Recycling at Boliden’s Rönnskär Smelter: Metallurgical challenges

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Rönnskär’s Metallurgy

Sulfur products

Copper 99.998%

slag

Cu  Fe  S

O2  silica
Rönnskär’s Metallurgy Flowsheet

1. Secondary Raw Materials
   - Dryer
   - Fluidized Bed Roaster
   - Copper Conc.
   - Dryer

2. Copper Conc.
   - Dryer
   - Gas Flow
   - Copper Flow
   - Lead Flow

3. Electric Smelting Furnace
   - Flash Furnace
   - Fuming Plant
   - Zinc Clinker Iron Sand
   - Dryer

4. Lead Conc.
   - Electronic Scrap
   - Kaldo Plant
   - Lead Refinery

5. Gas Flow
   - Copper Flow
   - Lead Flow

6. Precious Metals Plant
   - Electrolytic Refinery
   - Copper
   - Lead
   - Sulphuric Acid
   - Sulphur Dioxide
   - Gold
   - Silver
   - Selenium
   - Pt/Pd-slugde
   - Copper
   - Copper Sulphate
   - Crude Nickel Sulphate

7. Converter Aisle
   - Lead

8. Anode Casting Plant
   - Converter Aisle

9. Sulphur Products Plant
   - Sulphur Products Plant

Recycling illustrated
Metallurgy: collecting – separating

1. Receiving, weighing, sampling, assaying

• Collecting all

- Contract
- Radiak check on arrival
- Weighing
- Sampling
- Sample preparation
- Assaying
Metallurgy: collecting – separating

② Roasting

• Separating Arsenic from concentrate and waste by partial roasting

• Autogenous drying of sulfide sludge

$$[\text{FeAsS + CuFeS}_4] + O_2 \leftrightharpoons [\text{FeCuS}_x + \text{Fe}_3\text{O}_4 ] \ + \ As_4O_6 (g) + SO_2(g)$$

Note: buffered by excess FeS_x / Fe_3O_4
Metallurgy: collecting – separating

② Roasting

Dust capture and treatment

In off-gas system at decreasing temperature:

“MeS (s) + As₄O₆ (g) + Hg (g) + SO₂(g) → As₂O₃(s) + HgS(s) + MeS”

Complex dust for stabilization and deposit
Metallurgy: collecting – separating

3 Electric Smelting

• Separating Zinc from Copper
• Collecting precious metals

\[
[Cu_2S, FeS, Fe_3O_4, ZnS, SiO_2, Au] \rightleftharpoons (ZnO-FeO-SiO_2) + \{ FeS-Cu_2S, Au \} + SO_2
\]
Metallurgy: Rönnskär’s Electric Furnace

Calcine + Cu-Zn-ashes + dust + SiO₂

Matte

Slag

**Metallurgy: collecting – separating**

- Separating Copper from Fe-S
- Collecting precious metals

\[
2(\text{FeS})_{\text{matte}} + 3(\text{O}_2)_{\text{air}} + (\text{SiO}_2)_{\text{flux}} = (2(\text{FeO})x \text{SiO}_2)_{\text{slag}} + 2(\text{SO}_2)_{\text{off gas}} \quad [1]
\]

\[
(\text{Cu}_2\text{S}) + (\text{O}_2)_{\text{air}} = 2\text{Cu} + (\text{SO}_2)_{\text{off gas}} \quad [2]
\]

**Table: Combustion Energy [kJ/kg]**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Combustion Energy [kJ/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe S2</td>
<td>8</td>
</tr>
<tr>
<td>S</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>33</td>
</tr>
</tbody>
</table>

**BUT:**

O2/kg! And BTU
Metallurgy: collecting – separating

- Slag - properties
  - Impurity capacity
    - Eq. slag, matte, metal…
  - Composition
    - Liquidus temperature
  - Formation of high temperature melting phases
  - Viscosity
  - Etc…….
Metallurgy: collecting – separating

⑤ KALDO

• Separating Organics from Copper and slag
• Collecting precious metals

\[ [\text{Cu,Fe,Au,Ni,Zn,Al}_2\text{O}_3,\text{SiO}_2, \text{plastics}] \Leftrightarrow \]
\[ [\text{Cu-Fe-Zn-Au-Ni}] + (\text{FeO-SiO}_2-\text{Zn,Pb}) + \text{CO}_2 \]
Metallurgy: collecting – separating

6 Refining

• Separating copper from others by electrorefining

Cu 99.998
CuSO$_4$
NiSO$_4$
PM slimes
4N8…but I do not know if my roots are in the mine or in scrap …
Metallurgy: collecting – separating

7. Fuming

• Separating zinc and lead from slag
• Collecting precious metals

\[
\begin{align*}
(ZnO) + C & \rightleftharpoons Zn(g) + CO \\
Zn(g) + CO + O_2 & \rightleftharpoons ZnO + CO_2
\end{align*}
\]

\[
(FeO-SiO_2, Cu, Au, Ag, Ni, S) \rightleftharpoons (FeO-SiO_2) + \{Cu-Fe-S, Ag\} + [Cu-Fe-Sb-Ni, Au, Ag]
\]

”Iron sand”
Designed for recycling?

Complex scrap
Conclusion:
Metallurgists can!
if you let them do…. And can find them…..

Looking for the Metallurgist!