Current Arsenic situation
- JX Nippon Mining & Metals -

JX Nippon Mining & Metals
Technology Development Center
Kensaku Nakamura
Overviews of JX Nippon Mining & Metals

Upstream
Resource Development

Midstream
Smelting and Refining

Downstream
Recycling

JX Nippon Mining & Metals Corporation
The Overall Flow of Our Business Activities

Downstream
Electronic Materials
Smelting sites of JX-Nippon

<table>
<thead>
<tr>
<th>Operation site</th>
<th>Capacity*1</th>
<th>JX NMM’s share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saganoseki (Oita, Japan)</td>
<td>450 kt*2</td>
<td>66%</td>
</tr>
<tr>
<td>Tamano (Okayama, Japan)</td>
<td>200 kt*3</td>
<td>41.9%</td>
</tr>
<tr>
<td>LS-Nikko Copper (Onsan, South Korea)</td>
<td>680 kt</td>
<td>39.9%</td>
</tr>
<tr>
<td>Total</td>
<td>1,330 kt</td>
<td></td>
</tr>
</tbody>
</table>

*1 Annual production capacity of refined copper
*2 Including refining process at Hitachi Works
*3 Pro-rata share of capital participation
More $\textit{As}$ Input causes

1) Environmental Issue; Hard Regulation

2) Slag Quality

3) Cost Issue; Removal cost up in plant

- Smelter side faces problem of business continuity in long term viewpoint.

- There is not enough incentive to remove $\textit{As}$ for Mining side. (Ex. Value of copper in Enargite is more than $\textit{As}$ -penalty )
1) Environmental Issue

- Not to mention compliance with environmental regulations, we will strive to further reduce impact of our operations on the environment.

<table>
<thead>
<tr>
<th></th>
<th>As</th>
<th>Cd</th>
<th>Pb</th>
<th>Se</th>
<th>Cu</th>
<th>Zn</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese Waste Water Standard (mg/L)</td>
<td>0.1</td>
<td>0.03</td>
<td>0.1</td>
<td>0.1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Japanese guidelines on Air pollutant (ng/m³)

<table>
<thead>
<tr>
<th></th>
<th>As</th>
<th>Ni</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>25</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

- More As-Input will make As management in operation difficult. (in terms of the quantity of As which remains in process)
2) Slag Quality

Oxygen-enriched air

Flash smelting furnace

Copper matte

Slag-cleaning furnace

Slag

Pressurized water

Granulation (with water)

Copper slag (iron silicate)

Slag granulation system
Main use of Copper Slag

- Slag must pass the test of quality for sale.

Quality Standard of As for Slag

<table>
<thead>
<tr>
<th>Use for</th>
<th>Content Limit</th>
<th>Dissolve Limit</th>
<th>Recent Slag quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Aggregate</td>
<td>$\leq 150$ mg/kg</td>
<td>$\leq 0.01$ mg/l</td>
</tr>
<tr>
<td>Seashore</td>
<td>Caisson</td>
<td>----</td>
<td>$\leq 0.03$ mg/l</td>
</tr>
</tbody>
</table>

- More As-input causes more As in Slag and less Slag quality.
- Being out of limitation is serious problem.
3) Cost Issue

- Smelters have much inner As-returns.
- Increase of As-input makes us cost-up to recover As such as
  - Regents cost of waste acid treatment plant.
  - Power cost of purification plant in tankhouse etc.

Power consumption of Purification process

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td>121</td>
</tr>
</tbody>
</table>

Shown as a relative value against 2007 as 100
Developing technology

JX-Nippon is developing As treatment technology.

- **Arsenic** removal from Copper concentrate
  - Inert roasting
  - **Arsenic** sulfide leaching
- Removed **Arsenic** immobilization.
  - **Arsenic** sulfide for collected As from inert roasting
  - Biological scorodite
Summary

➢ $As$ in concentrate is increasing and this trend will continue.

➢ It causes Environmental, Slag quality and Cost issues.

➢ JX-Nippon has been developing $As$ treatment technology.