Reactive Silica Reduction on Bauxite by Flotation

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Abstract

Bauxite is the main ore used in the production of alumina. Amazonian bauxite has gibbsite (source of available alumina) as main mineral, and is commonly associated with iron and titanium oxides, in addition to clay minerals such as kaolinite (source of reactive silica). The presence of silica is a common and significant problem in the bauxite and alumina industry, due to the kaolinite, quartz, and other silicates present in bauxite. Reactive silica (RS) reacts with sodium hydroxide (NaOH) in the Bayer process, consuming it in the precipitation of the desilication product (DSP). This increases alumina production costs and residue generation at the refinery. The purpose of this work was to evaluate the reduction of the kaolinite content in an Amazonian bauxite via reverse flotation using an amide-amine (Flotinor 16939) as a kaolinite collector. Bench flotation tests were performed at natural pH (~ 7) varying the collector dosage at 100, 200, 300 and 400 g/t. In all evaluated conditions, there was a decrease and increase, respectively, in the contents of RS and available alumina (AA) in the concentrate. It was possible to promote the selective separation between gibbsite and kaolinite by flotation at natural pH using the Flotinor 16939. The collector was considered efficient to reduce the kaolinite content in the tested Amazonian bauxite. The highest kaolinite removal was at the collector dosage of 400 g/t with metallurgical recovery of AA of approximately 73.5 %, eliminating 47 % of the kaolinite content. The Al/Si ratio in the concentrate was 11.3 (the Al/Si ratio in flotation feed was 6.8).

Keywords: Bauxite, Flotation, Reactive Silica, Available Alumina.

1. Introduction

The production of alumina is an important process in the aluminum industry, as primary metallic aluminum is obtained from alumina. There are different methods for producing alumina, the Bayer process being the most commonly used [1].

Bauxite is the main ore used in the production of alumina. Amazonian bauxite has gibbsite as main mineral and it is commonly associated with iron and titanium oxides, in addition to clay minerals such as kaolinite [2].

The presence of silica is a common and significant problem in the bauxite and alumina industry, due to the kaolinite, quartz, and other silicates present in different types of bauxite. In the Bayer process, kaolinite reacts with sodium hydroxide (NaOH) consuming it in the precipitation of the

desilication product (DSP). This increases alumina production costs and waste generation at the refinery [3].

It is important to emphasize that the production of alumina generates residues. The refinery residue contains impurities and by-products of the Bayer process, such as silica, iron, and titanium oxides, which need to be properly treated and managed to minimize environmental impacts. The higher the RS content, the greater the residue generation in the refinery [1, 4]. Flotation can be a solution to concentrate bauxite and favor the Bayer process with a more adequate feed.

Flotation is a mineral concentration process that aims to selectively separate two or more mineral phases by exploiting differences in their surface properties. There are two types of flotation, direct and reverse. In direct flotation, the collector adsorbs on the surface of the main mineral and it is reported to the foam, while the gangue minerals are suppressed at the bottom of the equipment. In reverse flotation, the collector adsorbs onto gangue minerals surface, removing them through the foam, while the main mineral is suppressed to the bottom of the equipment [5, 6, 7].

Lot et. al. (2019) evaluated the use of an amide-amine (Flotinor 5530) to reduce the RS content in a Brazilian bauxite via reverse flotation. Tests were performed at pH 10 in the presence of 800 g/t of starch (gibbsite depressant), varying the collector dosage between 100 and 200 g/t.

The purpose of this work was to evaluate the reverse flotation in Amazonian Bauxite beneficiation to improve its chemical quality (decreases reactive silica grade and increases the available alumina grade).

2. Materials and Methods

2.1 Ore

To perform the bench flotation tests, a sample of Amazonian bauxite from Hydro Paragominas, was used. The sample was collected at the processing plant.

2.2 Reagents

Flotinor 16939 (amide-amine) was used as kaolinite collector. The reagent was supplied by Clariant Brasil and prepared in a 0.5 % w/v solution. Flotinor 16939 is used in silicates reverse flotation in iron ore industry.

2.3 Methodology

Sampling generated a global sample of approximately 40 kg. This sample was filtered, dried in an oven at 105 °C, homogenized, and quartered. 20 aliquots of approximately 1 kg were generated to perform the ore characterization and flotation tests. The rest of the sample was archived. To perform the ore characterization, three aliquots were randomly selected.

2.3.1 Particle-Size Distribution

The Particle-size distribution was made by wet sieving (> 400#) and laser diffraction (< 400#).

2.3.2 Chemical Analysis

Contents of Reactive Silica (RS) and Available Alumina (AA) were obtained by digestion, volumetry, and atomic absorption. Iron and titanium oxides were obtained by X-ray fluorescence spectrometry. The overflow and underflow of each condition tested were analyzed to perform the metallurgical balance.

The Flotinor 16939 collector was considered efficient in reducing the reactive silica content in the tested Amazonian bauxite.

In all tested conditions the alumina/silica relation in flotation concentrate was greater than 10.

The highest reactive silica reduction was under 400 g/t of collector dosage with available alumina recovery of 73.5 %, eliminating 47 % of re. silica content.

The elimination of 47% of reactive silica content on bauxite is a huge benefit to reduce the alumina production costs on the refinery.

5. References

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