Mechanism of Action of Filter Aids for Bauxite Concentrate Filtration and Performance Validation at Laboratory and Industrial Scale

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Abstract

Moisture control in concentrates is a challenging topic for the bauxite mining industry, as ores with high moisture content after filtration cause significant operational bottlenecks along the value chain. The use of chemical filter aids can improve the performance of filtering operations, especially in ores containing fine and superfine materials, because filter aids can change the surface tension of water and chemically modify the surface and agglomeration degree of bauxite particles, facilitating water flow through the pores of the filter cake. This paper describes the physical and chemical mechanisms involved in bauxite concentrate filtration processes and presents the results obtained in application tests with FLOTICOR™ DW 7278 by Clariant as a chemical filter aid for the filtration of fine and superfine fractions of a bauxite concentrate in lab and industrial scale tests. The use of Clariant FLOTICOR™ DW 7278 provided moisture reduction of 21 % in lab tests and achieved a 11.5 % lower moisture content in industrial trials, which should translate into lower operating costs for bauxite mining plants, as well as improvements in safety, and logistics.

Keywords: Bauxite dewatering, Filter aids, Moisture reduction.

1. Introduction

Solid-liquid separation is an important process for the mineral processing industry. The term dewatering is used to describe the production of a semi-dry solid by reducing the slurry bulk volume. Filtration is one of the methods used to produce such semi-dry solid in which the separation of solids from liquid is achieved by passing the slurry through a filtering medium forming a cake [1].

As mining companies mine the lower grade portion of their deposits, they often must grind ores finer to achieve the required degree of liberation, increasing the fines content in concentrates. The trend towards more fine-grained products means that moisture contents of filtration outputs will increase. The conventional dewatering techniques are not usually efficient for treating very fine particles, because the high particle surface area leads to higher hydration energy and capillary pressure and causes lower dewatering rates and increased moisture content. Fine particles also reduce the permeability and capillary diameter in filter cakes. There is interest in evaluating advances in moisture reduction techniques aiming to reduce costs and to ensure safer operations.

Frequently, mineral processing facilities must deal with changes in feed mineralogy or seasonal characteristics of the mine that result in operational hurdles to reach the desired moisture level of concentrates.

Approximately 100 million tonnes of bauxite ore are transported by ship annually [2], and special care must be taken regarding the moisture content of the material sent to alumina refineries across the globe to protect the integrity of the crew, ships, and cargoes. Solid bulk cargoes with fine granulometries and high moisture content present a considerable risk to the stability of the ship, as they shift along with ship's movements, shifting the center of gravity of the vessel and potentially causing accidents with personnel, environmental, and financial losses [3].

To prevent accidents, certain types of cargoes must only be transported by sea if their moisture content is below the transportable moisture level (TML), the maximum moisture content of a cargo for safe carriage according to international regulations and standardized methodologies [2].

In bauxite producing regions located in tropical regions, it is especially challenging to ensure that concentrates reach a moisture content below the TML before shipment. Consequently, the time for the concentrate piles to be ready for shipment is delayed, negatively affecting the productivity of the plants.

The usual solution to address both safety and process concerns is to improve filtration capabilities. Although expending filtration capacity generally solves issues directly related to excessive moisture content, this option is very capital intensive. Since many moisture-related problems are either caused by seasonal climatic conditions or eventual changes in feed characteristics, upgrading filtration and dewatering capabilities for use only during short periods of time also increases process complexity.

The use of chemical additives to improve dewatering processes is becoming increasingly common in mining operations [4], and many of the recurring challenges created by insufficient dewatering can be avoided or lessened by the application of chemicals as process aids for dewatering, including filtration.

Using chemical aids requires little to no capital expenditure and only minor changes in operating conditions. Their usage can be intermittent, only when required, such as during the rainy season for mines located in tropical climates or when facing high clay ores in mines with variable clay content in the ore.

Another benefit of the technology is the possibility to adjust dosages, allowing the operation to tackle scenarios of varying complexities and giving operators a swift response for capacity constraints and/or challenging moisture targets. Such flexibility potentially may allow process managers to reach product specifications even in scenarios that were not predicted in the early design of the operation.

To understand the physical-chemical mechanisms that come into play during solid-liquid separation processes via filtration and the interference of chemical additives, the Young Laplace as shown in Equation (1) is used [5]:

$$P_c = \gamma_{LA} \cdot \cos\theta_{SL} \cdot \left(\frac{1-\varepsilon}{\varepsilon}\right)\left(\frac{K}{d_m}\right) \quad (1)$$

where:

P_C	Capillary pressure
γ_{LA}	Air/liquid surface tension
θ_{SL}	Contact angle

The performance of Clariant FLOTICOR™ DW 7278 as a filter aid was further validated in industrial scale in a plant that filters a mixture of fines and superfines and the cake moisture decreased almost immediately.

Clariant FLOTICOR™ DW 7278 was shown to be an easy-to-implement solution for addressing dewatering challenges in mining operations, enabling the user to reach lower moisture contents in the filter cakes, which can lead to improved safety in handling at the plant and in the transportation of bauxite concentrate and to gains productivity by reducing the time and effort required for further drying in storage piles.

5. References

1. Laxmidhar D. Besra et al., Influence of surfactants on filter cake parameters during vacuum filtration of flocculated iron ore sludge, *Powder Technology*, Vol. 96, No. 3, (1998), 240-247.
2. Gustavo Ferreira Correia, Bauxite mining and shipping: transportable moisture limit (TML) test and further cargo assessments for safe shipping, Master of Science Dissertation, Polytechnique School of the University of Sao Paulo, Sao Paulo, Brazil, 2020.
3. Tim Evans et al., Development and performance of a rolling table used on a centrifuge, *International Journal of Physical Modelling in Geotechnics,* Vol. 19, No. 4, (2019), 200–207.
4. Artur Pinto Chaves, *Dewatering, Thickening and Filtering,* 4th Edition, Sao Paulo, Oficina de Textos, 2013, 240 pages.
5. George Eduardo Sales Valadao et al., Utilization of chemical aids in filtration, *Revista da Escola de Minas de Ouro Preto,* Vol. 57, No. 4, (2004), 229-234.
6. Y. Qi, K.B. Thapa, A.F. Hoadley, Application of filtration aids for improving sludge dewatering properties–a review*, Chemical Engineering Journal,* Vol. 171, No. 2, (2011), 373–384
7. Gharabaghi, M., Albijanic, B., Investigation on the effects of chemical pretreatment on the iron ore tailings dewatering, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, Vol. 625, (2021), 126855.
8. Stroh, G., Stahl, W., Effect of Surfactants on the Filtration Properties of Fine Particles, *Filtration & Separation*, Vol. 27, No. 3, (1990), 197-199.