Sustainable Recovery of Copper from E-Waste Using Acetic Acid and Hydrogen Peroxide Leaching

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The increasing accumulation of electronic waste (e-waste) presents a critical environmental challenge and a valuable opportunity for resource recovery, particularly of high-demand metals such as copper. This study explores an eco-friendly hydrometallurgical approach for copper recovery from e-wastes, e.g. printed circuit boards (PCBs), sourced from a local recycling company. Acetic acid was employed as a biodegradable leaching agent, in combination with hydrogen peroxide (H_2O_2) as an oxidizing agent, to facilitate copper recovery. The influence of key leaching parameters—including acetic acid concentration, H_2O_2 dosage, leaching temperature, and contact time—was systematically investigated to optimize the process.

Experimental results revealed that a maximum copper recovery efficiency of approximately 80% was achieved. Notably, comparable recoveries were obtained using acetic acid compared to conventional mineral acids such as sulfuric and nitric acids, highlighting the potential of organic acids as sustainable alternatives. The results showed that increasing the temperature had a detrimental effect on leaching efficiency, primarily due to the thermal instability and rapid decomposition of hydrogen peroxide at elevated temperatures, which diminished its oxidative capability. Optimal leaching performance was observed at moderate temperatures and balanced oxidant-to-acid ratios, underscoring the importance of maintaining reactive stability during the process.

The recovered copper was characterized using atomic absorption spectroscopy (AAS) for quantitative analysis and scanning electron microscopy (SEM) to assess surface morphology and purity. This research demonstrates that acetic acid, in conjunction with hydrogen peroxide, offers a viable and environmentally responsible pathway for recovering copper from e-waste. The findings support the adoption of greener chemical processes in electronic waste management, contributing to circular economy goals and sustainable resource recovery.