Technospheric Mining of Critical and Strategic Metals from Metallurgical Byproducts

Richard Diaz Alorro[1], Don Ibana[2], Sarah Anne Jones[3], Zela Tanlega Ichlas[3], Bona Lim[3], Muhammad Reza Kurniawan[3], Go-Gi Lee[4]

[1]Senior Lecturer, Metallurgical Engineering, Western Australian School of Mines: Minerals, Energy and Chemical Engineering, Curtin University, Kalgoorlie, WA, Australia 6430 (Email: Richard.Alorro@curtin.edu.au)

[2]Adjunct Associate Professor, Metallurgical Engineering, Western Australian School of Mines: Minerals, Energy and Chemical Engineering, Curtin University, Kalgoorlie, WA, Australia 6430 (Email: D.Ibana@curtin.edu.au)

[3]HDR/Postgraduate Student, Western Australian School of Mines: Minerals, Energy and Chemical Engineering, Curtin University, Kalgoorlie, WA, Australia 6430
(Email: sarah.jones23@outlook.com; zela.tanlega@postgrad.curtin.edu.au; bona.lim@postgrad.curtin.edu.au; m.kurniawan2@postgrad.curtin.edu.au)

[4]Senior Researcher, PosNEP Project Team, Research Institute of Industrial Science and Technology (RIST), 67 Cheongam-ro, Namg-gu, Pohang-si, Republic of Korea (Email: yikoki@rist.re.kr)

ABSTRACT

Metallurgical by-products, such as slag, process residues, and tailings are considered waste materials and may pose environmental and health hazards if not managed properly. These by-products may contain significant amounts of critical and strategic metals, such as refractory metals (Nb, Ta) and rare earth elements (Sc, Dy and Y), sometimes at concentrations higher than the conventional ore. Critical and strategic metals are vital for the economy, trade and national defence of a country. These metals have found wide applications in various high-technology and clean-energy applications, and commercialization of new inventions, hence, their recovery from secondary sources has high economic advantages and strong environmental motivation.

The extraction and recovery of critical and strategic metals from metallurgical by-products can be categorised under a broad concept of technospheric mining. Technospheric mining is a new term used to describe the extraction and recovery of mineral or metal stocks accumulated in the technosphere, a material stockpile that has been established by human activity and technological processes. Technospheric stocks may include urban solid wastes, industrial process residues, mine tailings, and metallurgical slags, in contrast to conventional mining, which targets primary ores.

In this study, the leaching of critical and strategic metals from tin slag and nickel laterite hydrometallurgical by-product using organic acids is reported. The slag sample was a by-product of the smelting of cassiterite to extract tin and contained significant amounts of Nb, Ta, W, and REEs. The laterite process residue was a by-product of chloride leaching of nickel laterite and contained substantial amounts of Sc. The effects of various process parameters on leaching of these metals were investigated. Experimental results showed that oxalic acid can effectively dissolve the target critical and strategic metals from slag or residue samples. More than 94% Sc recoveries and near complete dissolution for Nb and Ta were achieved.

Keywords: technospheric mining, critical metals, strategic metals, leaching, metallurgical by-products