Research on the Reduction of Arsenic in Copper Ore

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1. Copper Production in Japan

2. JOGMEC’s Activities

3. Technical development in arsenic reduction in copper raw materials
Copper smelters in Japan

Capacity [thousand t]

- **Naoshima**: 306 thousand t (17%)
- **Saganoseki**: 450 thousand t (25%)
- **Tamano**: 260 thousand t (14%)
- **Toyo**: 450 thousand t (25%)

**Total**: 1,814 thousand t

Source: JOGMEC
Copper Production in Japan by source

- Japanese refineries produce around 1.5 million tonnes of copper annually.
- Production from scraps are increasing, but copper concentrate is still the main feedstock.

Source: JMIA
Copper Concentrate Import by country

- Half of the concentrate are imported from Chile and Peru.

Source: METI
1. Copper Production in Japan

2. JOGMEC’s Activities

3. Technical development in arsenic reduction in copper raw materials
Japan Oil, Gas and Metals National Corporation

Established: February 29, 2004
Capital: 938 Billion Yen (8.8 Billion US$ (1US$=107 Yen))
Chairman & CEO: Mr. Tetsuhiro Hosono
Employees: 615 (as of July 1st, 2019)
Head Office: Minato-ku, Tokyo, Japan
Mission

Oil & Gas Upstream

Stockpiling of Oil, LPG & Rare Metals

Coal Mining

Geothermal Resources

Mineral Resources

Mine Pollution Control

Mission
1. Copper Production in Japan

2. JOGMEC’s Activities

3. Technical development in arsenic reduction in copper raw materials
Trend of arsenic in Japan

Since 1991

As (0.04 → 0.09%)

Cu (32 → 26%)

As/Cu Ratio 2.8 !!

Source: MERI/J
Japan Oil, Gas and Metals National Corporation
Japan imports all of copper concentrates from overseas while the arsenic content in copper concentrate is increasing. At present, the Japanese smelters fix almost all arsenic in slag. However, the more arsenic in concentrate increases, the more difficult treating arsenic would be at the smelters.

### Environmental regulation related to arsenic in Japan

<table>
<thead>
<tr>
<th>Regulation</th>
<th>As limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Air (Guideline)</td>
<td>6 ng/m³ (Annual average)</td>
</tr>
<tr>
<td>② Surface water</td>
<td>0.01 mg/L</td>
</tr>
<tr>
<td>③ Underground water</td>
<td>0.01 mg/L</td>
</tr>
<tr>
<td>④ Slag (Standard)</td>
<td>Elution: 0.01 mg/L, Content: 150 mg/kg</td>
</tr>
</tbody>
</table>
Cu mineral and As mineral have similar properties. As mineral is finely disseminated in Cu mineral, making it difficult to separate by conventional techniques.

Advanced Mineralogical Analysis

Comminution to promote separation

New separation technique including new flotation reagent

As binding substance

Non binding substance

Arsenic fixation

Ore with high As

Custom smelters

Ore

Mill

Open pit mine

Mining countries

Concentrate
Project structure

AIST
Development of comprehensive analyzer for mineral processing
- Furukawa
- Waseda Univ.

Nittetsu Mining
- Enhancement of mineral liberation of impurity mineral in Cu ore by HPGR and separation by flotation

Sumitomo Metal Mining
- AIST
- Kyushu Univ.

Mitsubishi Materials
- Akita Univ.
- Shibaura IT

JX Nippon Mining & Metals
- Development of separation and treatment process of ore with high As applicable to actual Cu ore
Development of comprehensive analyzer for mineral processing

- Evaluation of
  - Detailed mineral liberation in 3D
  - Shape characteristic of mineral particle in 3D
- Estimation of
  - Result of gravity separation
  - Result of magnetic separation
  - Flotation behavior
- Comprehensive evaluation of separation results with recommended process
High Pressure Grinding Rolls

Features

- Add pressure 5-10 times higher than conventional mill
- Feed highly packed particle to rolls
- Add sufficient grinding force to highly packed particle layer with hydraulic cylinder
- Achieve effective inter-particle grinding
Develop New Flotation Reagent

Search biosubstance binding to As mineral

Search chemicals based on first-principles calculation and experiments
Conditioning for flotation

JX and Akita Univ., Sumitomo and Kyushu Univ.

As mineral

Cu mineral

Similar surface property

Surface modification

pH Control

ORP Control

etc.

Cu mineral

As mineral

Only surface of As mineral modified
Precise magnetic separation of arsenic from copper concentrate with high content of arsenic

This figure indicates that enargite and tenanntite can be separated from chalcopyrite by precisely controlled magnetic separation.

Pretreatment before magnetic separation has also investigated.
As mineral treatment

High pressure leach

- O$_2$ gas
- Impeller
- Lixiviant
- Ore
- Thermometer

High pressure, max. 2MPa
High temperature, max. 200°C

Catalyst (e.g. silver)

Fe(II)-oxidizing microbes

Fe(II) → Fe(III)

S$_0$-oxidizing microbes

S$_0$ → SO$_4^{2-}$

Enargite (Cu$_3$AsS$_4$)

JX and Akita Univ.

Bioleach

Sumitomo and Kyushu Univ.

H$_3$As$^{III}$O$_3$
Summary

• Arsenic in copper concentrate is increasing and getting to cause serious problem.
• But, the property of Cu and As sulfide mineral is very similar.
• Some experiences using single mineral species in laboratories indicated the possibility of the separation, however, there are no actual operations.
• Against this background, JOGMEC has been carrying out research to separate Cu and As minerals by physical separation technique.
• The research will help to develop sustainable development of copper mining.
Thank you!