Circular Economy in Copper Smelting and Refining

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Circular Economy in the Mining Sector
Discussing Opportunities Available for Mining Companies

Eco Mining Concept
Agenda

I Context:
Some Numbers in copper.
Copper movements
Circular metals Cu/Pb/Zn

II EcoMetales Actual picture and Future
Value Recovery from waste (liquids/solids).
Flue dust treatment and Scorodite Process
Projects

III Opportunities
Water
Tires
Tailings

EcoMetales: Environmental solutions for the mining industry
Context

Cu⁰
Global Copper production in 2018 from mineral sources (kMT Copper Content and % of the World)

- **Oxide ore HYDROMETALLURGY**
  - Agglomeration
  - Leaching
  - Solvent Extraction
  - Electro-winning

- **Sulphide ore PYROMETALLURGY**
  - Crushing
  - Milling
  - Froth Flotation
  - Thickening
  - Smelter

**World Copper Production from Minerals by 2018 (kMT of Cu content)**

- Pure copper cathode, 99.99% Cu

**Percentage Distribution:**
- Oxide ore: 15% (3.055 kMT)
- Sulphide ore: 85% (17.797 kMT)

**Total Production:** 20.852 kMT

Source: COCHILCO / Chilean Copper Commission, based on company reports

EcoMetales: Environmental solutions for the mining industry
**Chilean Copper Production 1992-2018 and projection 2019-2023**

(kMT Copper Content)

**Production of Copper in Chile by 2018**

<table>
<thead>
<tr>
<th>Route (kMT)</th>
<th>2018</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total from Mine</td>
<td>5.832</td>
<td>6.309</td>
</tr>
<tr>
<td>Hydrometallurgy</td>
<td>1.575</td>
<td>1.130</td>
</tr>
<tr>
<td>Pyrometallurgy</td>
<td>1.246</td>
<td>1.246</td>
</tr>
<tr>
<td>Concentrate</td>
<td>3.010</td>
<td>3.933</td>
</tr>
</tbody>
</table>

*Source: COCHILCO*

**EcoMetales:** Environmental solutions for the mining industry
Copper concentrate market

**PRODUCERS**
- 2007: 16 Mt
  - 44% South America (Chile & Perú)
  - 56% Others
- 2012: 20 Mt
  - 44% South America (Chile & Perú)
  - 56% Others
- 2017: 30 Mt
  - 44% South America (Chile & Perú)
  - 56% Others

**IMPORTS**
- 2007: 16 Mt
  - 48% China
  - 26% Japan
  - 26% Others
- 2012: 20 Mt
  - 48% China
  - 26% Japan
  - 26% Others
- 2017: 30 Mt
  - 48% China
  - 26% Japan
  - 26% Others

Source: ICSG

Promoting EV: https://twitter.com/ThinkCopperEU/status/1272786097177866246

**EcoMetales:** Environmental solutions for the mining industry
Base & Minor Metals recovered from Primary and Secondary Resources in Non-Ferrous Industry

More than 20 metals can be recovered except RE, W, Mo, V, Mn, Cr, Nb, Ta and Li

Source: Voisin L. et al. Todaiforum 2018

EcoMetales: Environmental solutions for the mining industry
EcoMetales
Actual picture and Future
Our mission

ECL is a 100% subsidiary of CODELCO, established to implement environmental solutions and metal recovery processes in the mining industry.

Since 2007, EcoMetales has processed about 559,000 tonnes of flue dust and 1,142,000 m³ of acid effluent, recovering about 112,000 tonnes of copper.

More than 20,000 tonnes of arsenic have been disposed as scorodite since 2013.

EcoMetales: Environmental solutions for the mining industry
Flue dust leaching technology

Since 2007, EcoMetales has processed about 559,000 tonnes of flue dust and 1,142,000 m³ of acid effluent, recovering about 112,000 tonnes of copper.

EcoMetales: Environmental solutions for the mining industry
Arsenic and antimony abatement technology

EcoMetales: Environmental solutions for the mining industry
Actual Projects

**Waste Valorization**
Recovery of Ge & Ag at pilot scale.
Patent pending.

**PLCC Plant**
Pressure Leaching of Copper Concentrates
- Leaching of dirtiest Copper Concentrates, at high temperature and high pressure.
- Leverage with existing facilities SX/EW.
- Feasibility study completed
- Continuation decision in hands of CODELCO

**Tailings valorization**
- Project co-financed with CORFO.
- Focus in recover valuable elements from Tailings.
- Process OK
- End 2020 bench scale test will be finished.

**DET Plant**
Improvement of arsenical waste handling at DET
- Reduce the arsenic waste produced and develop a new hazardous waste landfill inside the industrial area.
- Feasibility study completed.
- Environmental permits approved, under review by ministry committee

**Ferric commercialization**
Ferric solution produced from magnetite
- Pre-feasibility studies concluded.
- First industrial application of the product already conducted

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**EcoMetales:** Environmental solutions for the mining industry
Opportunities
Short to medium term opportunities

- Water / ZLD
- Tailings
- Tires

EcoMetales: Environmental solutions for the mining industry
CORFO + JRI + EcoMetales: Recovering value from tailings
To a circular mining

EcoMetales: Environmental solutions for the mining industry

www.relavesconvalor.cl
H ow to recover value from tailings

I. Characterization
What do they contain and how is the minerals matrix presented?

RESULT: To know the matrix of the tailings and interpret it.

II. Processes identification

RESULT:
Design of a prototype of processes to recover value from tailings.

III. Prototype validation
To date, its have recovered species such as:

RESULT:
Validated prototype at bank level, scalable in semi industrial equipment.
PRODUCTOS DE REE OBTENIDOS

SX de REE

Precipitación de Oxalatos de REE

Oxalatos de REE Deshidratados

Calcínas de REE (La, Ce y Nd)

ECOMETALES: Soluciones Ambientales para la Minería