Solvent Extraction Applied to Mixed Copper and Zinc Bearing Materials

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Abstract

Refined copper produced by means of solvent extraction (SX) accounts for over 20% world production and that technique has become more popular recently as new hydrometallurgical projects dealing with primary copper ores and concentrates are under evaluation or have been implemented in last years in Chile, USA, etc.

The low capital and operating costs of SX plants together with the easy operation and the production of top quality electrolytic metals close to the mine site make the economics of the SX processes very attractive, being suitable and feasible in the range of small to medium capacities, where conventional smelting process is not applicable. In some cases, the alternative of obtaining extremely pure salts may be cheaper than metals production.

Thanks to the commercial success of the Skorpion Zinc integrated refinery in Namibia, producing 150,000 t/y SHG Zn since 2003, a significant expansion of new zinc projects focused on primary and secondary materials is currently underway based on the application of ZINCEX™ solvent extraction technology.

Copper SX and zinc SX are mature and well established commercial technologies, therefore, now is the right time to afford new mining and metallurgical projects dealing with mixed or polymetallic copper and zinc ores and secondary materials. That way, this paper presents relevant design features and technical advances of two industrial projects based on SX applications: (1) Heap leaching of oxidised copper/zinc polymetallic ores to recover both metals in form of the maximum purity cathodes; and (2) Processing of flue dusts and electrofilter solid particles from copper smelters to recycle copper and zinc and rejecting some impurities like arsenic. The preliminary evaluation results have been very positive in both projects, showing clearly the technical advantages and the potential profitability to recover those metals by means of SX techniques.

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1
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http://www.cu2010.gdmb.de/proceedings.epl

The following presentation for commercial use describes the content of this paper.
Copper

Solvent Extraction Applied to Mixed Copper and Zinc Bearing Materials

TECNICAS REUNIDAS
Proprietary Technology Development Division
COMPANY PROFILE - CORE BUSINESS

TECNICAS REUNIDAS:

- Biggest Spanish Engineering & Construction Company
- 6000 Employees
- Listed on the Selective Stock Market IBEX35
- Upstream, Downstream, Natural Gas, Power, Infrastructures, Proprietary Technologies

PROPRIETARY TECHNOLOGY DEVELOPMENT DIVISION:

- Over 40 years developing Technologies for:
  - Non ferrous metals Industry
  - Electrochemistry
  - Energy
  - Nitric Acid, Ammonium Nitrate
  - Fertilizers
  - Environment
PRESENTATION OUTLINE

1. Solvent Extraction. Reasons for Success
2. SX Applied to Copper/Zinc Materials. Pros & Cons
   - Oxide Cu/Zn Ore Heap Leaching
   - Cu/Zn Dust Recycling
3. Cases Studied
4. Laboratory Tests
5. Conclusions & Final Remarks
SOLVENT EXTRACTION

Reasons for Success

- Innovative Technologies Industrially Proven
- Economical Advantages:
  - Low Opex
  - Similar or lower Capex
- Environmental Advantages
- Vertical Integration at Mine Site

World Copper SX-EW production (icsg)
Skorpion Zinc SX plant 150,000tpa SHG zinc at lowest OPEX
SOLVENT EXTRACTION FOR Cu/Zn MATERIALS

Pros & Cons:

- Higher Feasibility Potential
- Complex Materials
- Difficult Metal Separation
- Whole Leaching
- High Efficiency
- High Impurity Content
- SX is as selective as flower picking
- SX Process
- Optimum Results
CASES STUDIED

1. Oxide Copper/Zinc Ore Heap Leaching

2. Copper/Zinc Dusts Recycling

...Study of industrial application of mature SX Technologies
Introduction & Goals:

The study has been accomplished with average composition:

<table>
<thead>
<tr>
<th>Components</th>
<th>Cu</th>
<th>Zn</th>
<th>Fe</th>
<th>Ca</th>
<th>Mg</th>
<th>Al</th>
<th>SiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content (%)</td>
<td>0.4</td>
<td>1.6</td>
<td>15</td>
<td>21</td>
<td>0.5</td>
<td>2.5</td>
<td>50</td>
</tr>
</tbody>
</table>

Goal: Find Optimal process configuration
OXIDE COPPER/ZINC ORE

Potential Configurations:

CASE I

Crushing and milling → Heap Leaching → Iron removal → Zn SX-EW → Cu SX-EW

CASE II

Crushing and milling → Heap Leaching → Iron removal → Zn SX-EW → Cu SX-EW

CASE III

Crushing and milling → Heap Leaching → Cu SX-EW → Iron removal → Zn SX-EW
OXIDE COPPER/ZINC ORE

Developed documents:

1) Conceptual but Complete Block Diagram
2) Gross mass balance
3) Determined Parameters:
   • Consumables
   • Energy
   • Wastes & Effluents

The developed documents were used for comparison purposes
OXIDE COPPER/ZINC ORE

Resulting Best Method: CASE III

Crushing and milling → Heap Leaching → Cu SX → Cu EW → Copper

Cu/Zn Ore → Iron removal (S) → Iron residue

Why?
- Highest efficiency
- Lowest Consumption
- Less Copper losses
- No need of acidic conditions that affect to selectivity
- Smooth and more simple
- Higher flexibility

Zn SX → Zn EW → Zinc
COPPER/ZINC DUSTS RECYCLING

Introduction & Goals:

The study has been accomplished with average composition:

<table>
<thead>
<tr>
<th>Components</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>As</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content (%)</td>
<td>15</td>
<td>9</td>
<td>3</td>
<td>13</td>
</tr>
</tbody>
</table>

Goal: Find Optimal process configuration to:

- Efficient integration of Zinc-SX in existing Copper-SX plant
- Recycle Copper/Zinc dusts
- Find synergies for maximum Economical Feasibility
- Environmental friendly results
Cu/Zn Dusts Production:

- Smelter Furnaces,
- Slag Treatment Furnaces and Converters,
- Brass and Bronze workshops
- Difuse Emissions
The following configuration is proposed:

- Conditioning and blending
- Leaching
- Fe & As removal
- Recycled to smelter
- Ferric Arsenate to disposal
- Copper Smelter Dusts
- Zn SX
- Zn EW / Cristallisation
- Cu SX
- Cu EW
- Zinc/Zinc Sulphate
- Copper
LABORATORY TESTS

Very satisfactory results:

A proper design of the ZINCEX™ Technology can separate perfectly Copper and Zinc in the PLS.

- Composition Cu/Zn PLS

<table>
<thead>
<tr>
<th>Components</th>
<th>Cu</th>
<th>Zn</th>
<th>Fe</th>
<th>PH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content (%)</td>
<td>19 g/l</td>
<td>6 g/l</td>
<td>6 ppm</td>
<td>3.3</td>
</tr>
</tbody>
</table>

- Final SX test results: Only ppb of Copper in Zinc Electrolyte

<table>
<thead>
<tr>
<th>Washing of the Organic Phase</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Phase</td>
<td>Cu (g/l)</td>
<td>0.2</td>
</tr>
<tr>
<td>Aqueous Phase</td>
<td>Cu (g/l)</td>
<td>0</td>
</tr>
</tbody>
</table>
CONCLUSIONS

- **Available:**
  Cu-SX & Zn-SX are mature and well established commercial technologies

- **Flexible:**
  Solution for new mining and smelting projects dealing with mixed or polymetallic copper and zinc materials

- **Attractive:**
  Low CAPEX and OPEX; Production of top quality electrolytic metals close to the mine site

- **Suitable:**
  Feasible in the range of small to medium capacities where conventional smelting process is not applicable
CONCLUSIONS

- **Alternative:**
  Possibility to obtain extremely pure salts which can be more profitable

- **Efficient:**
  Deal with pregnant solutions containing copper and zinc (and other impurities) is based on the fine performance of the ZINCEX™ technology

- **Assurance:**
  Perfect separation and fully selective extraction of zinc versus copper even in solutions containing 3 more times copper than zinc
FINAL REMARKS

- Tecnicas Reunidas is amenable to study the feasibility of new projects based on this proprietary Technological approach.

- A complete Hydrometallurgical Technology Centre is available for demonstration purposes and tailored experimental studies on suggested customer samples.
THANK YOU FOR YOUR ATTENTION