Plasma Reduction Process to Minimise Bauxite Residue

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Abstract

Bauxite of Indian origin typically contains 40 – 50 % Al_2O_3, 20 – 28 % Fe_2O_3, 3 – 10 % TiO_2, 4 –10 % SiO_2, 20 –30% LOI and other associated oxides in minor quantities. Due to the higher percentage of Fe_2O_3 in bauxite, generation of Bauxite Residue (or Red Mud), which is costly and problematic to manage, is substantially increased for these bauxites in the Bayer process. In view of this, the recovery of the iron content in bauxite by Plasma Reduction prior to the Bayer process is an interesting option. In this study, laboratory scale simulations have been made to reduce the Fe_2O_3 content in bauxite using the Plasma Reduction process where metallic iron is recovered. The iron produced by this process contains around 85.5% Fe with 85% recovery. The slag rich in alumina and residual iron in the form of FeO can be fed to the Bayer process for the production of alumina.

Key words: Plasma smelting reduction; Arc Plasma smelting reactor; iron from bauxite; Alumina.

1. Introduction

The conventional process for alumina production employing the well-established Bayer Process generates large quantities of Bauxite Residue (or Red Mud) the storage of which is a concern to the alumina industry and the communities in which they operate. So far, outside of some niche applications, no commercial technology has been developed for bulk utilisation of Residue. Utilisation of Bauxite Residue (Red Mud) has been generally limited to either laboratory or pilot scale simulations. However, significant research effort globally is being applied to address this challenge through the application of novel technologies. One such unique and state-of–the-art process is the plasma reduction process which envisages the reduction of iron oxide present in bauxite prior to being fed to the Bayer Process for the extraction of alumina. [1-5]

Bauxite of Indian origin typically contains 40 – 50 % Al_2O_3, 20 – 28 % Fe_2O_3, 3 – 10 % TiO_2, 4 –10 % SiO_2, 20 –30% LOI and other associated oxides in minor quantities. For the production of one tone of alumina, 1 to 2 tonnes of residue is generated out of 2 to 3 tonnes of bauxite. It is now a clear research challenge to reduce to a minimum the percentage of iron oxides present in bauxite prior to bauxite being refined into alumina in the Bayer process. The present work is directed towards this result, and a suitable laboratory scale process has been developed. By employing this process, it has been possible to reduce the bauxite iron oxide content by 85%, and the metallic iron produced contains around 85% Fe. The alumina rich slag produced can be fed to the Bayer process for alumina production.

2. Raw Materials

A Bauxite of Indian origin was the principal raw material for the study. The mineralogical composition and chemical analysis of the bauxite are furnished in Figure 1 and Table 1 respectively. The other raw materials used for the study were aluminium metal (Commercial grade), Hydrogen gas (99.9%) and Argon gas. Figure 1 shows the mineralogical composition of bauxite indicating $Al(OH)_3$ and Fe_2O_3 as major phases as shown in the XRD peaks.

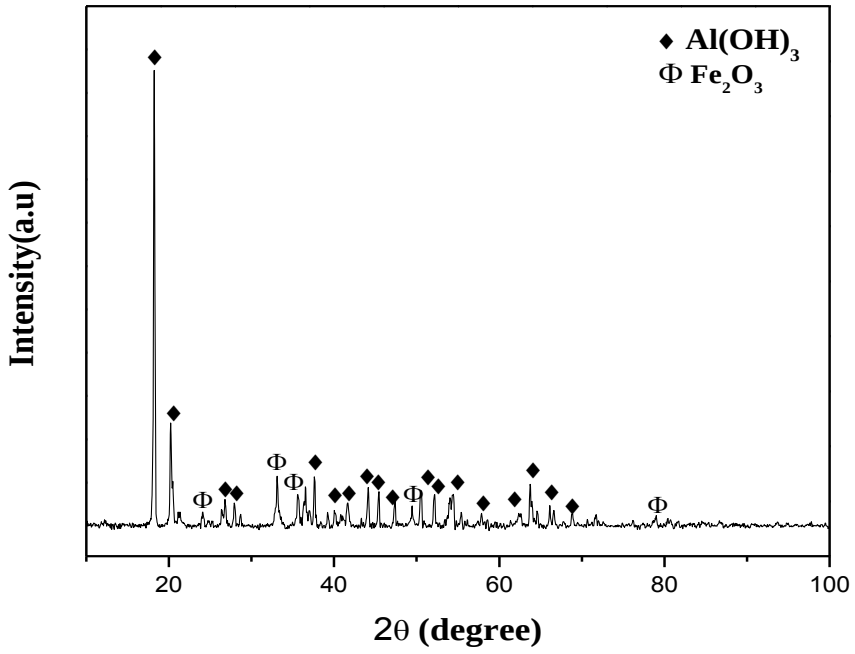

Figure 1. Mineralogical Composition of Bauxite of Indian Origin

Table 1: Typical Chemical Analysis of Indian Bauxite

Input Material	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	LOI
Indian Bauxite (%)	47.74	13.60	9.81	1.0	27.56

3. Experimental

Smelting studies were carried out in a 35 kW dc extended transferred arc plasma reactor. The reactor is basically a pot type, with zircon coated graphite crucible as the furnace hearth, which is thermally insulated by bubble alumina. Graphite electrodes are arranged in a vertical configuration. The bottom electrode (anode) is kept stationary and the top one (cathode), with an axial hole for feeding the plasma forming Argon gas, is actuated by a rack and pinion mechanism for arc stabilization. The hearth is provided with a graphite spout to tap both metal and slag. A schematic of the reactor is given in Figure 2.

Plasma Smelting process. The result obtained in the present investigation seems promising, and may be an option to minimize Bauxite Residue generation in Alumina Refineries.

Further studies are needed to establish higher reduction efficiencies for the iron oxide present in bauxite.

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