molybdenum
LOESCHE Grinding Technology
Influence on process chain

- Primary Crusher
- SAG Mill (2)
- Ball Mills (2)
- Cyclone Feeding Pumps

- Loesche VRM

- Primary Flotation Cells (4 Lines)
- Cyclones First Stage
- Cyclones Second Stage
- Thickener (4)
- To Tailings

- Concentrate Thickeners
- Dam
- Evaporation Nursery
- Concentrate Storage
- Concentrate Storage Shed

- Pebble Crusher
- Feed Bin
## LOESCHE Grinding Technology
### Influence on process chain

<table>
<thead>
<tr>
<th>Mining + Primary Crusher</th>
<th>Crushing + Grinding</th>
<th>Flotation</th>
<th>Dewatering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substitution of tertiary and/or secondary crushing</strong></td>
<td><img src="https://via.placeholder.com/150" alt="Dry gringing" /></td>
<td><img src="https://via.placeholder.com/150" alt="Improved flotation kinetics" /></td>
<td><img src="https://via.placeholder.com/150" alt="Higher recycling rate of process water" /></td>
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<td><img src="https://via.placeholder.com/150" alt="Increased mineral liberation" /></td>
<td><img src="https://via.placeholder.com/150" alt="Reduced reagent consumption" /></td>
<td><img src="https://via.placeholder.com/150" alt="Increased recovery (1 – 8%)" /></td>
<td><img src="https://via.placeholder.com/150" alt="Less problems with reagent recycling" /></td>
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<tr>
<td><img src="https://via.placeholder.com/150" alt="Increased mineral liberation" /></td>
<td><img src="https://via.placeholder.com/150" alt="Reduced reagent consumption" /></td>
<td><img src="https://via.placeholder.com/150" alt="Higher concentrate grade" /></td>
<td><img src="https://via.placeholder.com/150" alt="Increased mineral liberation" /></td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Steep product PSD" /></td>
<td><img src="https://via.placeholder.com/150" alt="Increased recovery (1 – 8%)" /></td>
<td><img src="https://via.placeholder.com/150" alt="Higher concentrate grade" /></td>
<td><img src="https://via.placeholder.com/150" alt="Increased mineral liberation" /></td>
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<td><img src="https://via.placeholder.com/150" alt="Increased mineral liberation" /></td>
</tr>
</tbody>
</table>

- **Dry gringing**
- **Reduced**
  - Process steps
  - Energy consumption
  - Specific wear ➔ less metal impurities
  - Ultra fines
  - Steep product PSD
- **Increased mineral liberation**
- **Increased recovery (1 – 8%)**
- **Higher concentrate grade**
- **Higher recycling rate of process water**
- **Less problems with reagent recycling**
LOESCHE Industrial Grinding Plants for Porphyry Copper Molybdenum Ore grinding to P80=212µm

100,000 t/day Copper grinding plant

Plant footprint 70 x 87 m
Recent Industrial Installations
Loesche Mills in the Copper Process Chain for Copper Matte grinding
Loesche Mills in the Copper Process Chain for Copper Matte grinding
Loesche Mills in the Copper Process Chain
Standard for Copper Matte grinding

1996: Kennecott Copper Smelter
1 x LM 31.2

2009: Yanggu Copper Smelter
1 x LM 31.3

2010: Tongling Copper Smelter
1 x LM 31.3

2011: Guangxi Copper Smelter
1 x LM 31.3
Loesche Mills for Tin Slag Grinding

LM 15.2 for grinding tin slag

- The ground slag is blended with Portland cement to slag cement
- The slag cement is used for backfilling in the mine

→ Transfer of a waste product into a valuable product
Recent Developments
LOESCHE concept for stainless steel slag processing

Target

- Metal Recovery
- Make Use of Dry Filler
- Save Water
- Avoid Landfilling
LOESCHE concept for stainless steel slag processing
Operating Principle

- **STAINLESS STEEL SLAG**
  0 – 20 mm,
  METAL CONTENT 3 – 30%

- **PRE-CONCENTRATE**
  20 – 70% PURITY

- **MIDDINGS**
  ABOUT 20% CIRCULATING LOAD

- **METAL RECOVERY + 95%**

- **DRY FILLER PRODUCT**
  3500 – 5000 BLAINE,
  METAL CONTENT - 0,2%

- **METAL PRODUCT**
  + 90% PURITY,
  + 95% RECOVERY
LOESCHE concept for stainless steel slag processing
Operating Principle

Pre Grinding and Metal Pre Separation

Dry Grinding and Filler Production

Metal Recovery
LOESCHE concept for stainless steel slag processing

Outlook

1st DRY PROCESSING PLANT INCLUDING CARBONISATION TO BE COMMISSIONED IN 2014
Ore Grinding Plant mobile
OGPmobile
LOESCHE OGP_{mobile} for the Proof of Concept

- Fully equipped grinding plant
- Throughput of 0.5 – 3.0 t/h
- Product particle sizes of P80 = 20 – 1000\(\mu m\)
- Continues production
LOESCHE OGP\textsuperscript{mobile} Projects

- Spain: Test runs
- Turkey: Gold ore
- Turkey Ankara: Gold ore; 2 X Copper Ore
- South Africa: Platin-, Copper-, Iron Ore, Rare Earth,
LOESCHE OGP\textsubscript{mobile} for the Proof of Concept
LOESCHE OGP_{mobile} for the Proof of Concept
LOESCHE OGP mobile for the Proof of Concept
Summary
Advantages of the Loesche Vertical Roller Mill:

Savings of:

- energy consumption
- wear rate
- water consumption
- plant foot print

Increase of:

- mineral recovery

→ higher profit
Advantages of the Loesche Vertical Roller Mill

- Increased mineral recovery
- Reduced energy consumption
- Reduced wear rate
- Reduced water consumption
- Reduced plant footprint

Thank you for your attention!!!