Innovative e-waste recycling processes for greener and more efficient recoveries of critical metals and energy

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Abstract

The manufacturing industry consumes increasingly large amount of scarce metals. For example, an electric vehicle (EV) utilizes about 15Kg of the rare earth metals (REMs) in its different parts [1]. According to a report by Business Insider [2], it is estimated that the global fleet of EV will reach 126 million in 2030, compared to the current 13 million EVs in use. Consequently, the manufacturing capacity of Li-ion battery, constituting valuable metals such as Co, in the EU is expected to grow by over 15 times within the coming 3 years [3]. A smart phone can also consume up to 0.25g of REMs. Therefore, the consumption of the valuable metals will also increase drastically. To address this concern, the European Commission has identified and compiled a list of critical raw materials (CRMs), which combine both high economic importance and supply risk. The CRMs list includes metals such as Co, REMs, PGMs, etc. [4].

To supplement the primary supply of the critical metals, processing of end-of-life electrical and electronic equipment (e-waste) are being highlighted. E-waste gives an important range of alternative sources of CRMs as well as organic materials, with the potential to substitute a large amount of primary raw materials that are becoming scarcer in Europe. Attempts to integrate the recovery of energy contents of organic materials in the e-waste in line with the critical metals recovery also contribute to overcome the techno-economic barriers prevailing in the recycling industry.

The efficient recovery of resources from waste streams is the key enabler of the circular economy. In this framework, the EU's target is to be able to recycle 65% of its municipal waste by 2030 [5]. In order to facilitate this move, besides designing recyclable products, innovative recycling technologies are essential. Currently, high-temperature recycling is the main processing route in Europe for the critical metals recovery from e-waste. To attain a higher recycling efficiency with less impact on the environment, the prevailing high-temperature recycling processes need to be further developed. The aim of this research is to develop innovative solutions for improving metals and energy recovery efficiencies while avoiding operational challenges and emissions in the e-waste high-temperature recycling. Recommendations for innovative and cleaner critical metals recovery from e-waste through high-temperature processes is made. This research is bold and a step forward in this research direction. The new and optimized thermochemical data will facilitate the digitalization of metallurgical processes that catalyzes the transition towards a more circular economy.

Keywords

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Biography

Dr. Fiseha Tesfaye is a High-T Process Metallurgist at Metso Outotec Finland Oy and Adjunct Professor in the Faculty of Science and Engineering at Åbo Akademi University, Finland. In 2018, Dr. Tesfaye was also appointed as a Visiting Research Scientist in Seoul National University, South Korea. Dr. Tesfaye serves as a V. Chair of TMS Energy Committee and as Subject Editor for JOM. In his research areas, Dr. Tesfaye edited several scientific research books and has published over 85 publications.