A COMPARISON OF TWO CIRCUIT APPLICATIONS FOR IMPLEMENTATION OF COARSE PARTICLE FLOTATION

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Summary of presentation

• Challenges for the future of mining
• How can Coarse Particle Flotation address these?
• How does Coarse Particle Flotation Work?
• Two configurations for the HydroFloat in a mineral processing flowsheet
• A quantitative case study to compare each configuration
• Summary
Challenges for the future of mining

• Head grades are decreasing leading to increases in tailing streams (waste gangue and water) & increases in grinding energy

• Estimated 3,500 active tailing storage facilities worldwide*

• Estimated annual increase of 2.9 Billion tonnes for copper miners and 1.6 Billion tonnes for iron ore miners**

• Three well publicized dam breaches since 2014. Multiple fatalities, headline “Brumadinho shocks investors”

• Institutional investors demanding that mining companies disclose details of their tailing storage facilities

* ICMM estimate, 2020 / ** Metso estimate / *** ICMM
How does overgrinding contribute?

• Conventional grinding produces tailings that are generally fine, this means that

1. De-watering is expensive and challenging, drainage is hindered
2. Significant quantities of water are entrained in tailing out-flows
3. Material properties of fine deposited tailings are more sensitive to external conditions in the environment (rain, load, shear stresses) and can become unstable rapidly
4. Fine particles can be more chemically reactive than coarse particles. More potential interaction with the environment

Question: why do we have to grind so fine?
Limitations of conventional flotation

![Graph showing recovery of copper in size fraction vs. particle size.](image)

- **Target grind size**

  - Chuquicamata
  - El Salvador
  - Disputada
Conventional configuration
Coarse particle flotation: Eriez’ HydroFloat
# Mechanical flotation vs HydroFloat

<table>
<thead>
<tr>
<th>Mechanical Cell (all types)</th>
<th>HydroFloat™</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mechanical agitator</td>
<td>• No mechanical stirring</td>
</tr>
<tr>
<td>• High shear stirring</td>
<td>• Low shear fluidized bed</td>
</tr>
<tr>
<td></td>
<td>• Increased buoyancy of coarse particle bubble aggregates</td>
</tr>
<tr>
<td>• Mixing is by forced convection, resulting in turbulence and short-circuiting, CSTR performance</td>
<td>• The contacting of feed and bubbles is counter-current and essentially plug flow.</td>
</tr>
<tr>
<td>• Bubble-particle contacting is random and particle density is low</td>
<td>• High particle density within the fluidized bed creates better flotation kinetics (law of mass action).</td>
</tr>
<tr>
<td>• Operates with a deep froth</td>
<td>• Froth separation at the top of the freeboard is achieved with a “zero-order” froth depth</td>
</tr>
</tbody>
</table>
1. Tail Scavenging application

- Fresh Mill Feed
- Ball Mill
- Cyclone Underflow
- Circulating Load
- TO Conventional Flotation
- Conventional Flotation
- Fine Tail
- HF Conc To Regrind
- Coarse Barren Tail
- Eriez HydroFloat®

Flow Diagram: 
- Fresh Mill Feed to Ball Mill
- Cyclone Underflow to Conventional Flotation
- Conventional Flotation to Fine Tail
- HF Conc to Regrind
- Coarse Barren Tail

- Eriez HydroFloat®

Diagram Illustration: 
- Flowchart showing the process of tail scavenging with key steps including ball mill, cyclone underflow, and conventional flotation.
Metal contained in conventional tailings

Tails of Producer A

Tails of Producer B
Commercial configurations

Cadia

USA
2. Coarse Gangue Rejection application
Evaluation of TS and CGR applications

- Case-study using the Cozamin concentrator in Mexico
- 3,000 tpd polymetallic sulfide mine
- HydroFloat lab test of samples from final tail and mill cyclone underflow
- JKSimMet to simulate CGR circuit
- Modeled impact on grinding, conventional flotation, coarse tail/ water savings
Samples from plant for HydroFloat test-work = ★
Lab test procedure
For TS

Overall Recoveries
Cu 86.4%
Ag 88.3
Pb 63.9%
Zn 77.4%
Mass pull 9.4%

For CGR

Cu 95.0-95.3%
Ag 87.0-90.0%
Pb 80.9-84.7%
Zn 85.0-86.8%
Mass pull 30.9%
Tail Scavenging results

- Increase in overall recoveries

<table>
<thead>
<tr>
<th>Recoveries</th>
<th>Cu [%]</th>
<th>Zn [%]</th>
<th>Pb [%]</th>
<th>Ag [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-case</td>
<td>95</td>
<td>70</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Increase with TS</td>
<td>+2</td>
<td>+11</td>
<td>+16</td>
<td>+9</td>
</tr>
</tbody>
</table>

- Effect on power, tailings and water consumption about the same
- recovery and potential to increase mill throughput.
Modelled Coarse Gangue Rejection Application
## Modelled benefits of CGR

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Increase in plant recovery [%]</th>
<th>Reduction in ball mill power [%]</th>
<th>Reduction in float capacity [%]</th>
<th>Reduction in fine tail/water [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-case</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Base-case with TS</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>?</td>
</tr>
<tr>
<td>CGR</td>
<td>?</td>
<td>&gt;30-50%</td>
<td>&gt;40%</td>
<td>&gt;30%</td>
</tr>
</tbody>
</table>
Conclusions

- Flotation at coarser particle sizes is now a commercial reality with Eriez’ HydroFloat
- This new unit operation is a key enabling technology to improve mineral recovery, energy & water consumption in mining
- In tail scavenging mode, additional concentrate is generated while processing the same amount of ore
- In coarse gangue rejection mode, the size distribution of tailings can be radically increased, making dewatering less expensive and reducing grinding energy and conventional flotation capacity