Chapter 10

Biomining Method to Extract Metal Components Using Computer-Printed Circuit Board E-Waste

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ABSTRACT

In the present scenario, the e-waste from the various electronic sectors has been increasing due to increased utilization of electric components. In this chapter, the bioleaching(biomining) process of a computer printed circuit board (CPCB) is illustrated to extract the metal components. Basic concepts for e-waste management, their impacts, and various e-waste treatment methods have been explained. The various existing conventional metal extraction methods for the wasted CPCB have also been explored. Definitions, types, cryogenic bioleaching (biomining), influencing factors, and procedures of the bioleaching process have been illustrated. The microbiological methods for the processing of e-waste, the selection of process parameters, and the optimization or maximization of metal extraction processes were demonstrated to promote the e-waste management processes.

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INTRODUCTION

Equipment that is electrical or electronic is no longer intended for use. One of the constantly expanding solid waste sources is e-waste. Consumers are being compelled to buy newer or current electronic equipment due to factors including a high obsolescence rate, a short life span, the design for dump policy of manufacturers, constant developments in technical applications, and lowered pricing. It is estimated that the globe creates millions of metric tonnes of e-waste annually. Few are known to be adequately collected, processed, and recycled. Under unfavourable circumstances, the maximum is likely to be dumped into the residual garbage. Recycling e-waste can reduce the demand for primary resources, save landfill space, and create jobs. Printed circuit boards (PCBs) contain metals that are 10 times more pure than natural ores. Urban mining refers to the treatment of e-waste as an "urban mine" because of its high metal concentration. Because there are so many valuable metals present, recycling presents a business opportunity. On a global scale, both formal and unofficial industries recycle e-waste. In order to prevent exposure to dangerous metals and poisonous compounds, only small portions are processed by the formal sector, i.e. in a way that is safe for the environment and the employees(Yaashikaa et al., 2022).

The present methods for recovering metals from e-waste are expensive, energy-intensive, and dangerous (for both humans and the environment), and they produce a significant amount of secondary contaminants. In contrast, hydrometallurgical processes produce liquid waste, hazardous fumes, a lot of sludge, and spent acid. The most popular approach for removing metals from e-waste is bioleaching. Utilizing microorganisms' innate capacity to change metallic materials into their watery state is known as "bioleaching." The method has a number of benefits, including minimal chemical sludge production, low energy use, and simple metal recovery.

In this work, microbes are primarily used for the bioleaching of Cu, Au, and Ag from waste CPCBs. Metals like Cu, Zn, and Ni are dissolved in the reaction by ferric ions ($Fe3+$), which act as oxidising agents and react with the material. Additionally, bacteria use $Fe2+$ as an energy source and oxidise it to produce $Fe3+$. Most of the heterotrophic cyanogenic bacteria, including C. violaceum, B. megaterium, and Pseudomonas, have been used in the bioleaching of Au and Ag. Metals were extracted from used CPCBs by fungi in the current study(Yin et al., 2018).

E-waste is poisonous to microorganisms, and cell metabolism affects how much bioleaching occurs. Foreign microorganisms should not be used instead of local microorganisms from polluted locations. The native microorganisms have the physiological and metabolic apparatus to withstand and degrade the contaminant/pollutant. E-waste recycling facilities and mines both contain native microbes that were isolated and tested for bioleaching and toxin tolerance. Like other biological processes, bioleaching is influenced by abiotic and biotic factors that have an impact on the metabolic activity of the microorganisms and, as a result, the recovery of the metals. Temperature, pH, aeration rate, medium make-up, a lixiviant precursor, incubation period, particle size, and e-waste concentration are among the abiotic parameters. Statistical methods like the RSM and standard OFAT can be used to optimise the bioleaching process. The influence of pH and pulp density on gold dissolution from e-waste was investigated by Natarajan and Ting. The effects of pH and glycine content on the bioleaching of gold were assessed. Using the cyanogenic bacteria B. megaterium, they improved the procedure using a response surface approach. From battery wastes to metal-contaminated sediments and mining wastes, bioleaching can be used to remove metals, including precious metals. In order to recover metals profitably, there is an urgent need for intense bioleaching research that focuses on the discovery of novel microbial strains and, as a result, process parameter optimization. The goal of the current research was to investigate new