Improving Ball Mill Efficiency through Application of Bauxite Grinding Aid

Santanu Dey[1], Sagar Pandit[2], Sandeep Patil[3], Airong Song[4], Alpha Barry[5], Hariharaganesan Natarajan[6] and Gaurav Gite[7]
1. Manager, Alumina Operations
2. General Manager, Bayer Process Development
3. Senior General Manager, Alumina Operations
Hindalco Industries Limited, Belagavi, India
4. Application Technology Scientist, Alumina Process Chemicals
5. Application Technology Group Manager, Alumina Process Chemicals
6. Technical Service Engineer, Alumina Process Chemicals
7. Technical Sales Manager, Alumina Process Chemicals
Solvay, Stamford, CT, USA
Corresponding author: santanu.dey@adityabirla.com

Abstract

Bauxite grinding is one of the important and critical unit operations in alumina refinery. Ball mill is a power intensive grinding unit where bauxite quality plays a major role in determining the efficiency of operation. However, with the limited flexibility available in terms of sourcing good quality bauxite, it becomes imperative to look out for other viable options for improving the efficiency of grinding, thereby, reducing the specific energy consumption.

In addition to operational improvements in ball mill which have a minor impact on the performance, various chemical grinding aids are tried to improve the grinding efficiency considering the ease of application and minimal CAPEX outlay.

Based on a detailed laboratory evaluation of various bauxite grinding aids, M/s Solvay CYQUEST® GA4400N grinding aid was found to be the most promising chemical aid. Further to the encouraging laboratory results, plant scale evaluation of the chemical was done at one of the refineries of M/s Hindalco which also supported the laboratory claims of increased ball mill throughput, thereby resulting in 8-9% reduction in specific energy consumption.

This paper gives an overview of the successful implementation of CYQUEST® GA4400N grinding aid and the benefits envisaged.

Keywords: Ball mill, Bauxite, Grinding aid, Energy.

1. Introduction

Generally, alumina refinery is designed based on the bauxite ore reserves at their vicinity. In any alumina refinery, bauxite grinding is one of the key steps where bauxite ore is ground to finer fractions to improve the efficiency of extraction. Bauxite grinding is one of the power-intensive unit operations in alumina refinery where the grinding energy consumption majorly depends on the quality of ore i.e., bauxite hardness. The production capacity of an alumina refinery is thus dependent on the performance of bauxite grinding unit which ensures appropriate fineness of the feed to the digestion process. Over a period, the quality of bauxite starts deteriorating with respect to its extractable alumina content. With the deterioration of quality of bauxite, the grindability of the ore denoted as Bond Work Index (BWI), kWh/t also gets affected adversely. Higher the BWI higher will be the energy required for grinding. Bauxite grinding unit is designed based on the quality of bauxite which is available for the refinery. Also, higher BWI could become a bottleneck

towards maintaining the required alumina production rate due to grinding limitation in bauxite grinding unit.

In ball mills, grinding is done with the help of different sizes of metal balls inside the rotating hollow cylindrical shell. The working principle follows the phenomena of impact and attrition based on which size reduction takes place. The capacity of the equipment is designed based on the bauxite feed requirement to the process of alumina extraction. The process is also called as wet grinding where finely ground bauxite ore gets further ground with caustic liquor to yield a slurry with very fine bauxite particles after further size reduction.

Maintaining steady grinding rate to sustain the refinery production level with control on specific grinding energy is thus the key focus area in grinding section. Hence, it becomes necessary to improve the grinding efficiency. Various chemicals are claimed as grinding aids to overcome these issues and various laboratory experiments are conducted to establish the results. To improve the product slurry quality, a closed-circuit grinding is practiced in many refineries wherein the ground bauxite slurry is screened through a particular size screen and the oversize material is returned to the mill for further grinding to yield the slurry with desired product granulometry suiting the digestion process conditions for maximum alumina extraction. Focus is then given to improve the product granulometry by optimizing the grinding rate with various grinding chemical aids.

A plant scale trial was conducted in two phases with a grinding chemical aid CYQUEST® GA4400N to improve the overall grinding efficiency. The application of chemical aid was successfully established after set of plant trials and thereafter, the application has continued to realize the benefits on a steady basis.

This paper presents the details of the detailed plant scale trial of the chemical aid CYQUEST® GA4400N which got established for the continuous use in the grinding section in order to support the steady refinery operation in one of the alumina refineries of M/s Hindalco.

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2. GA4400N Chemical Aid Trial Details

2.1 GA4400N Chemical Aid

In recent years, bauxite grinding section has emerged as a major bottleneck at one of the alumina refineries of M/s Hindalco. The major reason for the bottleneck is the change in the bauxite quality over the period. There was an increase in the MHA content in bauxite and correspondingly THA content got decreased. This led the plant to process harder bauxites with bond work in the range of 14-15 kWh/t as against 10-11 kWh/t found with softer bauxites. Hence various options were deliberated on improving the grinding efficiency, of which application of bauxite grinding aids emerged as the viable alternative.

Addition of grinding aid improves the grindability by decreasing agglomeration and increasing breakage. Grinding aid facilitates the size reduction so that the energy consumption in ball mills reduces without affecting the product slurry granulometry. Various chemicals were evaluated for grinding efficiency improvement, out of which CYQUEST® GA4400N chemical aid gave ~ 30 % reduction in recirculation. This chemical aid appears to be a low viscosity liquid and the basic properties of this chemical aid are tabulated below in Table 1. Reduction in recirculation in ball mill leads to an increase in bauxite throughput and thereby, reduction in specific grinding energy consumption without affecting the ball mill product fine slurry granulometry.

4. References

1. Sagar S Pandit, S. Sankaranarayanan and V.B. Usulkar, Bauxite Grinding Aids – Development of Test Method and Evaluation of Various Chemicals, *Proceedings of 32nd International ICSOBA Conference*, 12–16 October 2014, Zhengzhou, China, 9-10.