Expanding Sulphide Use for Metal Recovery from Mine Water

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Introduction: Sulphide Precipitation - Current Practise

- Effective metal removal
- High reagent and handling costs
- Limited current use:
  - Difficult metals (e.g. Cd removal)
  - High value (e.g. Ni recovery)
  - Specialised hydromet use (e.g. Ni-Co separation)
- Increasing operating experience
  - Separation of metals
  - Solid-liquid separation

Kemetco Research - Biometals Process

- Developing a new approach to biogenic sulphide generation
  - Low cost reagents
  - Operating efficiencies
  - Product/by-product value
  - Stage 2 laboratory development underway
  - Patenting in process
- Objective: Very low net-cost reagent sulphide
  - Expanding scope of feasible applications
- Testing for old and new applications
  - Individual metal recovery from ARD
  - Sequential recovery from complex drainage
  - New hydrometallurgical applications
- First site pilots in planning stage

Flowsheet 1 – Laboratory Results

<table>
<thead>
<tr>
<th>Sample Flow</th>
<th>Feed 12,000</th>
<th>pH</th>
<th>Cu</th>
<th>Zn</th>
<th>Co</th>
<th>Ni</th>
<th>Cd</th>
<th>Al</th>
<th>Fe</th>
<th>Mn</th>
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</thead>
<tbody>
<tr>
<td>Flowsheet 1 Feed</td>
<td>4.3</td>
<td>14.3</td>
<td>17.8</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>0.09</td>
<td>13.3</td>
<td>0.4</td>
<td>3.65</td>
<td></td>
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<tr>
<td>Stage pH Reagents</td>
<td>4.3</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
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<tr>
<td>Copper Recovery</td>
<td>-</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Zinc Recovery</td>
<td>4.0</td>
<td>3.7</td>
<td></td>
<td></td>
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<tr>
<td>pH Adjustment</td>
<td>6.2</td>
<td>70.4</td>
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</table>

- Eliminates lime use and minimizes waste sludge generation
  - Biological alkalinity sufficient for pH control
- Metal products off-set other operating costs
  - Cu product up to 56% Cu produced in lab work
  - Product value of $700/day net of process inputs
## Flowsheet 2 – Laboratory Results

<table>
<thead>
<tr>
<th>Sample</th>
<th>Flow (m³/day)</th>
<th>pH</th>
<th>Cu (mg/L)</th>
<th>Zn (mg/L)</th>
<th>Co (mg/L)</th>
<th>Ni (mg/L)</th>
<th>Cd (mg/L)</th>
<th>Al (mg/L)</th>
<th>Fe (mg/L)</th>
<th>Mn (mg/L)</th>
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</thead>
<tbody>
<tr>
<td>Sample B – High Strength</td>
<td>2,500</td>
<td>2.7</td>
<td>67</td>
<td>181</td>
<td>4.65</td>
<td>9.68</td>
<td>1.37</td>
<td>950</td>
<td>872</td>
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<table>
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<tbody>
<tr>
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<td>-</td>
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<td>0</td>
</tr>
<tr>
<td>Copper Recovery</td>
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<td>H₂S</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Al/CaSO₄ Removal</td>
<td>4.9</td>
<td>CaCO₃</td>
<td>100</td>
<td>8</td>
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<td>100</td>
<td>98</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Zinc Recovery</td>
<td>3.2</td>
<td>H₂S</td>
<td>100</td>
<td>97</td>
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<td>0</td>
<td>100</td>
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<td>10</td>
<td>1</td>
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<td>Ni-Co Recovery</td>
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<td>CaCO₃/H₂S</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>98</td>
<td>4</td>
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<tr>
<td>Fe Removal</td>
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<td>CaCO₃</td>
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<td>Final Treatment</td>
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<td>Bio. Alkal.</td>
<td>75</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>98</td>
</tr>
</tbody>
</table>

• Can replace lime with cheaper limestone
  - All metals removed at low pH except Mn (MnCO₃ @ pH 8)
• Reagent savings plus substantial metal product revenue
  - Cu and Zn products to 45% Cu and 60% Zn produced in lab work
  - Net reagent savings and product revenues >$3000/day projected

## Conclusions

Sequential multi-product sulphide precipitation flowsheets are now technically feasible:
- High grade metal products
- Reduced waste sludge volumes
- Improved water treatment
- Potential for reagent cost savings

With very low cost sulphide generated on site, new applications are possible:
- Advanced multi-stage treatment of AMD
- Metal recovery from heap leaching and other hydrometallurgical processes
- Metal extraction and recovery from solid wastes

Initial test results and economic analyses justify further development
- Patenting initiated
- Site pilot projects under development

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