Enhancing Wet Bauxite Processing Through Innovative Handling Aid Solutions

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Abstract

Handling and transporting wet bauxite presents significant operational and safety challenges. In industrial settings, moisture-related issues such as material adhesion, flow obstruction, and equipment clogging lead to increased maintenance and reduced plant efficiency. Moreover, during maritime transport, wet bauxite poses a serious risk of cargo liquefaction – recognized by the International Maritime Organization (IMO) as one of the three most problematic bulk materials – potentially endangering boat stability.

This study evaluates a novel range of SNF patented handling aids named FLOMIN™ BHA, developed to improve the flowability of wet bauxite while maintaining the integrity of the Bayer process. Laboratory-scale tests using Boké (Guinea) bauxite assessed flow performance and slurry rheology under simulated Bayer grinding conditions. At dosages of 300–1000 g/t, FLOMIN™ BHA significantly improved discharge rates and reduced agglomeration compared to conventional superabsorbent polymers (SAPs).

A key innovation of FLOMIN™ BHA lies in its controlled degradation during caustic grinding, generating dispersive by-products that reduce slurry viscosity. This dual functionality enhances bauxite handling and grinding efficiency while avoiding the gel formation typically associated with SAPs. Additionally, by reducing free moisture content, the product may contribute to safer maritime shipping. Ongoing evaluations are examining the impact of FLOMIN™ BHA on critical Bayer process parameters, with a particular focus on solid–liquid separation efficiency.

Keywords: Wet bauxite, Handling aid, Acrylate polymers.

1. Introduction

Handling wet bauxite before processing presents several challenges, particularly in transport, storage, and material flow. High moisture content causes agglomeration, leading to blockages in hoppers, silos, and conveyors, requiring frequent manual intervention [1–3]. During transport, wet bauxite tends to stick to vessels, trucks, conveyors and hoppers surfaces, reducing unloading efficiency and increasing maintenance needs. In cold conditions, moisture can freeze, further complicating handling. In storage, excessive moisture can cause bridging and arching in silos, disrupting material discharge. Additionally, inconsistent moisture levels affect dosing and homogenization, leading to unstable material flow in processing units.

To facilitate the handling of ore, several solutions have been considered. Mechanical flow aids such as air blowing, aeration, and vibration methods are commonly used to counteract consolidation forces, disperse loose agglomerates, and break formed bridges. However, these techniques are often ineffective when the strength of the solids exceeds that generated by these methods [4]. Additionally, they require large energy sources and present constraints such as inaccessibility, physical damage, design changes, and safety risks [5]. Flow additives, such as lubricants, anti-caking agents, and flow regulators, have also been used to improve production efficiency and product quality [6–10].

A more practical solution to improve the flow properties of ores is the use of superabsorbent polymers (SAPs). SAPs are cross-linked polymer networks composed of water-soluble base elements, characterized by a low cross-linking density, which gives them a high liquid absorption capacity (up to 1000 times their own weight) [11]. They physically trap water through imbibition mechanisms such as diffusion and capillary forces within their macroporous structure. SAPs have been already applied in the dewatering of coal, clays, activated sludge, and metal plating sludge, achieving better results than centrifugal treatments [12–17].

Industrial-scale trials in the Bayer process with the commercial SAPs have shown these products are not degraded during processing. Instead, gel-like agglomerates accumulate in the red mud settler, are entrained in the overflow stream, and subsequently obstruct the safety filtration systems.

Handling iron ore and coal often poses challenges due to their cohesive and adhesive nature, exacerbated by moisture. Some studies have explored the use of SAPs to improve the flowability of these materials [4, 18–20]. Notably, Dzinomwa et al. pioneered the use of SAPs for dewatering coal fines, showing significant moisture reduction and improved production trials [4].

2. Materials and Methods

2.1 Materials

2.1.1 Chemical

The reagents evaluated in this study, including both commercial references and SNF-developed products, are polymers derived from neutralized acrylic acid. These materials are supplied in powder form and are synthesized via a gel polymerization process, a method well established and widely recognized in the field of polymer chemistry.

Table 1. Handling aid reagents.

Product	Comments
Market Product 1	Conventional SAP from the market
Market Product 2	Conventional SAP from the market
FLOMIN™ SAP 7500 CF	Specific SAP designed by SNF as handling aid and dry mineral processing aid
FLOMIN™ BHA 5478-2	Newly developed reagent designed for Bayer Process
FLOMIN™ BHA 5478-4	Newly developed reagent designed for Bayer Process

2.1.2 Bauxite

Bauxite was sampled from Boké (Guinea) with a residual moisture content of approximately 10 wt%. It was then screened through a 10 mm sieve to remove large aggregates that could affect test reproducibility.

4. Conclusions

This study has led to the development of a new class of reagent specifically designed to improve the handling of wet bauxite: FLOMIN™ BHA (Bauxite Handling Aid). These innovative products demonstrate performance equal to or even exceeding that of conventional available SAPs proposed on the market, while potentially overcoming one of their major limitations – the undesirable poisoning effect of the Bayer process.

Nevertheless, at this stage, the investigation of the potential poisoning effects of the Bauxite Handling Aid (BHA) is limited to slurry viscosity and the presence of insoluble materials in the digestion liquor. Further work is required to evaluate its impact on solid/liquid separation and on the total organic content within the Bayer liquor. Additionally, other potential poisoning effects should be considered, such as the influence on precipitation and final alumina quality.

A key advantage of FLOMIN™ BHA lies in its unique behaviour during processing. It degrades during the grinding stage by the attack of caustic solutions into by-products that act as dispersants, thereby contributing to a reduction in the viscosity of the resulting slurry, so it also acts as a grinding aid. This dual functionality – improving handling during the early stages and enhancing dispersion downstream – positions FLOMIN™ BHA as a high-value additives within the Bayer process.

While a series of results obtained at laboratory scale are highly encouraging, one of the next critical steps is to validate this new technology in other process areas and then under real industrial conditions. Field trials by alumina producers will be essential to confirm the operational benefits of FLOMIN™ BHA and to assess its potential for large-scale implementation in the industry.

5. References

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