Development of a Model for Optimization of Bauxite Sources to Achieve Operational Excellence in Alumina Refinery

Sagar Pandit[1], Vikram Usulkar[2], Asutosh Acharya[3], Sandeep Patil[4] and Kaushal Gupta[5]
1. General Manager – Bayer Process Development
2. Senior Engineer – Analytical Development
3. Assistant General Manager – Analytical Development
Hindalco Innovation Centre – Alumina, Hindalco Industries Limited, Belagavi, India
4. General Manager – Standard Production
5. Manager – Technology & Process
Hindalco Industries Limited, Belagavi Works, Belagavi, India
Corresponding author: pandit.sagar@gmail.com

Abstract

Availability of a consistent quality and long-term sustainable bauxite source is a major challenge for the Bayer refineries around the world. With the depletion of high-grade bauxite ores and stringent environmental regulations, it is extremely challenging for most Indian alumina refineries to access indigenous high-quality bauxite ore for smooth operation of the process. Accordingly, there is a shift in the overall bauxite sourcing strategy, with imported bauxite ores making up a percentage of the overall bauxite requirements for the refineries. With this change, there is a need to revisit the overall refinery process control strategy owing to the sharp difference in the processing characteristics of both indigenous and imported bauxites. A model for bauxite source optimization has been developed to forecast the blend ratio for better process control in a plant. Bauxite sources (received at the refinery) were analyzed for their processing characteristics and the data used to optimize the blend ratio. The model developed entails a three-point strategy for evaluation of the bauxite sources and consists of a combination of i) preliminary screening of bauxites, ii) generation of detailed processing data and iii) a summary of bauxite performance for plant scale implementation at refinery. The developed strategy was put into practice through plant scale trials, where the performance of the various bauxite sources were analyzed for suitability of operations with various bauxite combinations. This unique model for bauxite source optimization led to achieving overall operational excellence for the refinery, with significant improvement in operational efficiencies, reduction in specific consumption factors including overall cost reduction in specific bauxite and caustic consumption, along with an increase in the liquor productivity. This paper presents a detailed explanation of model development, its application, and the benefits in terms of operational excellence for the alumina refinery.

Key Words: Bauxite, Bayer, Excellence, Model, Processability, Sourcing.

1. Introduction

Availability of high-grade bauxite reserves is a major challenge for the alumina refineries across the world. Stringent environmental regulations have made it extremely challenging for sourcing high quality bauxites for steady operation of refineries. In the context of India, alumina manufacturers are forced to shift the bauxite sourcing strategy from operating with only indigenous bauxites, to having a mix of imported and indigenous bauxites. This has led to a change in operating philosophy for bauxite sourcing due to the marked difference in processing characteristics of imported and indigenous bauxites.

Conventional philosophy for bauxite sourcing involved the evaluation of bauxite samples in the laboratory, then sharing of the results to the plant team. Based on the results from the processability studies, the bauxite sample was used in the refinery, unless a drastically negative

performance of the bauxite was found to be expected. This method worked well initially, since the bauxite samples were from a single mining location, and so drastic differences in the processing characteristics of the bauxite samples did not arise. However, with the change in the bauxite sourcing plan, the overall process control strategy of the alumina refineries needed to be revisited owing to the sharp difference in processing characteristics of both indigenous and imported bauxites [1].

With a view to forecast the preferred blend ratio for the different bauxites and improving process control in a plant, a model for bauxite source optimization has been developed. Model development involved analyzing all the bauxite sources (received at the refinery) for their processing characteristics, then using this data to optimize the blend ratio in the refinery. This unique model for bauxite source optimization led to achieving overall operational excellence for the refinery, with significant improvement in operational efficiency.

This paper details the process of model development, its application, and the benefits in terms of operational excellence for the alumina refinery.

2. Conceptual Approach

Bauxite processing studies involve simulating the alumina refinery unit operations of Predesilication, Digestion, Settling, Precipitation as well as organic carbon build up with the bauxite sample under evaluation. The process involves the following steps:

1. Optimisation of process conditions for predesilication & digestion
    a. These tests are done on a small scale using parr bombs
    b. Conditions of interest being temperature, residence time and charging A/C optimization.

2. Evaluation of settling, filtration, and organic load
    a. Tests under optimized conditions to evaluate settling, liquor filtration and bauxite residue filtration
    b. Cyclic organic load tests to determine the organic and oxalate conversion

Any new bauxite source was evaluated using the above procedure, in order to arrive at a set of process conditions which could be implemented by the refinery for the specific bauxite, along with gaining an understanding of the expected settling and the filtration characteristics.

In order to make this philosophy more relevant in relation to using a blend of bauxites from imported as well as indigenous sources, a 3-step evaluation strategy was developed. This strategy focused on preliminary screening of bauxites as well as development of a summary document outlining the plant scale implementation philosophy. This improved philosophy would help to speed up the process of bauxite evaluation as well as bridge the gap between laboratory generated data and plant scale implementation strategy.

3. Development of Model for Bauxite Source Optimization

Alumina refineries in India, currently face a major challenge in terms of adjusting the process conditions when using combinations of indigenous and imported sources as this can include as many as 5-10 or more sources of bauxite.

Historical data on the processing characteristics of imported bauxites show that there is a major difference in the quality, especially with respect to the lower reactive silica (k SiO_2) content and higher organic carbon content. Thus, processing of these bauxites in a blend with some indigenous

replacing some of the indigenous bauxites. This change in the bauxite sourcing plan has led to a need to revisit the overall process control strategy of the alumina refineries, driven by the sharp difference in the processing characteristics of both indigenous and imported bauxites.

The bauxite sourcing model developed assisted the refinery to rule out unacceptable sources and arrive at an optimum blend ratio when the refinery is required to process multiple bauxites, potentially sourced from 5-10 or more locations, and consisting of a combination of indigenous and imported bauxites.

The 3-step model process consisting of: 1) Preliminary analysis 2) Detailed Processability studies and 3) Summary was useful in arriving at the targeted long term bauxite sourcing for the refinery and has also helped in changing the process control philosophy from reactive to proactive. Summary data from the model has been extensively used for bauxite blend optimization thereby leading to significant improvement in the operational efficiency and allowing overall operational excellence for the refinery to be achieved.

6. References

1. Vikramkumar B. Usulkar et al., Bauxite processability manual, *Technical Report, Hindalco Industries Limited, HIC-Alumina,* 30 November 2013.
2. Sagar Pandit et.al., Optimisation of process conditions for use of IMP-1 bauxite sample, *Technical Communication, Hindalco Industries Limited, HIC-Alumina,* 25 February 2020.
3. Sagar Pandit et.al., Complete bauxite processability studies for IMP-3 bauxite sample, *Technical Communication, Hindalco Industries Limited, HIC-Alumina,* 3 March 2020.
4. Sagar Pandit et.al., Impact of INDG-1 bauxite processability on plant performance, *Technical Communication, Hindalco Industries Limited, HIC-Alumina,* 3 March 2020