Iron Source from Bauxite Residues by Using Microwave Technology

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Abstract

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Bauxite residue (BR) is an iron-bearing resource with Fe_2O_3 content higher than 40%, as in the case of MYTILINEOS Aluminium of Greece plant. Given that iron ores and commercial iron concentrates have significantly higher iron oxide contents, utilizing BR in the established iron producing technologies is non-competitive. Microwave roasting technology is a very promising technology to transform and enrich the iron in BR. A new microwave system (ALFER) was specifically developed to enrich and transform iron into competitive valuable products. A microwave BR roasting pilot for continuous operation was installed at MYTILINEOS in the frame of the RemovAl project. A monitoring and control system, including microwave power reflectometry, pyrometry and other complementary sensors, was used to control the parameters of the process. The parameters of mass flow, temperature of the reaction, residence time, power consumption, and gases liberated were evaluated to extract the different intermediated products. The level of enrichment of the different obtained intermediate iron products was also compared with the measured energy consumption and the estimated cost to evaluate the benefits of the process. Results showed that the technology is a promising solution for BR treatment for valorisation as an iron-bearing source.

Keywords: Bauxite residue, Iron extraction, microwave, energy efficiency, circular economy.

1. Introduction

The utilization of the microwave roasting process has emerged as a promising technology in mineral processing. Compared to conventional heat treatment methods, this approach offers distinct advantages, including significantly faster reaction times and potentially lower energy consumption [1]. These advantages are attributed to the interaction between the material and the electromagnetic field generated during the process.

Materials can be categorized into three groups based on their dielectric properties: absorbers, insulators, and conductors. Absorbers readily couple with microwave energy, leading to instant heat generation inside the material rather than heating the surface slowly and conducting it inward [2]. Thus, microwave heating presents promising opportunities for reducing energy consumption in intensive metallurgical processes [3].

Due to these significant advantages, several microwave-based processes have been developed in mineral processing and extractive metallurgy over the past few decades [1,4-6]. Microwave treatment has shown promise in recovering iron from bauxite residue (BR), which is the solid waste produced during alumina production from bauxite ores [7]. As iron comprises a substantial portion of BR, numerous studies have focused on iron recovery using pyrometallurgical processes.

These processes can be broadly categorized into two groups: solid-state reductive roasting followed by magnetic separation [8], and reductive smelting using various furnaces [9]. However, these approaches have their drawbacks, leading researchers to explore innovative methods for iron recovery from BR. Presently, the microwave process stands as an innovative and promising technology in the field of mineral processing.

The aim of this work is to present a new microwave system (ALFER) developed by CEINNMAT for the enrichment and transformation of iron as a competitive valuable product and the results obtained after its installation at the MYTILINEOS plant, in collaboration with NTUA, in the frame of the RemovAL project.

2. Procurement, Manufacturing and Plant Development

The procurement stage was performed on CEINNMAT premises. Some of the components were the following:

- Maritime container to install the plant.
- Feeding system
- Close circuit cooling system.
- Extraction gas circuit.
- Microwave system.

The electric cabinet was also designed and assembled with the fundamental elements, such as energy monitoring of plant and microwave, general switch, PLC and other ancillary elements (Figure 1).

Figure 1. Electrical cabinet.

A gas circuit chamber was also designed and instructed, using two versions for different conditions, assuring a controlled atmosphere during the pilot trials. The pilot plant was built in a single 20-foot-high-cube container of maritime standard size, enabling pilot

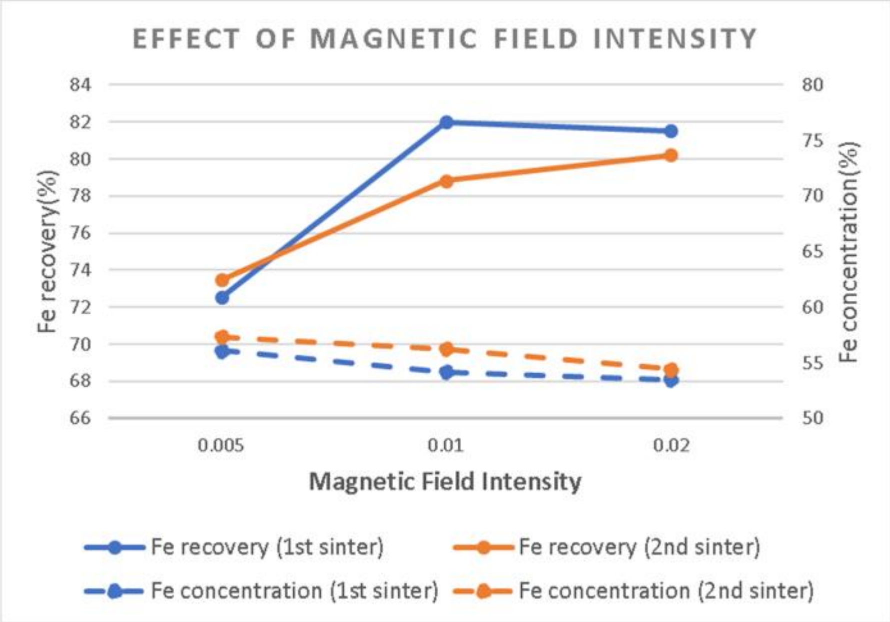

Figure 8. Magnetic separation of sinters.

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