Laboratory Settling Tests Applied to Define Bauxite Consumption Strategy in Alumina Refinery

Fernando Oliveira Tartarotti[1], Juliana Lima Alves[2], Inocêncio Alves Filho[3] and Andrew Todd Owen[4]
1. Senior Chemist
2. Chemist
3. Chemist Technician
Alumar, São Luís, Brazil
4.Senior Research Scientist
Alcoa of Australia Limited – Alumina Centre of Excellence, Kwinana, Australia
Corresponding author: juliana.alves2@alcoa.com

Abstract

Alumina refineries are usually designed to consume a specific source of bauxite, however the usage of bauxites with different grades of available alumina, reactive silica and iron content is becoming more prevalent as a requirement to balance financial and technical goals. The mineralogical composition of the bauxite is also one of the main parameters used to evaluate the capability of each alumina refinery with respect to the bauxite source. Performance within the clarification area can be affected by the mineralogy of the solids that must be separated. This paper outlines work that has combined data from XRD analysis with laboratory settling test results to establish flocculant dosage and slurry pumping requirements to help the refinery to define a consumption strategy for different bauxite sources. This strategy can be oriented/viewed in terms of bauxite blending in the refinery feed and the required flocculant dosages or co-dosages (combination of different flocculant products). Settling rates, compaction and clarity in the overflow (supernatant) have been evaluated for each combination of bauxite feed, adjusting flocculants dosages. The conclusion of this work is that it is possible to apply lab settling tests with success to get an estimate of how different bauxite grades can be blended and added into the refinery feed, minimizing impacts on refinery production and raw materials performance.

Keywords: Bauxite; Bayer; settling rate, compaction, clarification

1. Introduction

Every alumina refinery is originally designed to process a predetermined kind of bauxite in a tight range of variability with regards to its mineralogical and chemical characteristics. With reference to the refinery observed in this article, traditionally only bauxite from Northern region of Brazil was consumed until a few years ago. More recently, a significant effort has been undertaken to understand how to take advantage of other bauxite sources which, from time-to-time, may have more favorable economics with regards to availability and transportation.

The bauxite from other deposits or having originated from a different deposition process, mainly sourced from Africa, obviously have different chemical and mineralogical composition such as variations in the boehmite and goethite content. Prior to consuming a new bauxite, a lot of information needs to be studied to define the strategy of consumption, such as blending with the local bauxite, and also flocculant usage/dosage requirements.

Therefore, some laboratory test work is required to be undertaken to:

1. Identify the mineralogical and chemical composition of the said ore and,

2. Gain an insight into the settling characteristics of the residue produced from the digestion of the new bauxite. This is done by performing bench settling tests simulating the conditions of the clarification process within the refinery.

It is important that the above work is carried out well in advance of processing the ore or blend of ores so that when a given different bauxite starts to feed the refinery the strategy of blending and flocculent usage/consumption will be already defined.

2. Settling and Clarification Process

Clarification (solid-liquid separation) is a key step in the Bayer process. This process consists of separating the bauxite residue from the green liquor containing soluble sodium aluminate ensuring that upon arrival to the Precipitation circuit, the liquor is completely devoid of any solid particles. Usually alumina refineries combine two subsequent steps to perform the solid-liquid separation: thickening plus filtering. The thickening of residue from digestion step is conducted inside tanks named thickeners (other alumina operators may refer to these as decanters or settlers but the function remains the same) with subsequent "washing" of the dense underflow occurring in washers that works with a water counter-current flow against the residue with the objective to recovery soda and also to further thicken the slurry before sending it to the residue lakes [1].

To achieve effective solid-liquid separation, flocculants (macromolecular polymers) are applied to induce aggregation of the residue particles. The polymer acts by rapidly adsorbing onto the surface of multiple particles causing the fine suspended solids to form into larger structures (aggregates) which settle faster. The separation of solids and green liquor must be conducted quickly or alumina trihydrate will precipitate during clarification. This is known as auto-precipitation and results in loss of production. It is vital to alumina production that clarification be effective. Poor flocculation can lead to excessive fines in the overflow which can blind the filter–cloths in the security filtration building leading to lower production rates. Additionally, any solids which pass through the filter cloth can contaminate the product. Ineffective flocculation may also lead to higher loss of caustic by entrainment within the residue [2].

The flocculant dosages employed are related to the composition of Bayer residue with reference to the mineralogy. Most common minerals are hematite, goethite and quartz with anatase, calcite and non-digested aluminates also being found.

3. Mineralogical Characterization – Qualitative Analysis by XRD

XRD diffraction patterns are characteristic of a substance and can therefore be used for identification when compared to a standard diffractogram. The ICDD – International Centre for Diffraction Data - has a database containing 848 000 diffractometric standards with interplanar distances and intensities diffracted to the planes *hkl* of the crystalline structure listed [3].

The procedures to handle the identification of the crystalline phases in a sample were based on the Hanawalt method, detailed by Cullity [3]. Nowadays automatic systems are applied in crystalline phase identification where the most intense peaks of each phase contained in the datasheet are compared to the diffractogram obtained to the sample. Results are expressed according to the compatibility comparative probabilities [4]

Figure 6. Schematic for new bauxite evaluation through lab settling tests + analysis.

7. References

1. C. C. Góis, R. M. F Lima, A. C. Melo, Sedimentação de resíduo Bayer utilizando floculantes hidroxamatos e poliacrilamida. *REM: R.Esc. Minas*, Ouro Preto, v.56, n.2, p.119-122, 2003..
2. F. Jones, The mechanism of Bayer residue flocculation. 1998, *PhD Dissertation –* Curtin University of Technology, Western Australia, 1998.
3. B. D. Cullity, Elements of X-ray diffraction. 2 ed. Reading: Addison-Wesley, 1978. p. 555
4. J. L. Antoniassi, A difração de raios X com o método de Rietveld aplicada a bauxitas de Porto de Trombetas, PA, 2010. *Masters Thesis*– Escola Politécnica, Universidade de São Paulo, São Paulo.
5. J. L. Alves, Estudo mineralógico de bauxitas utilizadas como matérias primas em uma refinaria de alumina SGA. 2018, 71p, *Monografia – Universidade Federal do Maranhão*, São Luís, 2018