Performance evaluation of CYFLOC® HF series – New dextran-based hydrate flocculants for the alumina industry

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Abstract

Cytec Industries has been supplying hydrate flocculants to the alumina industry for over 20 years. In order to broaden and improve upon the hydrate flocculant product line, Cytec has launched a dextran-based hydrate flocculant series to the alumina industry: CYFLOC® HF-2220, CYFLOC® HF-1110, and CYFLOC® HF-222. These products are high molecular weight dextran-based flocculants that have been demonstrated to be extremely effective at flocculating and settling hydrate in the classification stage of the Bayer process. In addition, these flocculants substantially improve the rheology of the settled hydrate. This paper presents the laboratory performance test results of the new CYFLOC® HF series products applied in the hydrate slurry of the classification stage of an alumina refinery. The results indicate that by applying these products, it is possible to achieve up to 90 % performance improvement when compared with commercially available dextran-based flocculants.

Keywords: Hydrate; flocculant; classification; CYFLOC® HF series; Bayer process.

1. Introduction

In the crystallization stage of the Bayer process, precipitation of alumina hydrate is followed by a classification circuit. This circuit is usually composed of primary, secondary, and tertiary classifiers operating in series and serves to separate the coarse alumina hydrate fraction from the fines. The coarse alumina hydrate from the primary classifier is then sent on to calcination while the finer fraction is re-circulated back to the precipitation stage to be used as seed. In most instances, the classification circuit further segregates the seed into coarse and fine fractions. Underflow solids from the secondary classifier are used as coarse seed while the ones from the tertiary classifier as fine seed. The overflow spent liquor from the tertiary classifier is routed through evaporation and then recycled to digestion.

In the operation of the tertiary classifiers, flocculants play an important role in minimizing the amount of alumina hydrate in the overflow. Alumina hydrate in the overflow represents a recirculating load going back to digestion and reduces the overall yield of the plant. Most plants generally try to control the hydrate concentration in the overflow to 1 gramme per litre or less [1].

In the past, Cytec's focus has primarily been on bringing value to the industry through red mud flocculation and sodalite scale inhibition. In addition, Cytec has also supplied hydrate flocculants to the alumina industry for over 20 years. The primary products were CYFLOC® HFA, CYFLOC® HF-80/HF-40, and CYFLOC® TF-8000/TF-9000. Recently, Cytec has brought to the market the most efficacious and cost effective line of dextran based hydrate flocculants to the alumina industry. The three new commercially available products are CYFLOC® HF-2220, CYFLOC® HF-1110, and CYFLOC® HF-222. This paper summarizes the laboratory performance evaluation of these products against commercially available (C.A.) dextran as hydrate flocculants in the Bayer process.

2. Experimental

2.1. Slurry feed

Slurry feed was collected directly from the overflow of a secondary classifier in an alumina plant. The changes in slurry parameters such as solid concentration, particle size distribution, and temperature can largely affect the settling of alumina hydrate, and consequently the clarity of supernatant or overflow. These parameters among others (e.g. vessel design, control philosophy) need to be considered when evaluating the performance of flocculants on a classifier [2].

In this study, the solid concentration in the slurry was ~ 180 g/L of alumina hydrate seed in the liquor. The particle size analysis of the slurry feed was done using the Mastersizer 3000 laser particle size analyzer and the results are shown in Table 1. Approximately 10.1 % of the seed was below 45 µm and approximately 1.9 % below 20 µm.

Table 1. Particle size distribution analysis of seed from slurry used in the test.

Size (µm)	< 20	<45	>45	>75	>150
Percentage (%)	1.89	10.07	89.93	64.92	5.37

2.2. Laboratory evaluation methodology

The well mixed feed slurry from the 5 gallon container was equally split and transferred to a number of 1 L plastic bottles, which were then stored in the 70 °C water bath for another 2 hours for the samples to equilibrate to the bath temperature. The slurry in the bottle was then transferred to a number of 1 L graduated cylinders and mixed well with 6 rapid strokes of a perforated disc plunger to ensure uniformity prior to flocculant addition. The flocculant solutions were initially diluted to 1 wt % with DI water and then further diluted to 0.1 wt %. Using a syringe, the 0.1 wt % flocculant solution was added to the slurry in the 1 L cylinder and mixed with 10 moderated plunger strokes. Three different dosages were applied for each flocculant product with some repeats in order to better understand the degree of variability in the test. Dosage requirements in the application test will vary and be dependent on liquor composition, hydrate solids content and surface area, as well as the level of performance desired [2]. In this test, the dosage range applied was 33, 66, and 132 g/t of hydrate. The post-flocculated slurry was rapidly transferred into a graduated Imhoff cone and let settle for a determined length of time. The same test conditions were applied when the untreated slurry (blank) was evaluated. Finally, drainage time versus dosage and clarity versus dosage were evaluated. After settling the slurry, the time required to drain all the substrate out of the cone (drainage time) was recorded and a sample of the supernatant was taken to gravimetrically determine the level of solids in it (clarity). Finally, drainage time, clarity and dose values were analyzed using statistical software and plots were obtained for drainage time and clarity against dosage.

3. Results and discussion

Cytec's CYFLOC® HF series are dextran based polysaccharide flocculants manufactured by a proprietary fermentation process. These dextran products contain mainly an α-D-(1, 6)-linked glucopyranosyl backbone with the presence of a small percentage of branching. These products cover a wide molecular weight (MW) range with value of up to 100 mDa (millidalton) based on intrinsic viscosity measurements. In general, their MW's are higher than other dextran products in the market (MW < ca. 10 mDa).

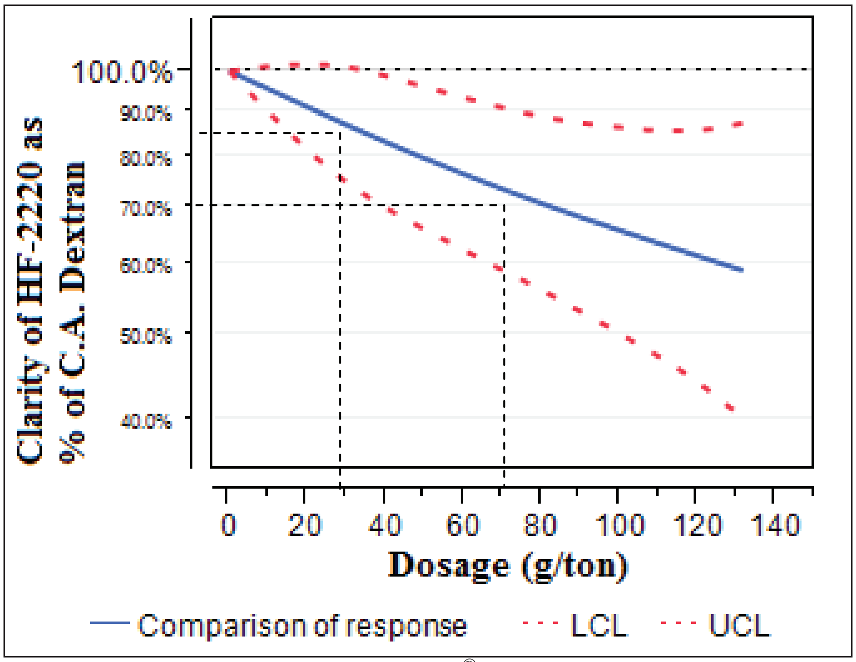

Figure 8. Percentage improvement of CYFLOC® HF-2220 in clarity as compared with the C.A. dextran.

4. Conclusions

Cytec has launched new dextran-based hydrate flocculants, CYFLOC® HF series, for application in the alumina industry. These dextran products have molecular weights of up to 100 mDa, which are higher than other C.A. dextran products. Based on laboratory performance evaluations, these products were found to show significant improvements in terms of overflow clarity and drainage time when compared with the C. A. dextran. At a dosage of 70 g/T, it is possible to achieve up to 90 % performance improvement using CYFLOC® HF-2220 when compared with commercially available dextran-based flocculants.

5. References

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