



Use of biosolids and its main component as frothers and collectors for the concentration of copper sulphide ores

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Introduction: Ore concentration in Chile



Chile is a South American country. Its economy is based on natural resources.

The Chilean mining industry is the main driving force of economic growth

For example:

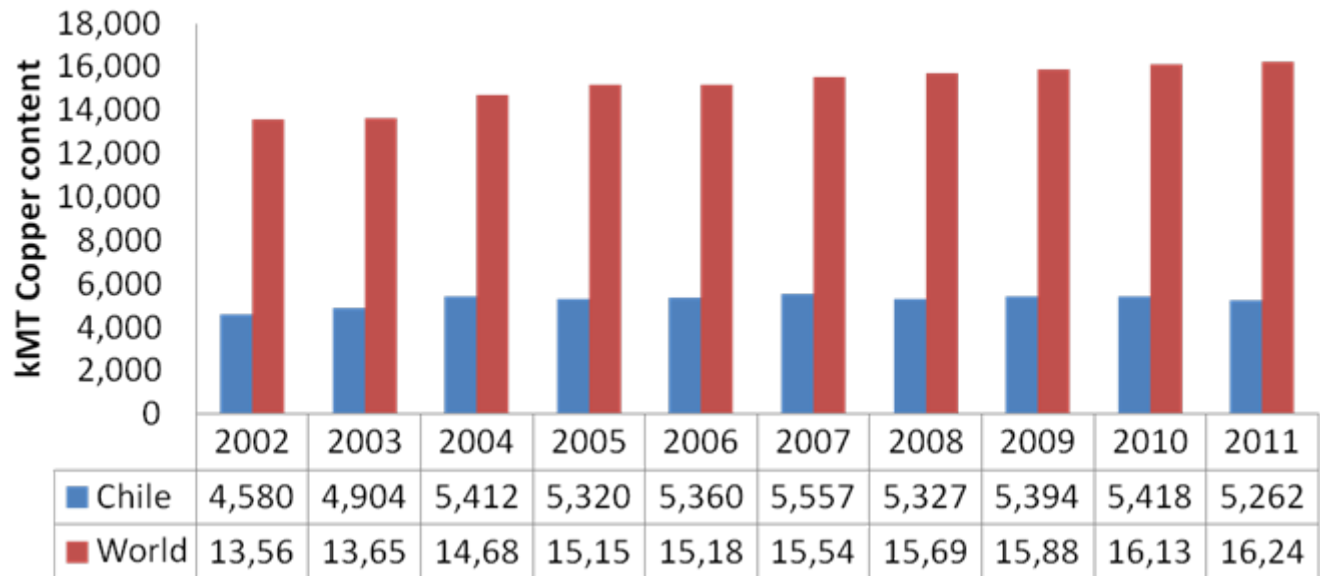
$$GDI_{2012} = \text{US\$ } 18.419$$

$$GDI_{2012 \text{ w/o copper}} = \text{US\$ } 10.130$$

Introduction: Ore concentration in Chile



Global Copper mine production



Yearbook Cochilco, 2011.

Chile produces a third of global copper.

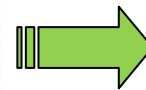
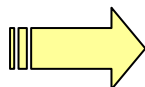
Nevertheless, relationships between mining industry and society have been historically complex due to its continuous environmental impacts.

Introduction: Ore concentration in Chile

The reagents used in froth flotation are characterized as expensive and hazardous materials due to its high environmental risks with strong potential health effects.



Ore milled +
Chemical
reagents +
water +
energy



Concentrates



**Tailings +
CO₂ + dust**

Mining industry needs to move ahead to try to find new environmentally-friendly reagents for froth flotation.

Introduction: Wastewater treatment plants



Activated sludge, main technology used in Chile.
 This technology produces huge volumes of organic wastes such as sewage sludge or biosolids.

Biosolids´ production (adapted from LeBlanc, et al. 2008)

| Country | Biosolids´ production (dry metric tons) | Population |
|---------|-----------------------------------------|---------------|
| Brazil | 372 | 188,078,000 |
| Canada | 550 | 33,100,000 |
| Chile* | 160,000 | 7,000,000 |
| China | 2,966,000 | 1,313,974,000 |
| Germany | 2,000,000 | 82,422,000 |
| Italy | 1,000,000 | 58,134,000 |
| Japan | 2,000,000 | 127,464,000 |
| USA | 6,514,000 | 298,444,000 |

* Annual rate for Santiago, Chile.

Introduction: Main component of biosolids used in the mining processes

Investigating the efficacy of biosolids and its main component as collector and frother agents for concentration of copper sulphide ores by froth flotation.

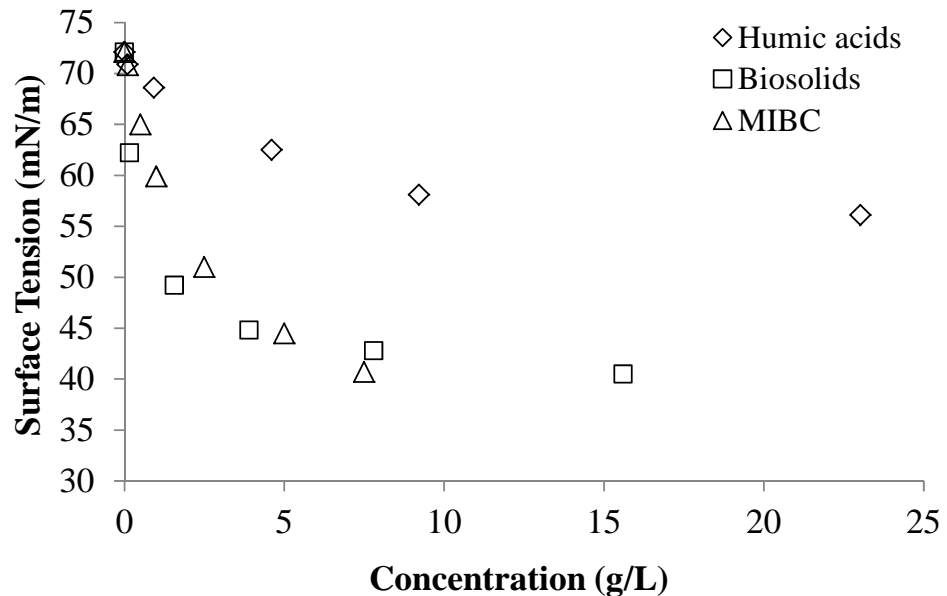


Sustainable mining practices (Laurence, 2011)

Use of wastes as frother agents



- Surface tension measurements
 - room temperature
 - Different solution concentrations
 - pH 7 and 10



- Bikerman test were performed to verify capacity for generation and stability foam.
 - Significant amounts of foam were found at different concentrations of MIBC, BS, and CHA.
 - CHA and BS showed a tensioactive activity at different stabilities.

Use of wastes as collector agents

- Film Flotation technique: room temperature; different solution concentrations.

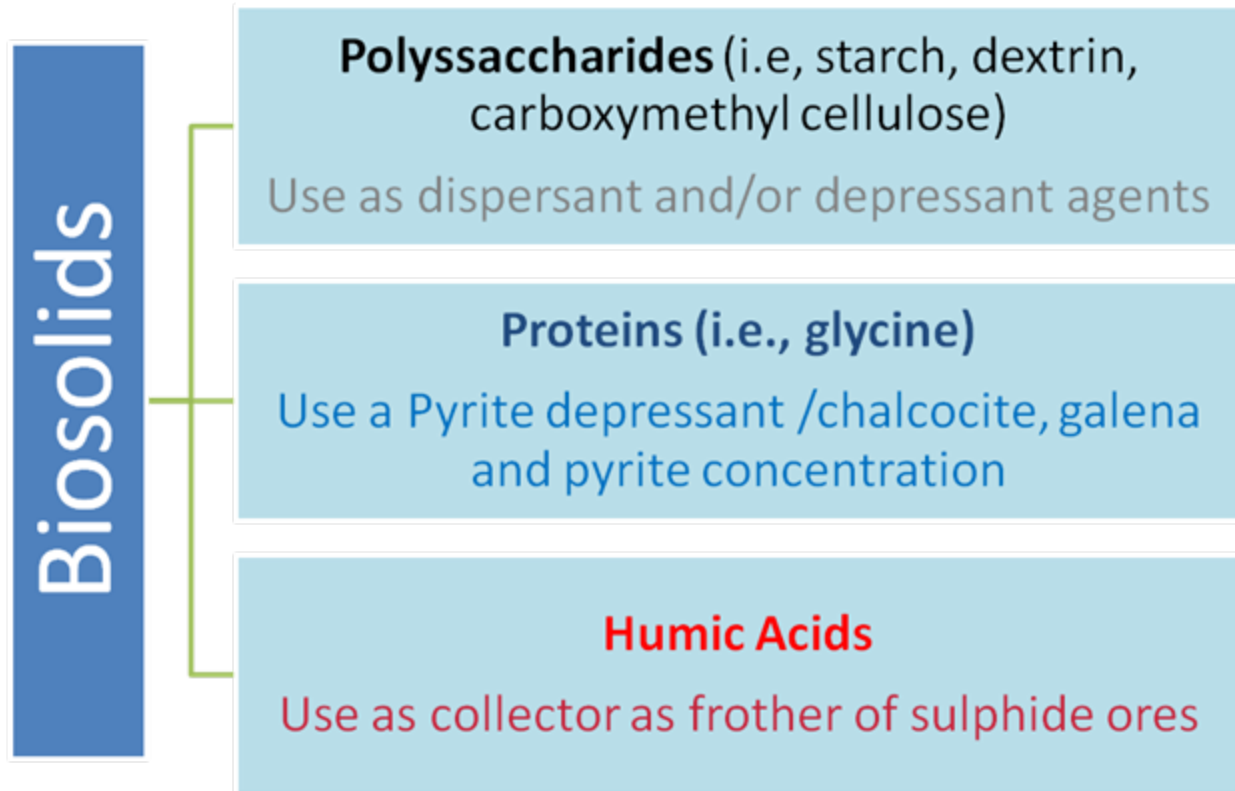


| | without reagents | humic acid | biosolids | chemical reagents |
|----------------------------|------------------|------------|-----------|-------------------|
| Copper sulphide ore | | | | |
| Chalcopyrite | | | | |
| Pyrite | | | | |

Film flotation results for 100% water experimental condition

The natural floatability of copper sulphide ore and mineralogical species such as chalcopyrite and pyrite are low.

Use of main component of biosolids as froth flotation reagents



- These types of reagents are natural and non-toxic agents representing an environmentally friendly alternative to use inside mineral concentration processes.

Current Assays

Rougher flotation test carried out at lab scale:

- pH 9.5
- Main collector 38 g/t
- Xanthate 10 g/t
- Frother 12 g/t



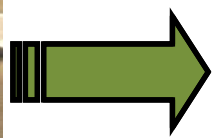
Chemical Reagents



Humic Acids



Copper Sulphide ore

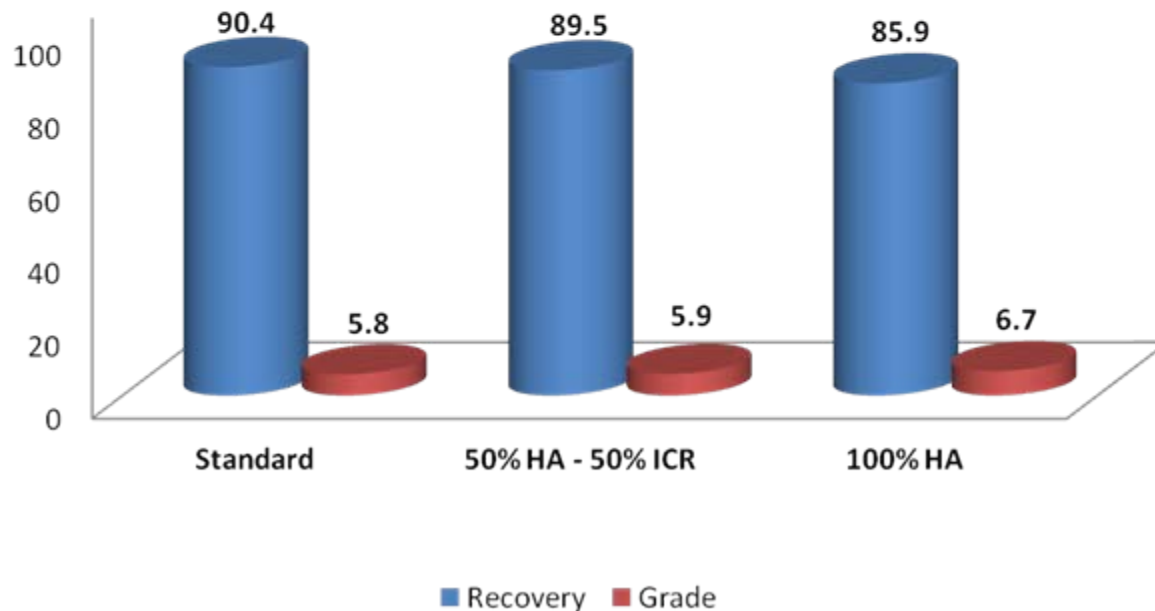


Concentrate

Tail

Replacement rate: 50% and 100% of main collector.

Current Assays: Main results



The copper recovery and grade obtained with humic acids were 85,9% Cu and 6,7% Cu, respectively. Similar results were obtained with industrial froth flotation agents.



Final Remarks

Wastes as frother

Biosolids and humic acid solutions are able to change surface tension of aqueous solutions, significantly. Biosolids dosages around 4 g/L showed a similar behaviour to MIBC.

Wastes as collector

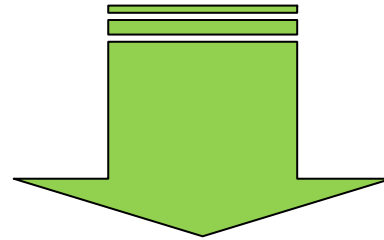
Film flotation results shown that biosolids and its humic fraction can adsorb on the surfaces of the sulphide ores, and improve their hydrophobicity.

Therefore, the main component of biosolids open an opportunity to be used in copper sulphide flotation plants replacing conventional collectors and frothers.



Final Remarks

The feasible end-use of organic wastes (i.e., biosolid and humic acids) could be a new environmentally-friendly organic agent inside the mining industry.



improving environmental
sustainability by replacement of
chemical reagents





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Thank you for your attention

Questions?

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