Development of Mud Rheology Modifiers

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Abstract

The use of flocculant to improve red mud settling in Bayer process mud washing circuit is critical for the effective and efficient operation of the circuit. However, the addition of flocculants has significant negative impacts on mud rheology, such as worse flowability and pumpability. These negative impacts could result in lower than desired underflow percent solids in settlers and washers. Syensqo has been developing mud rheology modifiers to address the issues related to mud flow-ability. In the process, proprietary methods were developed to replicate compacted mud in the laboratory, similar to what obtains in the settlers/washers in the refineries. This paper presents the progress made in improving mud rheology, highlighting how Syensqo's modifiers increased underflow solids by up to 5.1 % without compromising flowability, demonstrating both current achievements and future potential.

Keywords: Flocculant, Settling, Red mud settler, Rheology modifier

1. Introduction

The clarification process of the digested mud leaving the digesters, is one important step in the Bayer process. This is essentially the mud separation and soda recovery process.

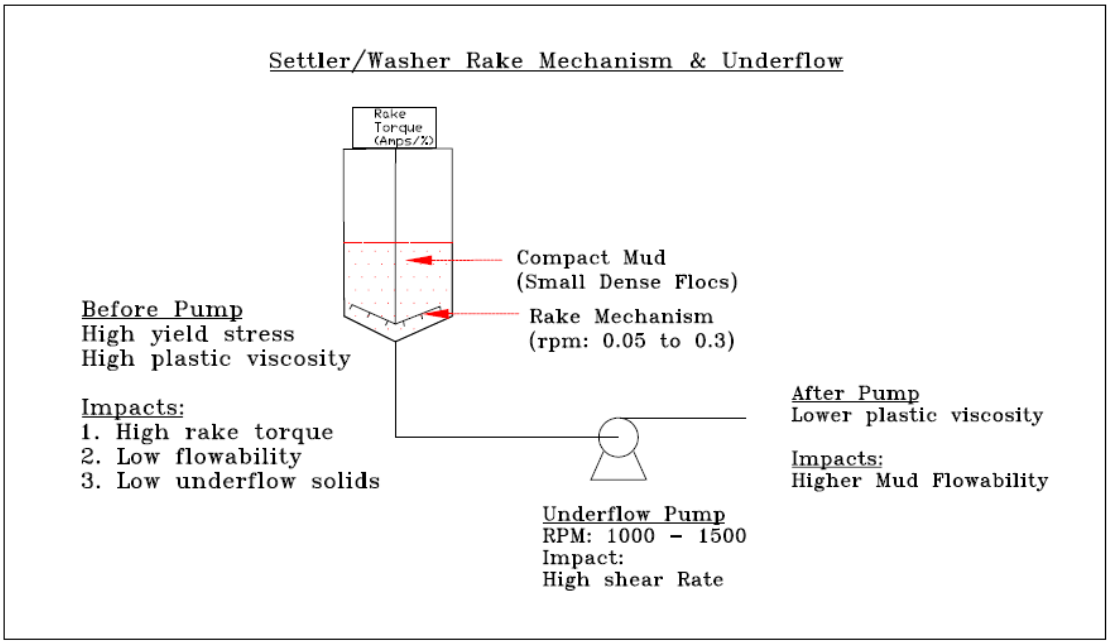

Figure 1. Typical settler/washer unit operations in an alumina refinery.

To efficiently enable the mud separation process, flocculation (the process where flocculants cause mud particles to attach and form larger, heavier particles) plays a major part. These large flocs increase in weight and settle out of the liquid (supernatant). However, once settled, they are broken down and compacted by the rake mechanism into small dense flocs (compact mud particles that are harder to move). These small dense flocs have poor mud rheology, meaning they do not flow easily due to high yield stress and high plastic viscosity. This poor flow behaviour can lead to high rake torque and plugged underflows, especially if there are attempts to increase underflow solids. It is an expensive process to turn around failed vessels, and the trade-off is low underflow solids resulting in low soda recovery. These problems tend to occur at the pump suction, since the high shear rate of the pump impeller would result in low plastic viscosity and better mud flowability [1, 2] at the discharge end (Figure 1).

The poor mud rheology, moving the mud from the vessel to the underflow pump is what Syensqo mud rheology modifiers seek to address. Syensqo's mud rheology modifiers are formulated to be used as rheo-flocculant. The mud rheology modifier is designed to flocculate the mud and improve the mud rheology. Optimum application would be determined at the refinery. The rheology modifier dosage may be slightly higher than the typical flocculant dosage in the refinery.

Syensqo is currently developing 1st generation of rheology modifiers under our CYQUEST® branding. These rheology modifiers interact with the mud during the bonding process known as polymer bridging. In this process, the polymer adsorbs onto suspended particles and it free ends attach to other particles, forming flocs. This interaction slightly weakens the adsorption mechanism between the rheo-flocculant and the mud particles, without negatively affecting the settling process (therefore, required settling rate will be achieved) [5].

2. Development of Laboratory Methods for Rheology Modifiers Evaluation

2.1 Lab-Scale Washer

A proprietary method was developed to test the rheology modifiers in the laboratory before testing in the refinery. This entailed developing a lab scale vessel to compact and create small dense flocs (mud). Compacted mud was generated, and flow-ability measurement was conducted on the mud. It should be noted that last stage washer mud was simulated for these tastings.

Figure 2. Lab scale washer vessel.

4. Discussion

The poor settling mud in this case is due to the bauxite quality change, such as boehmite content increase (in low temperature Refinery operating at around 140 °C) and reactive silica content increase. This mud required 242 g/t flocculant dosage to give the required settling rate, which is almost double the flocculant dose for the good settling mud. As was expected of the poor settling mud, mud rheology was worse than that of the good settling mud that used less flocculant dosage. The mud rheology for the poor settling mud was giving a flow of 1 cm for underflow solids of 26.75 %, while the good settling mud gave the same flow of 1 cm for underflow solids of 30.5 %. This therefore indicates that poor settling underflow solids had to be reduced by 2.45 percentage points from 30.5 to 26.75 % to give the same flowability.

As seen in Figures 6 and 7, Syensqo's mud rheology modifier gave a good rheology response to flocculated mud in the vessels For Figure 6, the untreated mud was giving flows of 1 cm for underflow solids of 29.49 %, while treated mud was giving flows of 1 cm for underflow solids of 34.6 % solids, achieving a 5.1 percentage points solids increase compared to untreated mud. For Figure 7, the untreated mud was giving flows of 1 cm for underflow solids of 27.7 %, while treated mud was giving flows of 1 cm for underflow solids of 31.7 %, achieving 4 percentage points solids increase compared to untreated mud. The mud rheology modifiers capitalize on the opportunity that Spitzer *et al* [2] mentioned, stating that major mud rheology improvement can be achieved from the vessel discharge to the underflow pump.

It should be noted that the laboratory simulation is a batch operation as opposed to the dynamic continuous operations in the refineries. Therefore, it is expected that the underflow solids improvement recognized by Syensqo's mud rheology modifiers may be even greater in the refinery.

5. Conclusion

Poor settling mud causes higher flocculant dosage required for settling purposes. This in turn causes poor mud rheology. As a result, the refinery needs to adjust the vessel's underflow discharge rates to achieve lower underflow solids, so as to prevent rake failure or plugged underflows.

Syensqo's mud rheology modifiers are shown to help increase the underflow solids without negatively affecting the mud flowability. This increase in vessel underflow flow-ability would help to prevent or reduce underflow blockage; or refineries could also increase underflow solids improving their soda recovery programs, resulting in caustic savings.

6. References

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