

Study of Settling Behavior in High Rate Decanters

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Abstract

In the Bayer process, production of alumina tri hydrate is controlled by availability of clear liquor for crystallization. Production of clear liquor is affected with decanter operation and filter performance. Decantation is used to separate bulk of the solids where flocculant is added to slurry to achieve rapid settling of solid particles. Feed conditions dictates flocculant consumption rate and overflow liquor clarity. Impact of mud characteristics and methods of controlling feed parameters are discussed in this paper. Attempt is made to study settling behavior with respect to mud composition and scheme to get desirable feed conditions was tested.

Keywords: Bauxite Residue Settling, Gibbsite, Flocculant, Desilication.

1. Introduction

Bayer Process uses caustic liquor to dissolve alumina from bauxite. Digested alumina stays in liquor phase which needs to be separated for further processing. Gravity decantation is used to separate bulk of the solids and supernatant liquor is further clarified with pressure filters to get clear liquor which is then subjected to crystallizers for precipitation of alumina tri hydrate. Hence decantation is a key step which dictates performance of filtration unit and process flow rates in alumina refinery.

NALCO refinery at Damanjodi is using high rate decanters (HRD) to achieve fast separation with compact mud generation. This study is conducted to find key operating parameters which are affecting settling performance. Effect of elemental & phase composition on settling is studied. Based on the outcome of this study, a modified dilution scheme is tested with jar settling test.

2. Impact of solids composition on settling

HRD feed solids were analyzed for mineral composition with XRD and elemental composition with XRF. It was understood that high Goethite content results in poor settling. High silica bauxite is also supposed to retard decanter performance.

Sample analysis during normal operation suggests that Goethite to Hematite ratio in range of 0.5 to 0.7. During troubled times also, Goethite to Hematite ratio was not varying much and staying in normal range. XRF analysis revealed that Al₂O₃ was sometimes higher than normal during episodes of poor settling. Flocculant dosage were analyzed against Al₂O₃, SiO₂ and Na₂O and presented at Figure and Table 1.

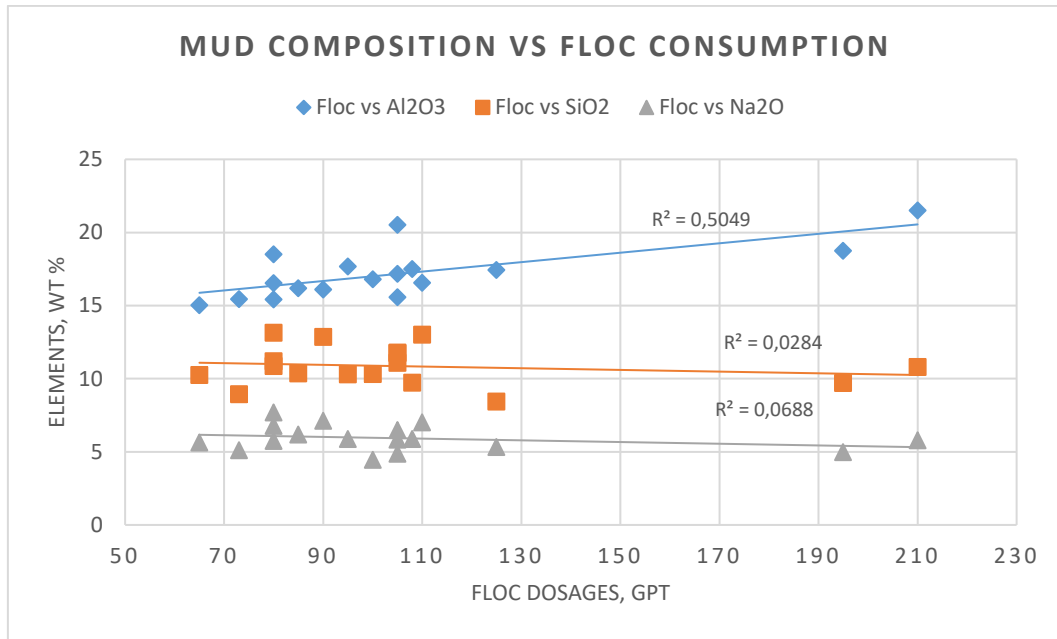


Figure 1. Flocculant dosages against elemental composition.

Table 1. Elemental & phase analyses of feed solids

Floc Dosage, g/T	XRD Analysis			XRF Analysis				
	Hematite	Goethite-Al	G/H	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	SiO ₂	Na ₂ O
125	39.83	26.73	0.670	17.43	56.29	4.09	8.44	5.33
85	48.03	29.81	0.620	16.18	54.60	4.08	10.36	6.18
73	52.67	32.18	0.610	15.43	57.17	4.21	8.93	5.10
105	51.17	33.89	0.660	15.57	53.60	3.87	11.79	6.49
65	56.40	31.06	0.550	15.01	56.25	4.17	10.24	5.64
80	50.59	33.84	0.670	15.41	53.97	4.00	11.20	6.76
80	46.19	27.62	0.600	16.54	50.17	3.48	13.13	7.68
110	49.39	28.70	0.580	16.55	50.66	3.85	13.00	7.00
90	52.99	31.10	0.590	16.10	50.92	4.02	12.86	7.12
100	50.17	33.33	0.660	16.79	55.56	4.56	10.32	4.44
105	33.00	22.31	0.680	20.52	51.80	4.26	11.07	4.86
80	32.87	17.31	0.530	18.51	52.36	3.84	10.86	5.74
210	18.36	10.62	0.578	21.50	50.86	4.66	10.80	5.79
195	36.13	16.84	0.466	18.74	53.58	4.40	9.69	4.97
95	28.62	15.11	0.528	17.68	53.67	3.87	10.30	5.87
105	34.09	19.98	0.586	17.16	52.55	4.09	11.74	5.83
108	33.69	21.52	0.639	17.50	52.78	4.16	9.73	5.86

XRF analysis of mud samples indicates positive correlation between Alumina in mud and flocculant requirement at HRD. Flocculant dosages were found to be independent of Silica & Soda in mud which suggests that bauxite Silica or reactive Silica doesn't interfere in settling.

3. Scheme to improve settling performance

High Al_2O_3 is an indication of undigested bauxite or higher reversion losses across Post desilication circuit. Reversion losses can be avoided by limiting primary dilution at Post desilication input. Dilution is added to digested slurry to facilitate DSP formation and to increase supersaturation. Schematic diagram representing existing dilution philosophy is provided at Figure-2.

Dilution also helps in settling as it decreases solids concentration of HRD input slurry. High feed solids cause settling disturbance and demands for high flocculant dosages. Feed solids concentration can be controlled by increasing primary dilution flow, but due to high residence time at post desilication this can lead to auto precipitation of alumina hydrate and high alumina in mud adversely affects settling and results in increased flocculant dosages. Dilution liquor can be minimized at post desilication input and desilicated slurry may be further diluted to reduce feed solids and achieve desired supersaturation. Liquor residence time in HRD is small which can help in avoiding alumina reversion losses.

Jar settling tests were conducted to check impact of dilution on settling behavior & flocculant dosages.

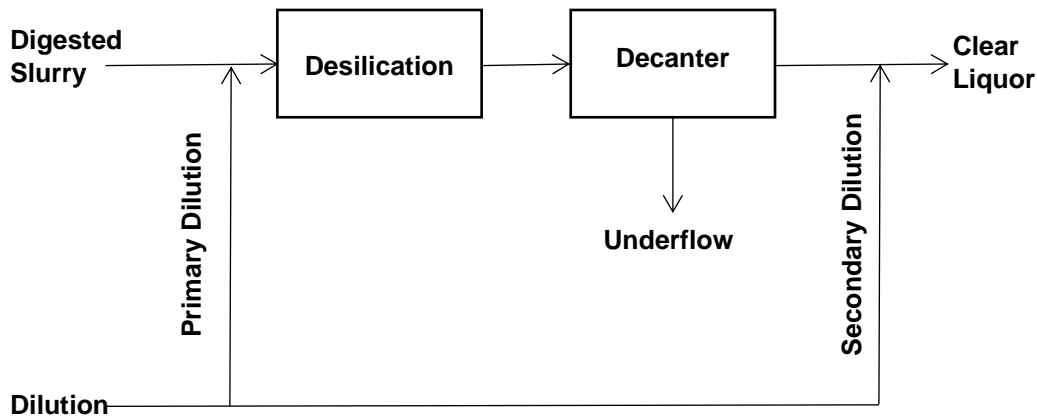


Figure 2. Existing dilution scheme.

3.1 Test Method

Desilicated slurry was collected in one-liter cylinder and measured amount of 0.2 % diluted flocculent was added to the slurry in 70:30 ratio. Time taken for solid-liquid interface to drop from 900 ml to 700 ml was recorded to calculate settling rate. For diluted slurry, 200 ml of secondary dilution was added to 800 ml of desilicated slurry and the same procedure was followed. Two sets of tests were done with four different dosages and each set was repeated.

3.2 Results and Discussion

Test results are summarized at Figure 3 and 4. These results indicate improved settling rate with diluted slurry (When secondary dilution is added prior to settling). Flocculant requirement for required settling rate of 15 m/hr was found to be 40 % less when feed slurry was diluted. Test results indicates that dilution can be used to control HRD feed solids and hence flocculant consumption. Based on test results a modified dilution scheme as depicted at Figure 5 is proposed.

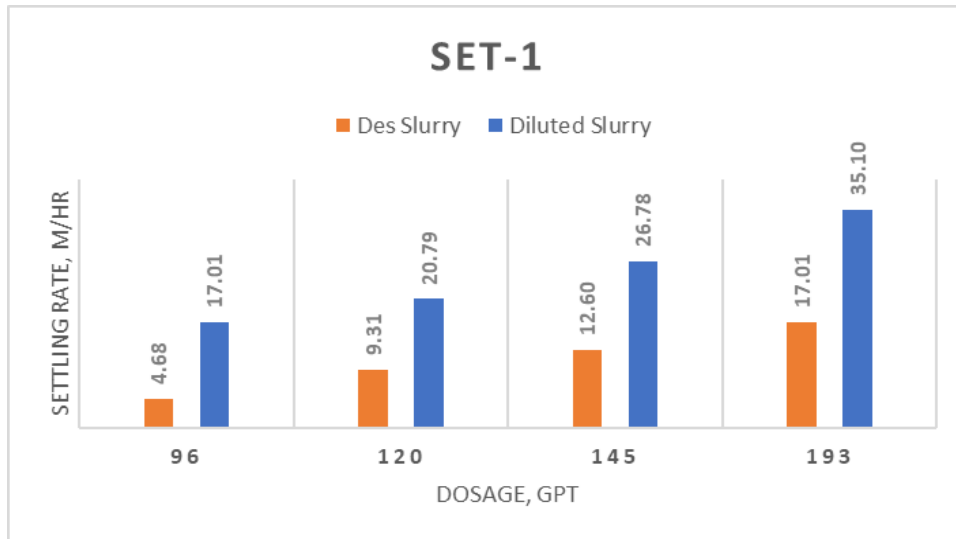


Figure 3. Impact of dilution on flocculant requirement (Set-1).

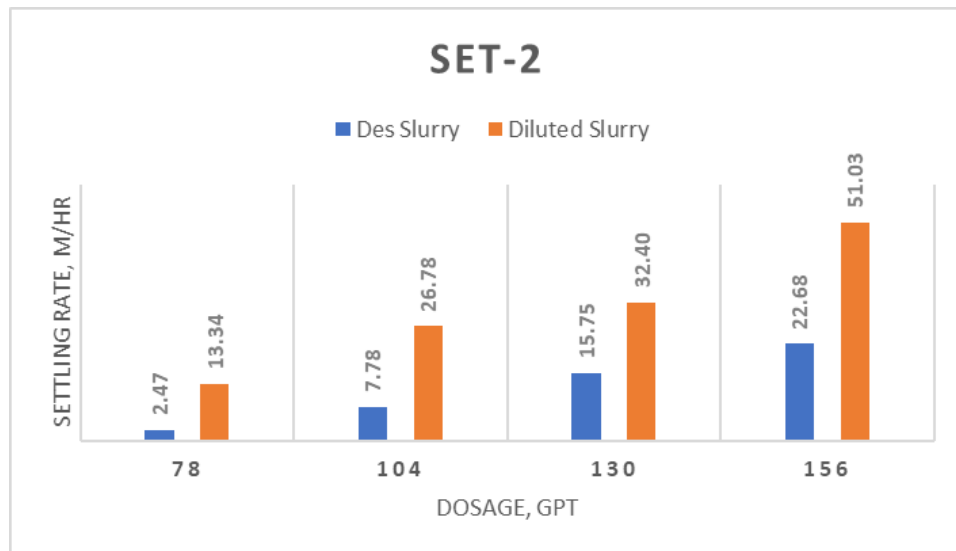


Figure 4. Impact of dilution on flocculant requirement (Set-2).

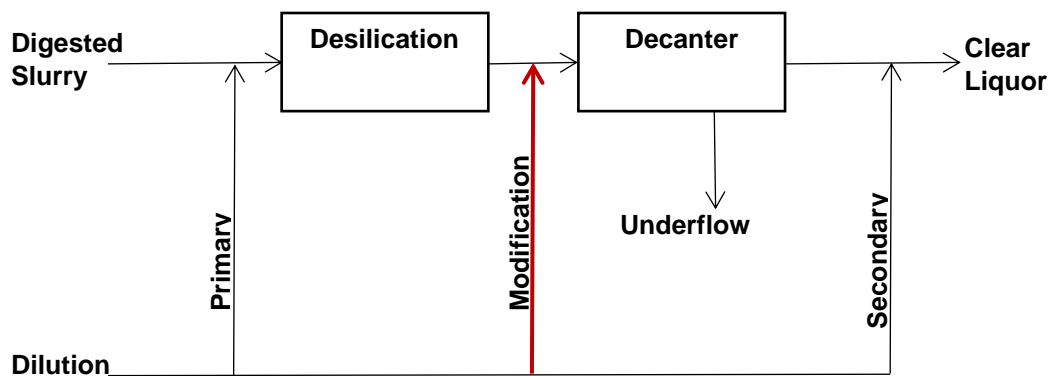


Figure 5. Proposed dilution scheme.

4. Conclusion

The effect of gibbsite present in mud is considerable. It was observed that presence of gibbsite in mud results in poor settling behavior. Goethite to hematite ratio remained fairly stable in all the studied samples. This ratio is function of ore quality which remains steady if ore from single deposit is used. Impact of other elements including silica were negligible on decanters performance. Jar settling test indicates that additional feed dilution helps in achieving better settling with lower flocculant dosages. Scheme to achieve optimum feed solids without affecting post-desilication performance is worked out.