ADVANCES IN UNDERSTANDING THE USE OF UNIT OPERATIONS IN METALLURGY FOR THE TREATMENT OF BAUXITE RESIDUES

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Abstract

Bauxite residue, commonly known as red mud is byproduct of the Bayer process for alumina production. It presents both environmental challenge as well as opportunity for resource recovery. With high content of iron, titanium, and other valuable metals such as gallium, scandium and vanadium, red mud has gathered significant attention as a potential secondary resource. This study investigates advanced metallurgical operations for the efficient processing of red mud with focus on reduction, separation, and leaching techniques to extract critical materials. The reduction of red mud was performed using different approach, including carbothermic reduction, hydrogen reduction in tubular furnace and rotary kiln as well as hydrogen plasma reduction. These reduction processes facilitate the conversion of iron oxides to metallic iron, enabling easy separation from the slag through physical methods. The resulting slag is enriched in titanium and other oxide compounds, which cannot be reduced by carbon or hydrogen. Slag was then subjected to a leaching process in a sulfuric acid medium under oxidizing and high-pressure conditions. This innovative leaching method effectively dissolves titanium, producing titanium oxysulfate as a valuable intermediate for industrial applications such as pigment production and advanced material synthesis. This work demonstrates a comprehensive approach to red mud processing by integrating advanced reduction technologies and optimized leaching conditions, addressing environmental sustainability while unlocking the economic potential of this industrial waste. The findings highlight the viability of recovering iron and titanium-oxide as marketable products, contributing to the circular economy and reducing the environmental impact which is associated with red mud disposal.

Keywords: *bauxite residue, reduction, leaching, iron recovery, titanium oxide.*