Sodium Benzoate as Promoter in the Soap Flotation of Phosphate Minerals

[1]Mihir, DM. [2]Vijay Kumar, P and [2]Prabhulingaiah, G.

[1]Department of Chemical Engineering, Satyabhama University, Chennai.

[2]JPM Plc. Co, Eshidiya Mines, Jordan.

Corresponding author; prabhu2626@yahoo.co.in , 00962796122148

Abstract:

In the present study we show that sodium benzoate substantially improves the efficiency of Soap LDO collector in the flotation of phosphate minerals.

Key Words: Soap Flotation, Hydrotropes, Sodium Benzoate.

Introduction

Jordan is blessed with huge phosphate ore deposits covering an area about 125 square kilometers. Eshidiya mine is located in the southern part of Jordanian plateau. The phosphate ore deposition occurred in three layers marked as A1, A2 and A3. A1 layer with a thickness of 2.6 meters has an over burden of 14 meters followed by an inter burden of 2 meters below which A2 layer of thickness 1 meter is located. Below the A2 layer there is an interburden of 0.3 meters followed by A3 layer of 1.7 meters. A1 ore analyses 40 to 50% Tri Calcium Phosphate [TCP]. The gangue minerals are clay, marl, detrital quartz. A2 ore analyses 73 to 75% TCP. Where as A3 ore analyses 25 to 45% TCP with gangue minerals such as clay and high silica. Thus where as A2 ore is directly marketed A1 anA3 ores need to be beneficiated. A1 ore beneficiation involves scrubbing and de sliming by cyclones where as A3 ore is scrubbed, de slimed and then fed to a flotation circuit.

Flow sheet for A3 ore

Sized A3 ore of – 12.5 mm is scrubbed in a drum scrubber and the discharge of the scrubber is fed to a primary vibrating screen with an opening of 2 mm and the -2 mm fraction is fed to secondary vibrating screen with screen openings of 1.25 mm. The over flow of the primary screen in the size range of -12.5 mm to + 2 mm is discarded as waste product. The over flow of the secondary vibrating screen is stored and marketed as sub commercial product. The under size of the secondary screen that is – 1.25 mm size is fed to the first stage de sliming hydro cyclone and the over flow of – 53 micron size is fed to a thickener. The under flow of the first stage hydro cyclone is fed to a second stage de sliming cyclones and the over flow is also fed to the thickener. The under flow of the second stage cyclones is fed to the third stage cyclones. The third stage cyclones over flow is re circulated as the feed of the second stage cyclones and the under flow of the third stage cyclones is fed to a hydro sizer to separate +53 microns to - 500 microns in the over flow of the hydro sizer and the under flow contains particles in the size range +500 microns to – 1.25 mm. The over flow of the hydro sizer is dewatered. The fine and coarse fractions from the hydro sizer are separately conditioned and fed to separate flotation circuits. Tall oil and Light Diesel Oil mixture is used as collector after reacting with sodium hydroxide to concentrate phosphate minerals as froth product and sodium silicate is used to depress silica which reports as the tailing. The rougher froth is cleaned thrice. The final concentrates are collected in a common sump and are fed to a cluster of dewatering cyclones. The under flow of these cyclones is fed to a belt filter and the filter cake is the final product that analyses 74% TCP plus or minus 2%

Plant capacity

Both the A1 and A3 circuits are in two lines each that can take unto 160 tons per hour. The weight percent recovery in A1 circuit is around 50% and the weight percent recovery in the A3 circuit is approximately 30%. The TCP recovery in A1 circuit is around 60% and in A3 circuit is from 25% to 30% depending on the type of ore fed. The total average production of A1 and A3 concentrates per annum of last fours is + 12 00000 tons of which 300000 tons is from A3 circuit.

R & D Efforts

Process Engineers at Eshidiya Beneficiation Plant have been attempting to improve the process and one of the areas is introducing new reagents for improved grade without reducing the TCP recovery. Hydrotropes[1] which are known reagents that enhance the solubility of non polar solutes in water were tried. So far urea[2], linear alkyl benzene sulfonate[3], Alfa olefin sulfonate[3] were successfully tested and tri sodium citrate, sodium salicylate are being tested.

Present Study

In the present study sodium benzoate is tested at bench scale at doses 0.58 and 1.15 Kegs per ton of ore and compared with plant conditions that is tall oil at 0.97 Kg per ton of ore, light diesel oil at 1.16 Kg per ton of ore and sodium silicate 0.35 Kg per ton of ore. The bench scale tests were of kinetics studies where incremental floats were taken. The tests were conducted using Denver flotation cell of 2 liters. The results are presented in Table 1 which are also plotted as shown in figure 1. It is obvious from figure 1 that sodium benzoate improves the soap flotation performance at a dose of 0.58 Kg per ton of ore and a higher dose may not be useful. All reagents used in this study are of commercial grade that are being used in the Eshidiya plant except sodium benzoate which is of AR grade assaying 99.5%.

Closing Remarks

As it can be seen from the figure 1 that improvement of flotation efficiency of soap LDO emulsions up on adding sodium benzoate is unequivocal. Phosphate Beneficiation plant of RSMML Udaipur is already using Alfa Olefin Sulfonate as promoter in the flotation process which reduced the consumption of soap drastically. We expect similar results with sodium benzoate also.

Figure 1

Expt 1, Plant condition		Expt 2, Na Benzoate 0.58 Kg/ton of ore		Expt 3, Na Benzoate 1.15Kg/ton of ore	
% Cum TCP Grade	% Cum TCP Recovery	% Cum TCP Grade	% Cum TCP Recovery	% Cum TCP Grade	% Cum TCP Recovery
73.76	26.00	76.06	17.08	76.20	11.24
71.53	65.34	73.47	45.02	76.24	22.93
70.85	85.80	72.54	71.21	73.38	44.07
70.79	92.25	72.54	87.11	71.01	68.33
70.85	93.54	72.59	90.47	70.67	93.5

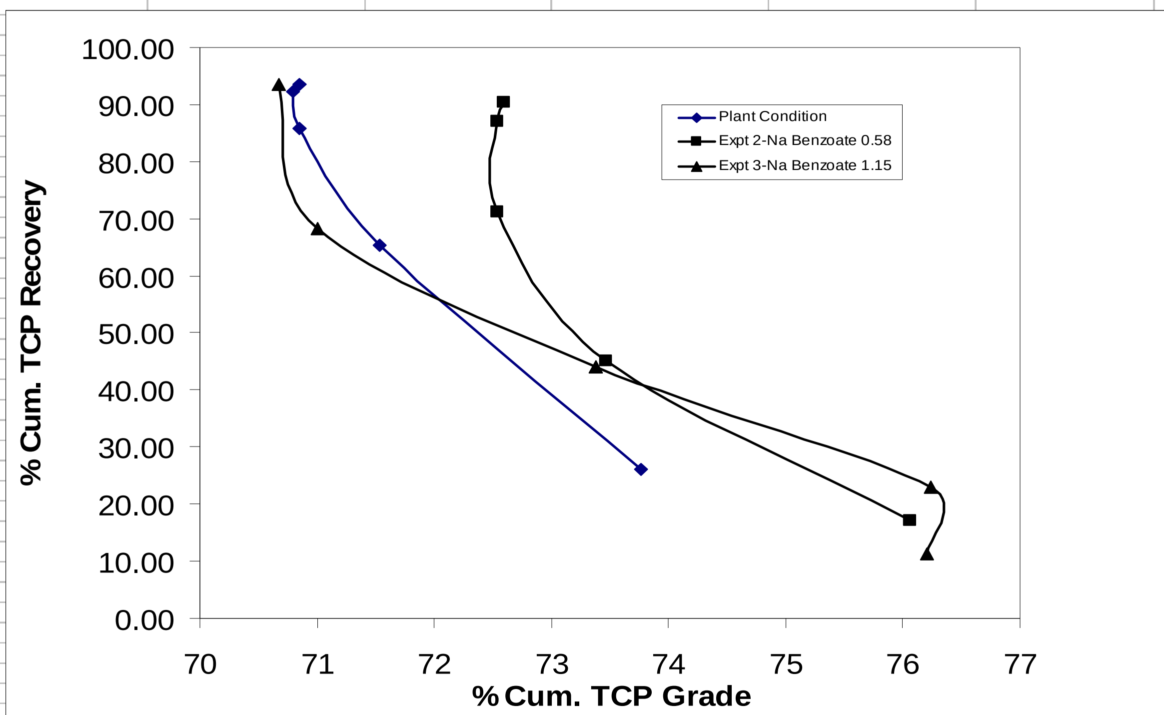

Table 1

Bench Scale Experimental Details

Experiment-1, Plant condition

Sample coll. i	Wt. in gms	Wt. %	Cum. Wt. %	% TCP	% TCP Rec.	% Cum. TCP Rec.	% Cum. Grade
15 sec	109.90	18.87	18.87	73.76	26.00	26.00	73.76
30 sec	174.90	30.03	48.89	70.13	39.34	65.33	71.53
45 sec	92.80	15.93	64.82	68.76	20.46	85.80	70.85
60 sec	28.70	4.93	69.75	70.00	6.44	92.24	70.79
75 sec	5.40	0.93	70.68	74.25	1.29	93.53	70.85
R Tail	170.80	29.32	100.00	11.80	6.46		
Total	582.50	100.00			99.99		

Calculated feed %TCP 53.53

Reagent Dosing:

Tall Oil: 0.97 Kg/ton of ore, Light diesel oil: 1.16 Kg/Ton of ore, Sodiun silicate: 0.35 Kg/ ton of ore

Conditioning Time:

Conditioning time with depressent one minute and with collector two minutes.

Feed slurry: 25% solids by weight

Experiment-2, with Sodium Benzoate

Sample coll. i	Wt. in gms	Wt. %	Cum. Wt. %	% TCP	% TCP Rec.	% Cum. TCP Rec.	% Cum. Grade
15 sec	72.70	12.45	12.45	76.06	17.08	17.08	76.06
30 sec	125.60	21.51	33.97	72.00	27.94	45.03	73.47
45 sec	119.40	20.45	54.42	71.00	26.19	71.22	72.54
60 sec	70.80	12.13	66.55	72.68	15.90	87.12	75.57
75 sec	14.90	2.55	69.10	73.16	3.37	90.48	72.59
R Tail	180.40	30.90	100.00	17.09	9.53		
Total	583.80	100.00			100.01		

Calculated feed %TCP 55.44

Reagent Dosing:

Tall Oil: 0.97 Kg/ton of ore, Light diesel oil: 1.16 Kg/ton of ore, Sodium silicate: 0.35Kg/ton of ore.

Sodium Benzoate: 0.58 Kg/ ton of ore.

Conditioning time:

Conditioning time with depressent one minute and with Collector two minutes.

Feed slurry 25% solids by weight

Experiment-3, with Sodium Benzoate

Sample coll. i	Wt. in gms	Wt. %	Cum. Wt. %	% TCP	% TCP Rec.	% Cum. TCP Rec.	% Cum. Grade
15 sec	46.10	7.96	7.96	76.20	11.24	11.24	76.20
30 sec	47.90	8.27	16.23	76.28	11.69	22.93	76.24
45 sec	93.70	16.18	32.41	70.52	21.14	44.07	73.38
60 sec	113.00	19.51	51.93	67.11	24.26	68.34	71.01
75 sec	114.00	19.69	71.61	69.00	25.17	93.50	70.67
R Tail	164.40	28.39	100.00	12.34	6.49		
Total	579.10	100.00			100.00		

Calculated feed %TCP 53.97

Reagent Dosing:

Tall Oil: 0.97 Kg/ton of ore, Light diesel oil: 1.16 Kg/ton of ore, Sodium silicate: 0.35Kg/ton of ore.

Sodium Benzoate: 1.15 Kg/ ton of ore.

Conditioning time:

Conditioning time with depressent one minute and with Collector two minutes.

Feed slurry: 25% solids by weight

Acknowledgement.

We are thankful to the management of M/s JPM Plc. Co for permitting to take in plant training in their Eshidiya beneficiation plant. He is thankful to Mr. Ahmed Salameh, Mr. Yasser Dassin, Mr. Daksh Shukla, Mr. Gummadi Karun, Mr. John Britto, Mr. Krishna Kumar Godara.

D M Mihir is thankful to Dr. Joshua Amarnath, Head of the Department of Chemical Engineering, Sathyabama University. The content in this paper is a part of the project work of DM Mihir submitted to Satyabhama University.

References

[1] Roy, BK and Moulik, SP, Effect of hydrotropes on solution behavior of amphiphiles, Current Science, 85(8), 25 October, 2003, P 1148-1155.

[2] Sekhar, DMR., Srinivas, K., Prabhulingaiah, G. and Yasser Dassin, Urea as promoter in the soap flotation of phosphate ores, Trans. IIM Vol.62, issue 6, December 2009, p 555-557.

[3] Sekhar, DMR, Srinivas, K., Prabhulingaiah, G., Dassin, Y. and Alftinah, A., Promoters for soap flotation of Phosphate minerals, Proceedings of the International Mineral Processing Congress 2010, P 2345 – 2349.