Wise process routes for varying feedstock in base metal extraction

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Aim

• Predict consequences of changing raw material base, primary/secondary, on the metal extraction chain
  – Complex and impurity rich mineralizations
  – Efficient use of secondary raw materials
  – Network

• Suggest tailor-made process routes
  – Hydrometallurgical
  – Pyrometallurgical
  – Combination hydro/pyro
Background

• Lower grade raw materials (primary and secondary)
  – Large reserves of complex Cu-sulphide mineralizations in Northern Sweden, high impurity content, e.g. Sb.
  – Increased treatment of scrap with varying and complex concentration, Sb, Al…
  – Extensive internal recycling may lead to enrichment of elements, Sb is today a limiting element in smelting processes
  – Control of material composition and flows for efficient process operation
  – Predicting element distribution for extraction of value added materials and/or elimination of deleterious elements
Research organisation

- WP 1: Impurity management and valorisation
  - Hydrometallurgical treatment (PhD student)
- WP 2: Impact of impurities on extraction, smelting and refining processes (PhD students)
  - Thermodynamic modelling
  - Impurity distribution in smelting systems
  - Impurity capacity
- WP 3: Evaluation of process options
  - Selection of raw materials
  - Tools for modelling
  - Collection of data
Ore
Mineralization
Beneficiation
Refining/
Further processing
Smelter
Hydrometallurgy
Leaching and electrowinning
Sb (As)

Cu, Zn, Pb, Au, Ag
S, Fe
Sb, As, Bi, Sn...
Al, Cr...

Secondary mtrl.
scrap/residues

Influence of alumina on
slag properties
Prediction of
impurity distribution
Vaporisation of Sb

By-products
Products
Waste
Hydrometallurgical pretreatment of complex concentrate

- Tetrahedrite rich Cu concentrate
  - Leaching
    - Slurry separation
      - Upgraded Cu concentrate for smelting (As & Sb < 0.2%)
    - Antimony electrowinning
      - Sb metal (cathode)
      - Na₂SO₄ (anode)
  - As precipitation by acidification (As₂S₃)
Hydrometallurgical pretreatment of complex concentrate

- Laboratory leaching tests on tetrahedrite-bearing concentrate has been conducted and completed.
- Alkaline sulphide leaching shows a good selectivity for Sb and As.
- Sulphide leaching of tetrahedrite depends strongly on sulphide and hydroxide ions concentrations, reaction temperature, particle size and leaching time.
- Electrowinning of Sb from alkaline sulphide electrolyte in laboratory scale is on-going.
- A complete process for hydrometallurgical pretreatment will be evaluated.
Copper flow
Rönnskär smelter

Sampling campaigns

Fuming plant
Impurity capacity slag (Al)

Enhanced vaporisation of Sb

Copper converter
Modelling - slag formation, element distribution
Thermodynamic model

- Converter model (SimuSage)
  - Verification with process data

- Thermodynamic description; (GTT Aachen)
  - Cu-Fe-S system
  - Slag system
  - Distribution data
  - Minor elements
Influence of alumina on slag properties
Mineralogy, leaching, thermo-chemical and physical properties
Influence of alumina on slag properties

• Mineralogy
  – Formation of alumina-rich spinel phase
  – New phase (anorthite) is formed ~10 alumina (alumina saturation)

• Leaching
  – Initially slight increase in leaching
  – Lowest leaching values at alumina saturation (spinel formation)

• Melting
  – Increased melting temperature (spinel formation)
  – Decreased solidification temperature (undercooling)

• Thermophysical properties
  – On-going tests
Student projects

- Project based learning
- Integrating undergraduate studies with research
- Preparation for master thesis work
- Project’s related to Gruvforskningsprogrammet
  - Leaching of secondary materials
  - Leaching of different types of Sb minerals
  - Distribution of Sb between different melt phases
Concluding remarks

• Close cooperation between Industry and University – strong R&D
• Integrating undergraduate studies – recruitment of engineers
• Focus on Sb (complex concentrates and secondary materials)
  – Different alternatives for treating complex materials with high Sb content (hydro- and pyro-metallurgical)
• A ”good” slag is a key to efficient smelting