Proceedings of the International Seminar on Mineral Processing Technology - 2006, Chennai, India. pp. 564 - 567.

Effect of Teetering Pulp Density in Floatex Density Separator – A Case Study

C. Raghu Kumar, Rakesh Ranjan Singh, O.K. Venugopalan*, V.S. Murty and **S. Suresh Kumar***

Indian Rare Earths Ltd., Research Centre, Kollam
**Indian Rare Earths Ltd., Chavara, Kollam*

Abstract

The combination of gravity separators like air/wind/wet tables and spirals were used in multi stages for the separation of heavier minerals such as monazite, zircon etc. from other minerals such as sillimanite, quartz etc. The introduction of modified commercially available hindered settling separators, like floatex density/cross flow separators have revolutionized the separation techniques and simplified the earlier complicated process flow sheet. This paper deals with the use of such equipments and some experimental results on separation of fine sillimanite and quartz from the zircon rich fraction which was difficult to separate using conventional gravity concentrators.

INTRODUCTION

In general classification is a method of separating minerals into two or more fractions based on the velocity with which the particles fall through water as a fluid medium. Two conditions by which solids settle in fluids are free settling and hindered settling. Free settling takes place when the individual particles fall freely either in still water or against an opposing upward current, without being hindered by other particles, whereas hindered settling is a process where in the particles are densely mixed with varying size, shape and density, yet free to move among themselves, are separated in a rising column of water or fluid.

The effect of particle crowding becomes apparent when the percent of solids in the pulp increases and the settling velocity of the particle starts to decrease. Then the system begins to behave as a heavy liquid whose density is that of pulp rather than that of the liquid. Because of the high density and viscosity of the slurry, the resistance to fall is mainly due to the turbulence created. The lower the density of the particle, more is the effect of reduction of the effective density and greater is the reduction in settling velocity. Similarly, larger the particle, the greater is the reduction in settling rate as the pulp density increases. For hindered settling conditions the fluid density is the apparent density of the suspension, a generalized equation for the hindered settling ratio is

$$\frac{d_a}{d_b} = \frac{D_b - D_p}{D_a - D_p}$$

Where D_a & D_b are density of a & b minerals and d_a & d_b are diameters of a & b minerals respectively

The hindered-settling ratio is always greater than the free settling ratio. The denser the pulp; the greater is the ratio of the diameter of equal settling particles. Hindered settling classifiers are used to increase the effect of density on the separation whereas the free-settling classifiers use relatively dilute suspension to increase the effect of size on the separation.

The floatex density separator works on hindered settling principle, wherein a rising current of water is introduced into the column so as to form a teeter column, an expanded mineral bed. During the process the particles fall until it reaches a point where the falling velocity equals to that of rising water current. Under such conditions the trapped particles build pressure and move up ward along the path of least resistance, usually through the center of column. The void thus created is filled by sliding of mineral mass from the side and a process of circulation is build up is said to be in teeter. Hence in a teetering column of sand, the pulp density will be greater towards the bottom where the particles are lying close together.

EXPERIMENTAL WORK

The experiments were conducted using laboratory scale floatex density separator. Studies were carried out to separate lighter minerals such as fine sillimanite, quartz etc from heavier mineral like zircon. Two types of feed material with varying composition were used for experimentation. First sample consisted of 28 to 32% zircon, 30 to 35% sillimanite, 30 to 35% quartz and about 2 to 3% conducting minerals. Whereas, the second sample contains 25 to 28% zircon, 40 to 45% sillimanite,3 to 5% conducting minerals, 3 to 5% garnet and 15 to 20% quartz. The size & mineralogical analysis of the two samples are tabulated in table 1& 2 respectively. All the experiments were conducted by varying the teeter pulp density, keeping all other parameters constant.

Table 1: Composition of Feed Material Without Garnet (Sample-1)

Minerals	Size in microns						
	250	**212**	**150**	**125**	**100**	**75**	**-75**
Conductings	0.4	0.3	0.8	0.4	0.4	--	--
Monazite	--	0.1	0.2	--	0.1	0.1	--
Zircon	3.5	6.4	8.5	5.1	5.0	0.9	1.1
Sillimanite	12.0	9.7	7.6	1.2	0.8	0.2	0.3
Other heavies	0.2	--	--	--	--	--	--
Quartz	9.7	7.5	11.9	3.1	1.2	0.4	0.9
Total	25.8	24.0	29.0	9.8	7.5	1.6	2.3

Table 2: Composition of Feed Material with Garnet (Sample-2)

Minerals	Size in microns						
	250	**212**	**150**	**125**	**100**	**75**	**-75**
Conductings	0.1	1.3	2.6	2.2	1.6	0.6	0.1
Monazite	0.2	1.0	0.9	0.8	0.6	0.2	0.1
Zircon	1.5	6.6	5.6	4.1	4.3	2.5	0.6
Garnet	0.3	0.9	0.7	0.3	0.2	--	--
Sillimanite	0.3	7.4	16.7	9.9	6.9	1.6	0.1
O.H	--	0.2	0.2	0.1	0.1	--	--
Quartz	0.6	2.4	5.0	4.1	3.6	1.1	0.1
Total	2.9	19.6	31.7	21.5	17.3	6.1	1.0

Table 3

Products	**Wt%**	**R**	**M**	**Z**	**Sill**	**OH**	**Q**	**Sh**
Over flow	6.7	0.3 (1.8)	--	0.5 (0.1)	5.7 (1.2)	--	93.2 (18.2)	0.3 (6.7)
Under flow	93.3	3.1 (98.2)	0.6 (100)	31.3 (99.9)	34.3 (98.8)	0.3 (100)	30.1 (81.8)	0.3 (93.3)

(Parenthesis indicate recovery values)

RESULTS AND DISCUSSION

Series of tests were carried out with the samples-1 by varying the process variables to remove the fine quartz and sillimanite. The test result and the mineralogical analysis are given in table 3.

From the results it is seen that overflow & underflow d_{50} is 150 microns and 180 microns respectively. The over flow size wise individual mineral distribution w.r.t feed was plotted in figure 1 and it is seen that less than 75 microns zircon particles were reported in the over flow fraction along with less than 180 micron size of quartz and less than 130 micron size of sillimanite. The underflow was further subjected to another floatex separator to recover the maximum possible quartz and sillimanite as over flow. The test result and the mineralogical analysis are given in table 4. From the test results it is seen that overflow & underflow d_{50} is 180 microns and 200 microns respectively. The over flow size wise individual mineral distribution w.r.t feed was plotted in figure 2 and it is seen that less than 150 microns zircon particles were reported in the over flow along with quartz and sillimanite of 250 microns respectively. Both the experiments were conducted at a constant teetering density of about 1.2 (calculated).

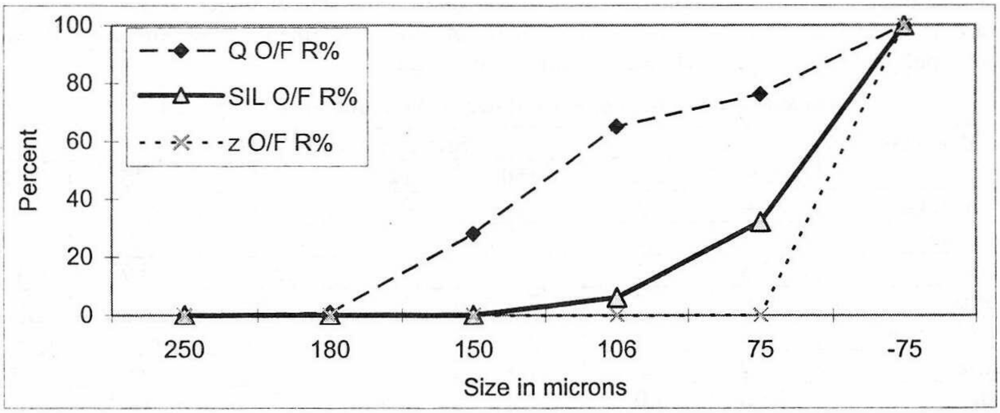

Fig.1: Size Wise Distribution of Individual Minerals of Overflow

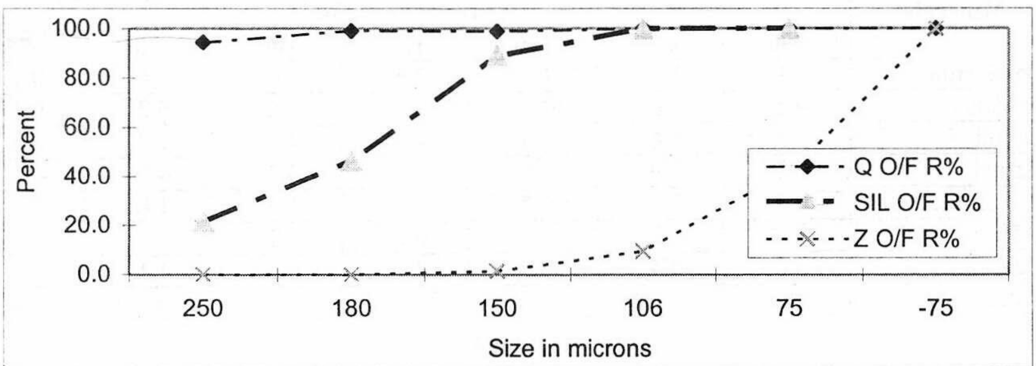

Fig. 2: Size Wise Distribution of Individual Minerals of Overflow

Table 4

Products	Wt%	R	M	Z	Sill	OH	Q	Sh
Over flow	49.8	2.1 (29.4)	0.2 (18.1)	6.3 (10.0)	33.0 (47.8)	0.1 (9.9)	57.9 (96.6)	0.4 (79.9)
Under flow	50.2	3.8 (70.6)	0.9 (81.9)	56.5 (90.0)	35.8 (52.2)	0.9 (90.1)	2.0 (3.4)	0.1 (20.1)

(Parenthesis indicate recovery values)

Table 5

Product	Wt%	I	R	L	M	Z	G	Sill	OH	Q
Over flow	79.3	0.33 (78.8)	7.71 (73.1)	0.03 (100)	0.8 (20.9)	12.51 (40.7)	1.25 (48.8)	53.96 (99.1)	0.84 (88.3)	22.54 (99.8)
Under flow	20.7	0.35 (21.2)	10.85 (26.9)	0.03	11.54 (79.1)	69.76 (59.3)	5.03 (51.2)	1.88 (0.9)	0.43 (11.7)	0.13 (0.2)

(Parenthesis indicate recovery values)

Series of tests were carried out using sample 2 by varying the process variables to obtain zircon concentrate with optimum recovery. The mineralogical analysis and individual mineral distribution of the test products were given in table 5. From the results it is seen that overflow & underflow d_{50} is 150 microns and 125 microns respectively. The over flow size wise individual mineral distribution w.r.t feed was plotted in figure 3 and is seen that less than 250 micron size of quartz and sillimanite were reported in the over flow along with the garnet and fine zircon. The experiment was conducted with high teeter density of about 1.8 (calculated) in order to achieve the maximum removal of quartz and sillimanite in the over flow fraction.

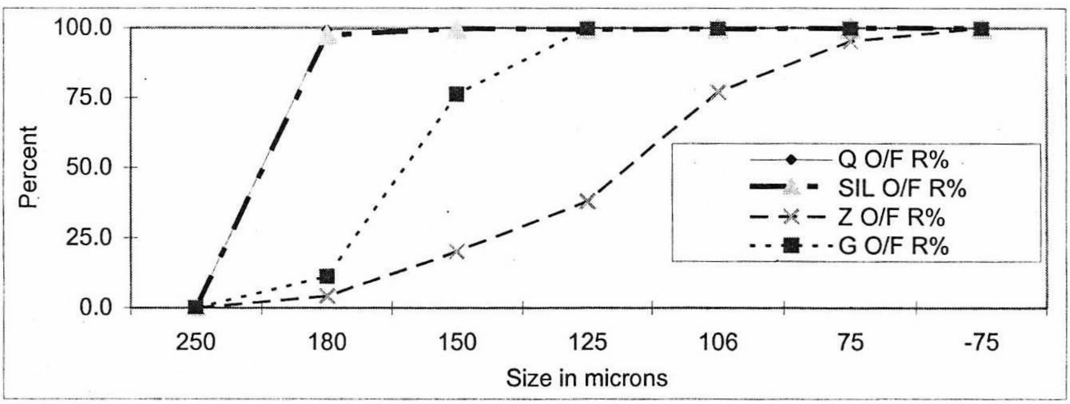

Fig. 3: Size Wise Distribution of Individual Minerals of Overflow

CONCLUSION

The study reveals that at about 1.2 teeter bed density maximum removal of quartz and sillimanite could not be achieved even after two-stage operation. Where as by increasing teeter bed density to about 1.8, about 99% of sillimanite and quartz were recovered in over flow, with single stage operation only. The presence of garnet does not influence the separation.

ACKNOWLEDGEMENT

The authors are thankful to IRE management and Shri.S. Sivasubramanian, CMD, for all support and permission to publish this article.