Laboratory Experiments on Bauxite Processability in Al Taweelah Alumina Refinery

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Abstract

Alumina is extracted from bauxite, with each type of bauxite having its own distinct physical and chemical characteristics. These characteristics vary based on geographical location and source mine, making it crucial to understand their impact on refinery processability. Laboratory experiments are conducted to assess the processability of each bauxite type, providing an initial indication of potential limitations within the refinery. The results of these experiments can identify opportunities for optimisation or necessitate changes in maintenance, operating, and process procedures to overcome these potential limitations and production losses.

In accordance with standard procedures at the Al Taweelah alumina refinery, several laboratory simulations are performed prior to introducing the refinery to any new source of bauxite, or when using bauxite of relatively lower quality than the typical Al Taweelah alumina refinery bauxite feed from the same source. These laboratory tests include bauxite slurry viscosity measurements, flowability tests, breakeven point curves, settling tests, flocculants selection, liquor filtration, and mud filter press filtration simulations using different bauxite types and blends. This paper outlines the methodologies employed for Al Taweelah alumina refinery's various laboratory processability experiments and provides an evaluation of the results on how the outcome is applied to optimise the bauxite blend, refinery process parameters and to a financial model.

Keywords: Bauxite processability, Financial model.

1. Introduction

Al Taweelah alumina refinery has been processing mainly Guinean bauxite from the startup of the refinery and is now also processing non- Guinean bauxite. These bauxite types vary physically and chemically, and it is therefore necessary to understand the behaviour prior to feeding the refinery. Many laboratory experiments have been carried out, simulating plant conditions using different bauxite types and blends which will further support the refinery operations.

This paper describes the refinery's various laboratory processability methodologies and how these results are used as a whole: supporting plant scale operation and estimating the refinery capability to make strategic decisions.

2. Bauxite Quality

The difference in bauxite quality when comparing the Guinean and non-Guinean bauxite processed at Al Taweelah alumina refinery is in alumina, silica content and organics. Table 1 shows the range of the different bauxite qualities:

Table 1. Bauxite quality.

Bauxite type	Guinean bauxite processed at Al Taweelah alumina refinery	Non- Guinean bauxite processed at Al Taweelah alumina refinery
Total Al_2O_3, wt%	44–50	49–54
Total SiO_2, wt%	1.5–2.4	6–11
Fe_2O_3, wt%	18–27	10–16
TOC (total organic carbon), wt%	0.08–0.1	> 0.2
G/H (goethite to hematite ratio)	1.0–1.5	< 1

3. Laboratory Experiments Outcomes and Application

Laboratory results of the processed Guinean bauxite and historical plant performance are used as a baseline for the comparison to the non-Guinean bauxite for the applications which are described in the following sections. The Guinean bauxite types are referred as A and B while the non-Guinean bauxite types as bauxite types c, d, e, and f.

3.1 Laboratory Experiments: Equipment and Methodologies

3.1.1 Pre-Desilication Slurry (PDS) Preparation and Parr Reactor Digestion

To determine the appropriate quantities of bauxite charge, Milk of Lime (MOL) addition, and excess liquor for digestion, several input parameters were incorporated into the calculations. The prepared bauxite-liquor slurry was subsequently subjected to pre-desilication under controlled laboratory conditions. The slurry was placed in a rotating water bath maintained at a constant temperature of 75 °C for a duration of 16 hours. This setup was designed to simulate the pre-desilication conditions employed at the Al Taweelah alumina refinery prior to the Bayer digestion stage. Continuous rotation ensured uniform heat distribution and mixing, thereby facilitating effective interaction among slurry components and improving silica removal efficiency.

Bauxite digestion experiments were conducted using a high-temperature, high-pressure (HT/HP) Parr reactor at a target temperature of 280 °C, utilizing plant liquor feeding digestion (LTD) as the caustic medium. The bauxite was charged to achieve a target alumina-to-caustic ratio (A/C). For each test, the required amount of slaked lime was added to the reactor feed to simulate plant conditions.

Figure 1. Laboratory equipment. Left: Parr reactor, Right: filtration unit.

of its characteristics, e.g., silica, rheology impact, settling behaviour, filtration rates in liquor and mud filtration, underflows mud compaction, oxalate generation and hence, nucleation control and white side filtration. The process has to be adapted, not only for operations but also for maintenance strategies and tactics, e.g., to accommodate different turnover regimes for tanks and equipment due to different scaling behaviour.

Lab results are relative and might not always show quantitative results even when simulating experiments under the same plant conditions, however, most results were consistent when comparing to plant data with very few inconclusive results.

6. References

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