Study of Guinean Bauxite Processing under Low and High Digestion Temperatures

Yuguo Chen[1], Zhiguo Li[2] and Yuehua Jiang[3]
1. Senior R&D Engineer
2. Chief Engineer
3. Chief Engineer
Shenyang Aluminum and Magnesium Engineering and Research Institute Co., Ltd (SAMI), Shenyang, China
Corresponding author: jyh@sami.com.cn

Abstract

This article studies the digestion performance of one Guinea bauxite. The chemical and mineralogical composition of the bauxite were analyzed, the digestion performance was studied in detail under different digestion conditions such as temperature and holding time. Empirical formulas were used to verify the experimental results. Based on the experimental results and the industrial practice of China alumina refineries, mass balance and heat balance calculations were conducted. The production costs in different digestion conditions were compared, as well as the impact on the bauxite residue properties in the context of its utilization. The research results of this article have important guiding significance for the selection of production conditions for the treatment of Guinea bauxite.

Keywords: Guinea bauxite, Digestion, Temperature, Holding time, Production cost

1. Introduction

China is the world's largest alumina producer, with a total alumina production of 81.86 million tonnes in 2022, about 57.6 % of the world's total alumina production. However, with the decline of domestic bauxite resources, the greenfield and brownfield alumina projects mostly use imported bauxite. Bauxite imports to China mainly come from Guinea, Australia, Indonesia and other regions with rich bauxite resources, of which Guinea is the largest with about 56 % of the total bauxite imports in 2022. Guinea bauxite is typically gibbsitic bauxite. In addition to gibbsite, it also contains a certain amount of boehmite and alumogoethite [1-3]. In Chinese alumina refineries treating Guinea bauxite, either low or high temperature digestion process is used according to the bauxite composition. This article compares the digestion performance and production costs of one Guinea bauxite under high and low temperature conditions.

2. Experimental Materials and Methods

2.1 Experimental Materials

The bauxite sample is from one bauxite mining area in Guinea. The test liquor used for digestion is prepared with distilled water, aluminium hydroxide (industrial grade), sodium hydroxide (analytical pure), and sodium silicate (analytical pure).

2.2 Digestion Test Method

The digestion test is carried out in a molten salt/oil bath heating device (oil bath at 150 °C, molten salt heating above 200 °C), with a temperature control accuracy of ± 1 °C, equipped with digestion steel bombs. The materials in the steel bomb achieve uniform reaction due to a continuous flipping mechanism. After reaching the target test temperature, the temperature is maintained during the appropriate holding time, then the reactor is removed and cooled down quickly. After cooling, the digested slurry solids-liquids are rapidly separated. Bauxite residue is washed with hot water above 98 °C combined with vacuum filtration, the liquid and solid phase components are analyzed.

The extraction efficiency is expressed as a relative number using the calculation formula:

$$\eta_A = \frac{Al_2O_3(D)}{Al_2O_3(A)} \times 100\% \quad (1)$$

where:

η_A Relative digestion rate, %

$Al_2O_3(D)$ Fraction of alumina digested, %

$Al_2O_3(A)$ Fraction of available alumina in bauxite, %

2.3 XRD, XRF and LOI

The chemical composition was determined by an ARL PERFORM'X 4200 X-ray fluorescence analyzer (XRF), the loss of ignition (LOI) was determined by a muffle furnace calcination, and the mineralogical composition was determined by an XRD-7000 X-ray diffraction (XRD) instrument.

3. Experimental Results and Discussion

3.1 Chemical and Mineralogical Composition

The dried bauxite was first crushed by a jaw crusher. After crushing, the bauxite was ground using a disc milling equipment and sieved to the proper size distribution. The product bauxite samples were used for chemical and mineralogical analyses, and subsequent experiments. The results of chemical composition analysis is shown in Table 1, and the XRD spectrum is shown in Figure 1. The mineralogical composition calculated based on the XRF and XRD results is shown in Table 2.

Table 1. Chemical composition of bauxite samples.

Al_2O_3	Na_2O	K_2O	SiO_2	CaO	Fe_2O_3	TiO_2	LOI
46.87	0.01	0.01	2.15	0.02	23.1	2.12	24.12

Table 2. Mineralogical composition of bauxite samples.

Gibbsite	Boehmite	Kaolinite	Quartz	Goethite	Hematite	Anatase
61.3	3.95	3.15	0.68	18.3	8.86	2.12

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