Bauxite beneficiation modifying factors

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Abstract

The Alumina Rondon project consists of a bauxite mine, beneficiation plant and an alumina refinery, along with its associated utilities and logistics. It will be installed in the Rondon do Para municipality in the Para state – northern Brazil. The refinery production capacity is three million tons of alumina per year. For this production, 12 million tons of ROM will be beneficiated, resulting in 9 million tons of washed bauxite (wet basis). The beneficiation process will occur in a single line plant at 1500 tons per hour. During the early stages of the project engineering, a characterization study was conducted. Such a study consists in the evaluation and quantification several key aspects of the material needed to proper equipment sizing. To confirm the values of the laboratory studies, an industrial test was done in the operating bauxite beneficiation plant installed in the Miraí municipality located in the state of Minas Gerais – southeast Brazil. The test was done with two bulk samples obtained from two pilot mines. The main aspects evaluated were: product loss, product contamination and effects of residence time in the scrubber.

1. Introduction

To produce aluminium, it is necessary to refine alumina. In the year of 2013 the total smelting grade alumina (SGA) production was 100 million tons. In the last ten years, the SGA production has doubled [1]. Alumina is refined from bauxite, and usual grades range from 35 % to 55 % of Available Alumina (AA). From the circa 200 million tons of bauxite annually refined nearly 20 % [2, 3] are from washed bauxite.

In the Bayer process, the Available Alumina (AA) contained in the bauxite is digested. Along with the AA digestion the Reactive Silica (RS) digestion also occurs. There are two sources of reactive silica (RS) quartz and kaolinite. Depending on the digestion temperature one or both might be digested. At 150 °C (or low temperature process) only the kaolinite is digested, at 250 °C (high temperature process) the digestion of quartz also occurs. After its digestion, the reactive silica precipitates as Desilication Product immobilizing Sodium Cations which will have to be replaced by the addition of NaOH – one of the main costs of Alumina production. Thus, the amount of NaOH makeup is directly related with the amount of reactive silica in the ore. So, for bauxite to be considered viable, the amount of AA must justify the consumption of NaOH by the RS. In a first approach, the ratio AA/SR (or module) must be higher than 10.

In this specific case, samples of the Rondon do Pará bauxite were analyzed. A typical sample from the ROM obtained from drill holes was analized. This sample had 33.9 % AA, 7.8 % RS with a module of 4.3. If this material is wet screened, in ideal conditions, the fraction coarser than 37 µm has 44.1 % AA and 2.5 % RS, with a module of 17.8. The fraction finer than 37 µm has 7.1 % AA, 21.6 % RS and a Mass Recovery (MR) of 27.7 % of the ROM. Table 1 summarizes the values.

This data justifies the beneficiation, i.e. the separation of the minus 37 µm for this specific bauxite. Kaolinite is a clay mineral and has a naturally fine particle size. The beneficiation process aims to reduce the particles size to expose or liberate the clay, disaggregate and separate it from the coarser particles. One point of attention is the comminution process: the separation is done by size, if this process is too intense, naturally coarser particles will be broken and separated as reject.

Table 1. ROM, Product and Reject grades, mass recovery and moisture (w/w).

	ROM %	Ideal Product **+37 µm, %**	Reject, %
AA	33.9	44.1	7.1
RS	7.8	2.5	21.6
MR	100	72.3	27.7
Moisture	12	12	25

Given the above, the mission of the processing plant is not the product grades or mass recovery, but to *efficiently separate the coarse particles from the fine ones*. The quality of this separation may be evaluated by the amount of natural coarse fraction lost to the reject (product loss) and the amount of natural fines present in the product (product contamination). The AA and RS grades are consequence of the natural qualities of the ROM or the process route, having the operation little influence on those values. The same applies to the product Mass Recovery (MR), as it is a natural characteristic of the ROM.

1.1 Beneficiation unit operations

The simplified flowchart of the Alumina Rondon beneficiation is shown in image 1.

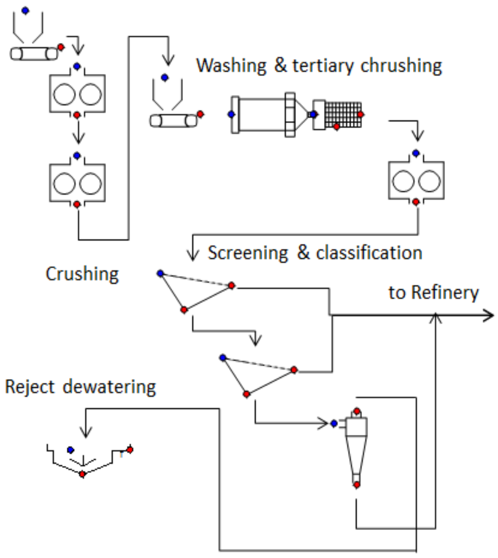

Figure 1. Alumina Rondon simplified beneficiation flowchart.

1.1.1. Crushing

The beneficiation of the Rondon do Pará bauxite begins when the mine trucks dump the material in the primary crusher hopper. This hopper may receive simultaneously material from six 32 ton trucks and a front-end-loader. The crushing area is the first step in the beneficiation process, and, as such, it must be able to handle the natural variability of the ROM: trucks dump intermittently and ore blocks vary in top size and size distribution. With that, the instantaneous capacity of the crushers must be high enough to deal with this variability and to form an intermediate stock pile to be consumed in case of a crushing shutdown.

The crushers selected for the Alumina Rondon beneficiation plant are sizer type crushers. These crushers have been successfully used in bauxite beneficiation, especially with the Amazon bauxite. They have several desired characteristics for bauxite processing, such as: self-cleaning, rotate at low

These tests increased the company's knowledge about bauxite beneficiation processing and ore dressing as a whole. More tests, varying feed rates and water ratios in the scrubber feed should be conducted to better understand the effects on residence time and rheology of the pulp inside the scrubber.

5. References

1 http://www.world-aluminium.org/statistics/ alumina-production/#data - 21st July, 2014.

2 http://www.riotintoalcan.com/ENG/ourproducts/1803_weipa.asp - 21st July, 2014.

3 http://www.mrn.com.br/en-us/operacao/ sequencia-operacional/pages/default.aspx - 21st July, 2014.

4 Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves - JORC Code, 2012 Edition, Joint Ore Reserves Committee 2012.

5 JKSimMet V6 Manual, JKTech Pty Ltd, 2013

6 Pitard, Francis F. Pierre Gy's Sampling Theory and Sampling Practice, 2nd edition,

7 Mineral Resource and Exploration Department from Votorantim Metais, Relatório de Atividades e Avaliação dos Recursos Minerais das Lavras Piloto Norte e Sul – Platô Rondon Norte – Projeto Alumina Rondon, Aug. 2013.