Addressing decreasing water availability for the mining industry using cost-benefit analysis

World Water Congress 2017

Douglas Aitken, Alex Godoy-Faúnde, Marcelo Vergara, Fernando Concha and Neil McIntyre
Introduction – Mining and water scarcity

Figure 1. Copper mining operations in Chile

Figure 2. Water scarcity indices and allocation
Introduction – The upshot

Negative media coverage of the industry

Water use related issues have strongly affected the industry not just in Chile but around the world.

Spending on water related infrastructure almost doubled from 2011 to 2014 ($7.7bn to $13.6bn) (WWI 2014)

Figure 3. Number of disputes over water resources
Figure 4. Projected levels of water consumption in the mining industry (COCHILCO 2016)
Research question – what’s the most cost-effective way to replace freshwater?

Model developed to consider the use of:
1. Desalinated seawater
2. Raw seawater
3. Seawater precipitated with lime

Each water source with the implementation of water saving strategies:
   a. Tailings thickening + synthetic dust suppression
   b. Tailings filtration + synthetic dust suppression
Scenarios of operational models

Figure 5. Operational models tested
Basic operational model and assumptions

- Ore throughput: 150,000 tpd
- Solids content of tailings: 32%
- Distance to coastline: 160 km
- Elavation: 0-4,000 m
- Life span: 25 years

- Desalination plant: 100,000 m³ (Northern Chile)
- Tailings solids content following thickening: 60%
- Tailings solids content following filtration: 83.5%
- Electricity cost: $0.15/kWh
Water losses for each scenario

<table>
<thead>
<tr>
<th>Process</th>
<th>Base case - S1, S2 &amp; S3 (m³/day)</th>
<th>Scenario 4 (m³/day)</th>
<th>Scenario 5 (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road dust suppression</td>
<td>10,560</td>
<td>1,620</td>
<td>1,620</td>
</tr>
<tr>
<td>Human consumption</td>
<td>174</td>
<td>174</td>
<td>174</td>
</tr>
<tr>
<td>Raw water evaporation</td>
<td>6.6</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Process water tank evaporation</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Primary crusher</td>
<td>1080</td>
<td>1080</td>
<td>1080</td>
</tr>
<tr>
<td>Stockpile</td>
<td>360</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>Flotation cell</td>
<td>20.1</td>
<td>20.1</td>
<td>20.1</td>
</tr>
<tr>
<td>Concentrate thickener</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Final concentrate</td>
<td>267</td>
<td>267</td>
<td>267</td>
</tr>
<tr>
<td>Tailings storage facility</td>
<td>96,076</td>
<td>78,036</td>
<td>29,164</td>
</tr>
<tr>
<td>Tailings thickener</td>
<td>-</td>
<td>52</td>
<td>-</td>
</tr>
<tr>
<td>Total losses</td>
<td>108,558</td>
<td>90,570</td>
<td>32,706</td>
</tr>
</tbody>
</table>
Net present values of scenarios 1, 2 and 3
Net present values for scenarios 1, 4a and 4b
Net present values of scenarios 2, 4b and 5b
Net present values of scenarios 3, 4c and 5c
Comparison of cost-effectiveness between water saving strategies

<table>
<thead>
<tr>
<th></th>
<th>Dust suppressant</th>
<th>Tailings thickening</th>
<th>Tailings filtration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water saved (m³/day)</td>
<td>8,940</td>
<td>235,574</td>
<td>315,208</td>
</tr>
<tr>
<td>NPV ($M)</td>
<td>13.7</td>
<td>459</td>
<td>1,912</td>
</tr>
<tr>
<td>NPV/m³ ($/m³)</td>
<td>0.17</td>
<td>0.21</td>
<td>0.41</td>
</tr>
</tbody>
</table>
Sensitivity analysis of Net Present Values

Low

High

Desalinated seawater

Raw seawater

Lime precipitated seawater
Conclusions

The use of seawater in copper mining is costly but ultimately necessary in many mining areas.

Desalination is expensive – raw seawater or simple treatment is preferred.

Thickening of tailings is the most cost-effective water saving option at low levels of elevation.

Filtration of tailings is the most cost-effective option at elevations greater than 1,600 m.
Further research

Further experimental analysis of lime precipitation and copper recovery rates

Analysis of the impact upon operational profitability of the proposed scenarios

Analysis of the environmental impacts and risks of the proposed scenarios
Acknowledgements

The authors would like to thank the Conicyt/Fondap Project 15130015 Centro de Recursos Hídricos para la Agricultura y la Minería (CHRIAM)

The authors would also like to thank the Sustainable Minerals Institute at the University of Queensland for collaborating on this research.

Daitken@udd.cl