Bioleaching of sulfur enriched discards applied to circular economy

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Keywords: Coal, Acid Rock Drainage, Ferrous Sulfate

# ABSTRACT

Coal waste discards are currently treated as non-valuable materials despite containing minerals of interest such as pyrite, aluminum silicates, and rare earth elements (REEs). Under natural weathering conditions, these materials generate acid rock drainage (ARD), leading to environmental issues. Isolating pyrite from coal waste can reduce the residual waste’s acid generation potential while creating a stream for valorization. This study explores bioleaching as a method to accelerate sulfur removal from these discards under controlled conditions, mimicking the ARD process in a controlled setting. The bioleaching process enhances sulfur removal efficiency, with sulfur removal exceeding 90%, while generating an iron-rich solution from which we have produced ferrous sulfate crystals with potential for other valuable by-products. Additionally, this approach creates a safer disposal pathway for the residual material, reducing its long-term environmental impact through risk removal rather than delaying risk. The results highlight the potential of integrating bioleaching into circular economy strategies, transforming coal waste into a valuable resource while mitigating ARD-related risks. The implementation of bioleaching can contribute to more sustainable mining practices, reducing environmental footprints while extracting value from previously discarded materials. This research underscores the potential for bioleaching to play a key role in the transition toward a circular economy in the mining sector.