An Effective Filter Aid for the Direct Filtration of Digester Blow-off

Scott Moffatt[1] and Gregory Flieg[2]
1. Principal Research Engineer
2. New Business Development Director
Syensqo, Princeton, United States of America
Corresponding author: scott.moffatt@syensqo.com
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Abstract

In the early 1990s, experimental work was done to identify an additive for the direct filtration of digester blow-off. The developed chemistry is largely unknown across the alumina industry since there were only 1 or 2 plants that operated, at that time, by directly filtering blow-off slurry. Research efforts resulted in a filter aid that increased plant filtration rate by 25–30 %, along with other benefits such as: increased A/C ratio, increased precipitation yield, improved product quality, reduced energy consumption, increased filter cloth life, and easier cleaning of the presses. The product was used continuously in plant scale operations for approximately 10 years. In recent years, the topic of 'returning' to direct filtration has been discussed as it offers some benefits over mud removal via gravity sedimentation in CCD circuits. This paper provides an overview of the application and performance of this filter aid in the direct filtration of digester blow-off.

Keywords: Filtration, Filter Aid, Digester Blow-off, Red Mud, Bauxite Residue.

1. Introduction

One of the most challenging aspects of the Bayer Process is the effective separation of the insoluble residue from the saturated sodium aluminate solution. This was reportedly true during the original development of the process [1], and arguably remains so today; especially with a general decline of bauxite quality. Initially, the process consisted of batch digestion of bauxite followed by direct filtration using plate and frame [2] or Kelly filters [3]. The term 'red pressing' was used for this operation (the direct filtration of digestion blow-off solids).

As the process evolved, starch was introduced, around 1939, as a flocculant-filter aid for the filtration step. Filter media also improved, going from heavy weight cotton as filter cloth to synthetic cloth in the 1950s [2]. Interestingly, the early filtration operation was heavily dependent on operator control, with several manual valves to operate, and highly sensitivity to overcharging in digestion, and meeting pre-desilication specifications. Eventually, around the 1940s, red pressing gave way to thickeners as part of a counter-current decantation (CCD) process to remove the majority of the residue. In the North American industry, this change was deemed necessary due to the introduction of Caribbean sourced bauxite that produced a higher mud load, and a much finer residue that was harder to capture in direct filtration. Filtration remained an integral part of the process but was moved downstream of the primary thickeners and fed with thickener overflow. This became known as 'clear pressing', and largely utilized Kelly presses. This general configuration largely dominated the alumina refineries built from the 1950s to the end of the 20th century.

The plant-scale practice of red pressing or direct filtration of digester blow-off is largely unknown today. The last plant reported to filter blow-off converted to a CCD circuit in 2003 [3]. However, developments in filtration technology over the last 20 years have made it feasible to consider a return to red pressing due to the considerable benefits that it offers [4–6]. One of the last plants to practice red pressing was the plant in Burnside, LA. During the early 1990s, Cytec

Industries/Syensqo developed an effective organic filter aid specifically for filters in this plant. It provided a number of benefits in this type of operation and was used continuously for approximately 9 years. An overview of this application is provided in this paper.

2. Reagent Development and Lab Evaluations

Reagent development for the direct filtration of blow-off began in 1990 and focused on the plant in Burnside, Louisina, USA. This plant, commissioned in the 1950s, used low temperature digestion and processed Trombetas bauxite. Digester blow-off was sent to an agitated filter feed tank, and the red mud was removed through Kelly filters. Cake from the filters was re-slurried and sent to a single stage of washing before being disposed of in the mud lake.

Several variations in chemistry, including varying molecular weight, were examined in the development of a filter aid for this process. Initial laboratory results showed 25–30 % improvement in filtration rate over untreated slurry. In 1991, three short plant trials were conducted using the most promising product chemistry, S-7099. However, the plant results only yielded approximately 10 % improvement in filtration rate. Laboratory studies completed onsite averaged approximately 20 % improvement in filtration rate. This laboratory work utilized 2-Liter Parr reactors fitted with internal steam coils for rapid heating and assisted cooling. Digestions comprised of 1500 mL of spent liquor and 150 grams of bauxite at 141 °C for 25 minutes. After cooling to 110 °C, digested slurry was discharged from the bottom of the reactor directly to a filter with plant filter cloth. Data on filtrate volume versus time was collected for each test. An example of the type of results received from this is shown below in Figure 1 where a particular filter aid was tested at several dosages.

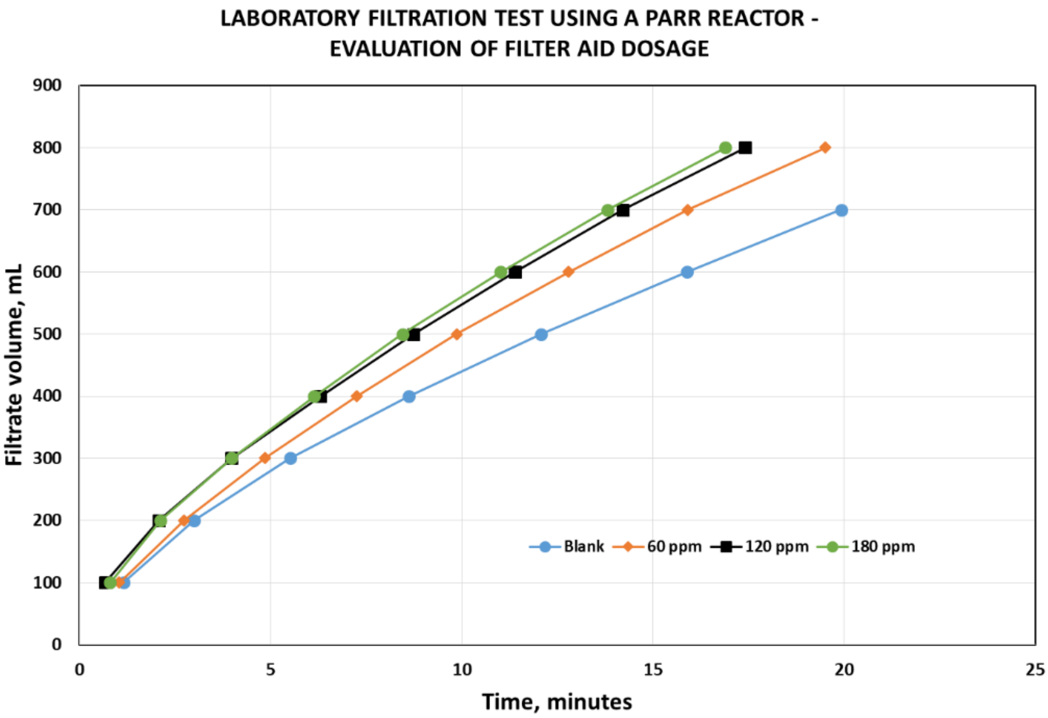

Figure 1. Filtration rate at varying filter aid dosages demonstrated under laboratory conditions.

The data in Figure 1 illustrates two important aspects of a filter aid. First, there is a significant improvement compared to untreated slurry. For example, at 500 mL filtrate volume, 60 ppm of filter aid dosage lowered the filtration time from approximately 13 minutes to 10 minutes.

in some of the references in this paper [4–6], there are process advantages such as increased A/C ratios, more direct washing of the residue, and a smaller or consolidated footprint of the plant process area. Further, as documented in this paper, the use of an effective filter aid helped realize several benefits leading to higher production and improved operation of the filters. But there is more to consider than the merits of direct filtration. An analysis of the challenges associated with thickeners and washers should also be considered.

In general, the operation of a CCD circuit to remove residue is one of the most challenging operations of the process, and can arguably contribute to most process upsets leading to production cuts. The entire unit operation is heavily reliant on consistent residue characteristics in addition to consistent and well-controlled flocculation of the residue. Changes in bauxite (higher mud load or higher goethite ratios) and digestion conditions regularly lead to technical challenges operating the clarification circuit. Furthermore, problems with flocculant preparation (due to water quality, equipment, incorrect solution concentration), maintaining the optimal flocculant, maintaining the distribution system (dosing pumps and scale free distribution lines/addition points) for the flocculant also often lead to process upsets and lost production. This entire system is very sensitive and often labor intensive, especially around cleaning and maintenance cycles.

Interestingly, the plant in Burnside (LA), undertook a 'modernization' project in the late 1990s which consisted of the installation of a CCD circuit. This circuit commenced operation in 2000–2001, and consisted of 2 primary thickeners followed by 5 stages of washing. The plant interest in this scale of investment was in part due to gaining the ability to process bauxites other than Trombetas. Additionally, the plant believed this would provide much better dewatering of the red mud residue and help prolong the life of the residue disposal area. After years of operation, it could be seen that plant production with the CCD circuit was actually lower than using direct filtration of blow-off.

Thus, it can be conjectured that the advancements made in pressure filtration make direct filtration an attractive option.

4. References

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