Treatments of Secondary Raw Materials in Non-Ferrous Smelters in Japan

ETSURO SHIBATA
Institute of Multidisciplinary Research for Advanced Materials, Tohoku Univ. (IMRAM), Japan
Construction of Metal Resources Circulation System (Resource Circulation Society)

Mass use of electrical and electronic equipments (use of various metal material) (Electric vehicles, Batteries, PC, Mobile phone, Consumer appliances etc.)

- Population increase
- Depletion and low grade of mineral resources
- Movement of resource efficiency in EU

Base metals (Cu, Pb, Zn)
Little metals (Ni, Co, Se, Te, Sb, Bi, Sn, In, Ga etc.)
Precious metals (Au, Ag, Pt, Pd)

Mineral resource
Difficulty of metal resources ensure / low-grade ores
(China's economic growth, Resource majors, etc.)

Secondary materials (E-scrap etc.)
(Physical separation, New technology of metal recovery, Effective use of existing smelting facilities)

Supply of metals
Wastes

Efficient circulation of metal resources based on non-ferrous metal smelting industry
Secondary Materials and Wastes Treated in Non-ferrous Smelters

Electric Vehicle (ELV)  Hybrid Vehicle (HV)

- ELV and HV (waste) (Motor, battery, wire harness, electrical parts etc.)
- Waste electrical and electronic equipments (print circuit board)
- Metal smelting dust (ferrous and non-ferrous smelting dusts)
- Sludge from waste water treatment (containing Cu, Pb, Zn etc.)
- Shredder residues (heat source, containing Cu)
- Fly ash from municipal wastes melting treatment (containing Zn)
- Others (scrap, industrial wastes)
Social Role of Non-ferrous Smelting Industry

Intensification of environmental regulation

Use of low-grade concentrates

✓ Non-ferrous smelting industry: Originally, the industry has technologies to control a wide variety of elements

※ Necessity of technology development according to social condition

• Recovery of metals from wastes and secondary materials

• Control of hazardous elements (stabilization)

Essential industry for the realization of a resource circulation society

To a growth industry by acting an important role of metal recycling
Copper Smelter

- PCB is important secondary material containing Au and Cu (usually in incineration as pre-treatment)
- Treatment of shredder residue using copper smelting facilities
- Production of copper matte from sludge containing Cu and heavy metals
- Recovery of Au, Ag, PGM, Se, Te etc. from by-product (anode slime)
- By-products (residues) containing Pb need to be treated in lead smelter
- Control of arsenic (As) by recharge of smelting dust and reutilization of slag
- Severe problems of increasing in impurities (Ni, Sb, Sn, Bi etc.) from PCB
- Operation of a copper smelter treating only by-products and secondary materials (mainly PCB)
Lead Smelter

- Lead smelter is necessary in order to treat various by-products and wastes from copper and zinc smelters and other industries.
- 45-50% of lead bullion is produced from secondary materials (mainly waste battery) in Japan.
- Various types of wastes containing heavy metals can be treated.
- CRT glass is treated as an alternative to silica flux.
- Control of molten lead, speiss, matte, slag, and vapor phases in the furnace (various metals can be separated).
- Removal of heavy metals from slag by a fuming technology.
- Recovery of Au, Ag, PGM, Sb, Bi, Sn etc. from by-products (anode slime, dross etc.).
Treatment of Secondary Materials in Non-ferrous Smelters in Japan

Zinc Smelter

- EAF dust is important secondary material for zinc smelter
- Operations of hydrometallurgical smelters for zinc concentrate, and (pyrometallurgical) ISP for various types of secondary materials containing Zn, Pb and halogens (Cl, F)
- ISP is necessary for resource circulation in Japan
- Production of crude ZnO by treating fly ashes containing heavy metals from melting treatment of municipal wastes
- Recovery of Cd, In and Ga from by-products (dust, leaching residue, precipitation etc.)
- Development of halogen removal technologies for secondary material treatment
- Intensification of environmental regulation for mercury (Hg) discharge
Tasks for Secondary Material Treatment in Non-ferrous Smelters in Japan

※Problems by increasing in secondary materials

• Pre-treatment technologies different from mineral dressing

<Physical separation technologies of E-scrap, and concentration of valuable metals from industrial wastes>

Different from ore properties

(Ex. E-scrap → Mixture of plastics and metals)

※Engineers in non-ferrous smelters must develop physical separation technologies of E-scrap to remove impurities by themselves, and also for efficient utilization of copper and lead smelters, respectively
Tasks for Secondary Material Treatment in Non-ferrous Smelters in Japan

- Development of new smelting technology due to the increase in impurities
  <Improvement of primary smelting process, and development of new process>
- Generation of various by-products, and their efficient processing technologies
  <Recovery technologies of valuable metals from smelting by-products, and extraction and stabilization of toxic elements>
Ideal Linkage among Non-ferrous Smelters

Various secondary materials

Linkage among Cu, Pb and Zn smelters

Efficient treatment of by-products (recovery of metals)

※Separation of active metals (REEs, Ta, W etc.) by pre-treatment

※Refinery specialized for treatment of by-product from Cu, Pb and Zn smelters
**Kosaka Smelter (DOWA)**

- Copper smelter utilizing TSL furnace for treating only secondary materials (PCB etc.) and by-products from smelters
- Control of oxidizing and reduction stages in the single TSL furnace
- Sulfuric acid leaching of copper blister, and recovery of insoluble residue containing precious metals
- Electro-winning of copper sulfate electrolyte (purification of electrolyte by bleed-off)
- Recovery of 16 metals by combining with Lead smelter

(Provision of information from DOWA)
Important Smelters for Secondly Materials in Japan

HMC (JX Nippon Mining & Metals)

- Recovery of valued metals such as Cu, Pb and rare metals (Ni, Sn, Sb, Bi, etc.) from secondary products of copper smelter and a wide range of secondary material (at Hitachi from 2008)

Flow sheet of the HMC

Proceedings of Copper 2013, Vol.IV, 79-90
Important Smelters for Secondly Materials in Japan

HMC (JX Nippon Mining & Metals)

Lead sulfate
Carbonation
electric furnace
Harris furnace
Lead anode
Electrorefining
Refined Lead
Lead slime
Smelting-reduction
Volatilization
Chlorination
Electrorefining
Lead ingot
Antimony trioxide
Bismuth ingot
Tin ingot
Indium ingot
Pb Sb$_2$O$_3$ Bi Sn In

Flow sheet of recovery process of Pb, Sn, Bi, Sb, and In from lead sulfate

Proceedings of Copper 2013, Vol.IV, 79-90
Takehara Smelter (Mitsui Mining & Smelting)

- By-products from non-ferrous smelters (anode slime, dross etc.) are treated by pyrometallurgical and hydrometallurgical processes.
- Various type of wastes are treated by utilizing lead blast furnace.

![PCB](image1.png)

![Lead battery](image2.png)

![CRT glass](image3.png)

![Residues containing Pb](image4.png)
Important Smelters for Secondly Materials in Japan

Takehara Smelter (Mitsui Mining & Smelting)

Pamphlet of Takehara Smelter, Mitsui Mining & Smelting
Conclusions

Non-ferrous smelting industry is crucial for Japan’s resource circulation system for recovery of valuable metals from by-products. However, we need the establishment of more organic linkage among copper, lead and zinc smelters for the efficient interchange of smelting intermediate compounds.

Especially, lead smelters such as blast furnaces and ISP are important in the treatment of by-products generated in copper and zinc smelters, because of the control of several phases such as molten lead, speiss, matte, slag, and gas.

Furthermore, non-ferrous smelters in Japan must develop physical separation technologies of E-scrap to remove impurities for more efficient by-product treatment.
Thank you for your attention!!