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for Green Engineering, Sustainable Materials
and Technologies for Circular Economy
GREEN CIRC 2025

BOOK OF ABSTRACTS

Faculty of Technology and Metallurgy,
University Ss. Cyril and Methodius in Skopje,
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GREEN EXTRACTION OF CRITICAL METALS: CHEMICAL LEACHING AND ELECTROCHEMICAL RECOVERY FROM COAL

Katarina R. Pantović Spajić[1], Marijana R. Pantović Pavlović[2,*], Srećko Stopić[3], Katarina Đ. Božić[2], Đorđe V. Gjumišev[2], Branislav Marković[1], Miroslav M. Pavlović[2]

[1]*Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, Serbia*

[2]*University of Belgrade - Institute of Chemistry, Technology and Metallurgy, Department of Electrochemistry, Belgrade, Serbia*

[3]*Process Metallurgy and Metal Recycling, RWTH Aachen University, Aachen, Germany*

m.pantovic@ihtm.bg.ac.rs

This study investigates the selective recovery of critical metals from coal through chemical leaching and electrochemical processes, with a focus on copper (Cu) recovery. Chemical leaching was performed using 15 vol.% HNO_3 at 60 °C for 30 minutes per cycle. After each leaching step, a new coal sample was introduced, while the used acid was replenished with concentrated HNO_3 to maintain a consistent 15 vol.% concentration. This process was repeated for six cycles, leading to the progressive accumulation of leached metal ions in the solution.

The composition of the leachate, analyzed via ICP-OES, revealed increasing concentrations of metals, with Fe and Zn being predominant. Electrochemical studies, including cyclic voltammetry (CV) and linear sweep voltammetry (LSV), were conducted to evaluate the feasibility of Cu recovery and the influence of co-leached metals, particularly Pb and Fe. LSV results demonstrated that Pb did not significantly hinder Cu recovery, as indicated by distinct Cu redox peaks. Selective Cu deposition was achieved by controlling the applied potential, with reduction occurring at -0.70 V. Furthermore, Cu was successfully deposited by holding the potential at -0.10 V and subsequently oxidized at approximately 0.15 V during the anodic sweep, confirming its electrochemical recoverability.

These findings highlight the potential of chemical leaching combined with electrochemical recovery as a sustainable strategy for extracting critical metals from coal. This approach supports circular economy principles by minimizing waste, reducing the need for virgin raw materials and valorizing coal as a secondary resource for metal recovery.

Keywords: Chemical Leaching, Electrochemical Recovery, Critical Metals, Nitric Acid Treatment, Circular Economy.

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