Maximizing Processing of Low-Grade Bauxite to Fulfil the Specialty Alumina Demand

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Abstract

Bauxite is the most common source and a critical raw material for hydrate and alumina production through a consistent and controlled process. The Belagavi Alumina Refinery, renowned globally for its specialty alumina hydrate production, was originally designed to process high-grade bauxite with a Tri-Hydrate Alumina (THA) content of 40 % and a reactive silica content of 3 %, sourced from captive mines. Following the depletion of these mines, the refinery transitioned to using purchased bauxite (imported and domestic), incorporating a blend of 20-30 % low-quality bauxite to maintain a minimum feedstock quality of 37–38 % THA. Under the current global challenges in bauxite availability, the Belagavi refinery was further forced to increase the proportion of low-grade bauxite (THA 34 %, Reactive Silica 4.5 %) in its feedstock wherein the quality variations in loads received from mines posed significant challenges in addition to design limitations of its conventional clarification vessels across the mud circuit. The processing of such bauxite has introduced significant technical challenges in the clarification process, leading to persistent issues in the filtration of decanter overflow across the Kelly filters. To mitigate these challenges, extensive laboratory evaluations were conducted to assess applications of various chemical additives to enhance process efficiency and to apply the same at plant scale. Through these rigorous collaborative efforts, the Belagavi refinery has been capable to adapt, now processing 100 % low-grade bauxite and meeting the demand for specialty alumina without compromising product quality. This paper details the methodologies and process optimizations deployed to enable the effective utilization of low-grade bauxite, ensuring a sustainable and efficient refinery operation.

Keywords: Specialty Grade Alumina, Tri-hydrate Alumina.

1. Introduction

The Belagavi Alumina Refinery of Hindalco Industries Limited is globally recognized for its consistent production of high-quality specialty grade alumina (VAP and Super VAP). Originally commissioned to process high-grade bauxite from captive mines, the refinery was optimized for a feedstock containing approximately 40 % Trihydrate Alumina (THA) and less than 3 % reactive silica. However, following the depletion and subsequent closure of these mines, the refinery was compelled to diversify its raw material base, gradually shifting towards both imported and domestically sourced bauxites.

Further compounding the challenge was the abrupt disruption in imported bauxite supply during August–September 2024 due to external factors at the supplier's end in Guinea. As a result, the

refinery had to pivot rapidly to 100% domestic purchased bauxite, triggering a range of operational bottlenecks and quality control concerns. One of the most critical constraints has been processing low-grade bauxite with higher reactive silica and lower available alumina content, which affects key Bayer process areas, especially clarification and filtration in conventional thickeners and Kelly filter setup.

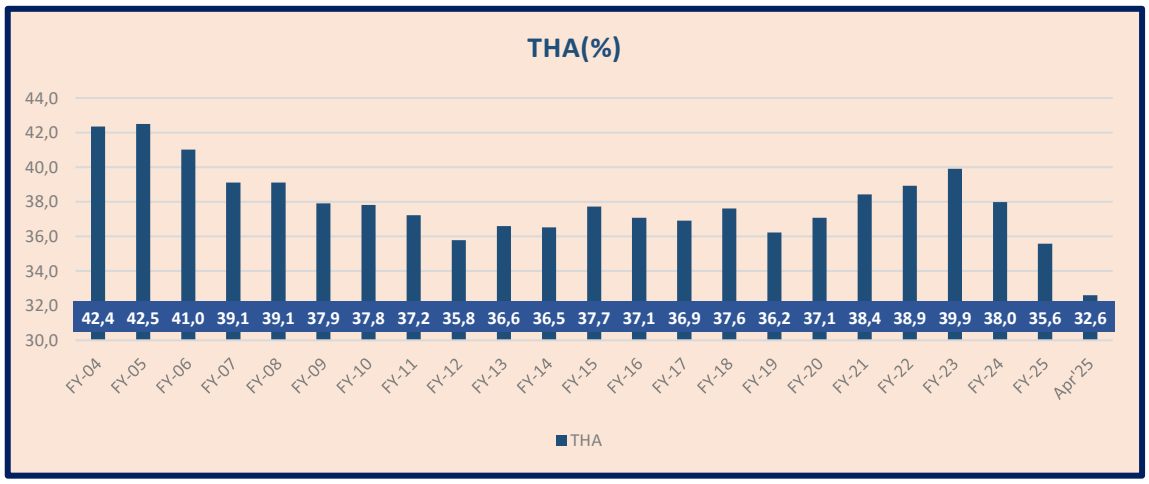

Figure 1. Feed bauxite THA from last 20 years.

As the refinery progressively increased the proportion of low-grade bauxite in its feed blend (as shown in Figure 1), a distinct shift in process behaviour was observed – most notably in the clarification and filtration sections. Flocculation used that had worked efficiently with high-grade or blended bauxite were no longer yielding desirable results. Overflow liquor from settlers exhibited elevated solids content, which began overloading the security filtration stage and significantly reducing the filtration capacity of the Kelly press filters.

Despite the absence of visible cloudiness in the settler overflow, fine suspended particles continued to persist in the clarified liquor. These ultrafine solids were consistently impacting the filtration rate at the security filtration stage. Their presence led to premature clogging of filter media in the Kelly press filters, reducing effective liquor throughput and sometimes increasing mud content in the filtrate.

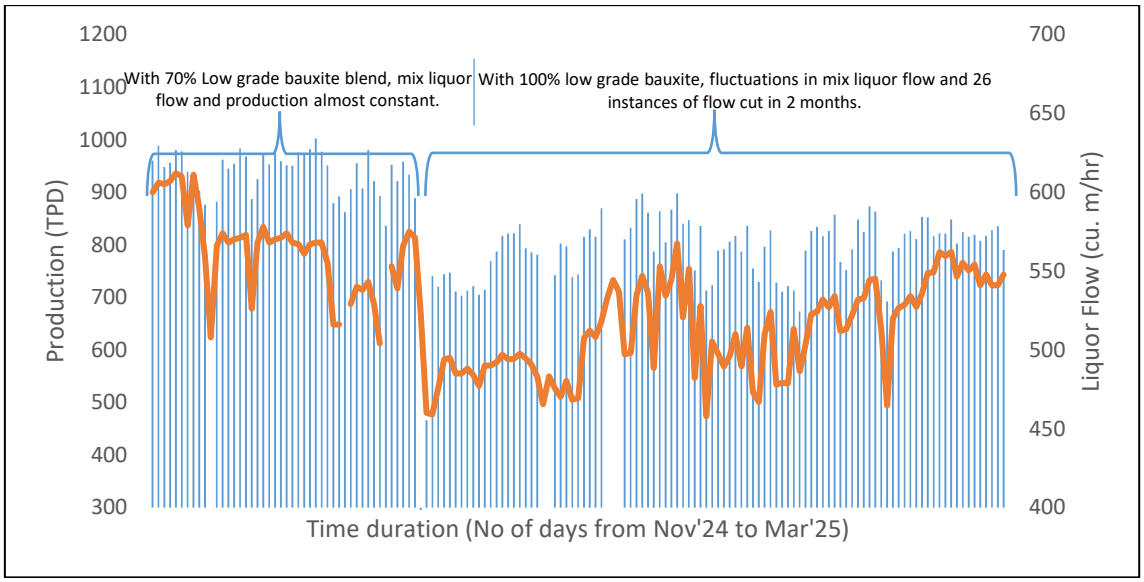

Figure 2. Production rate vs mix liquor flow.

This successful plant-scale demonstration reaffirmed the lab findings and validated the approach of using targeted chemical and process interventions to restore control, reduce variability, and sustain high-quality specialty alumina production in a challenging raw material regime.

5. Conclusion

The Belagavi Refinery's transition to processing 100 % low-grade bauxite presented considerable operational challenges, particularly in clarification and filtration due to increased fines. Through a combination of systematic laboratory investigations, pilot-scale evaluations, and carefully designed plant trials, the refinery successfully re-engineered its process to adapt 100 % low grade Bauxite.

The introduction of optimized flocculant systems (N-9779 and N-85700), in conjunction with appropriate filtration aids on top of TCA, significantly improved overflow clarity and filtration rates. These interventions reduced the standard deviation of overflow solids, stabilized the clarification process, and increased the availability and performance of Kelly filters. As a result, the refinery regained consistent liquor throughput and achieved steady production rates of high-quality specialty alumina, including VAP and Super VAP products. A major innovation in process was seen as new filtration aid as additive was identified and dosing point was identified to sustain the filtration during processing low grade bauxite to cater specialty alumina demand.

Through collaborative efforts and targeted process improvements, the refinery demonstrated that even a conventional design can adapt to 100 % domestic, low-grade bauxite while maintaining stringent product quality and operational stability. This achievement supports consistent performance and reflects a strong commitment to long-term sustainable mining and responsible resource utilization.

6. References

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