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Doctoral dissertation titled „Research on the recovery of metals from selected metallurgical slags with the use of printed circuit boards as a reducer"

ABSTRACT

This doctoral dissertation focuses on the development of assumptions and a detailed analysis of an innovative technology for recycling metallurgical slags using printed circuit board (PCB) scrap as an alternative reductant. The proposed approach responds to the growing demand for efficient processing of electronic waste aimed at recovering valuable functional metals such as Cu, Pb, Sn, Ag, and Au contained in these materials. The technological solution presented in the dissertation enables a reduction in the consumption of natural resources and a decrease in the amount of hazardous waste. At the same time, it contributes to the implementation of the key principles of the Circular Economy through sustainable management of electronic waste.

The achievement of this objective was made possible through the implementation of a comprehensive research program that included the determination of the physicochemical properties of the investigated materials, laboratory-scale slag reduction experiments using PCB scrap, and reference tests employing coke as a conventional reductant. The effectiveness of the slag reduction process was evaluated using indicators such as the degree of slag decopperization and metal distribution coefficients. In addition, mass balance analyses were performed to determine the distribution of metals among the individual process products.

At the same time, the study included implementation-oriented tasks, comprising the development of a method for agglomerating PCB scrap with solid slag, the preparation of briquettes, and pilot-scale slag reduction tests conducted in an 80 kVA electric furnace. Based on the obtained results, assumptions for the industrial implementation of the proposed solution were developed, and an economic analysis was performed, taking into account the estimated economic benefits of this alternative technology.

The results obtained within the planned and executed research program confirmed the validity of using PCB scrap as an alternative reductant in metallurgical processes from both technological and economic perspectives.