Grind optimisation studies at Rakha concentrator by laboratory tests

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INTRODUCTION :

This paper briefly describes the studies conducted in Rakha concentrator for improvements in economy of operation. Studies have been conducted on flotation of ore, ground to a coarser size than the present milling practice. The objective of grinding to coarser sizes is to optimise the grind size and mix so that overgrinding may be reduced, which, in turn, will help to improve the overall economy.

PLANT DESCRIPTION :

Rakha concentrator is one of the three concentrators operating in the Singhbhum Copper belt and is owned and operated by M/s. Hindustan Copper Ltd. Its treatment capacity is 1000 tpd. The ore at Rakha is mainly quartz and chlorite with chalcopyrite as primary economic mineral. It is medium to medium hard ore with work index of around 10. In the crushing plant 300 mm ore is crushed to -12 mm in three stages. The crushed ore is led off to the mill house, where two identical streams each consisting of a ball mill (2.59 m dia $\times$ 2.85 m long) in closed circuit with 600 mm hydrocyclone, the overflow of which is sent to the flotation section at 25 – 30% solids, and the underflow at about 70 – 75% solids, is circulated back to mill. The flotation section also has two streams each consisting of one 3×3 m conditioner, 12 nos. of 1.7 cu.m. Agitair type rougher cells and 4 nos. of 1.12 cu.m. cells of same type as cleaner cell. The final concentrate is thickened and filtered and despatched to Moubhandar for smelting, and the tailing is sent to mines for back filling purpose after desliming.

The petrological studies on Rakha ore have shown the liberation size to be 100 mesh (150 microns) and operating experience over the years has brought out that grind of 50 percent passing 200 mesh (74 microns) gives the best size distribution for flotation. Based on this, the mills are run at 22 MT/hr, to deliver the required product. The typical data are given in Table : 1 to show the size distribution of various streams at above mentioned feed rate :

Table—1 : Size analysis of cyclone overflow and underflow

Mesh	Weight percent retained	
	Cyclone overflow	Cyclone underflow
+48	0.99	35.94
– 48 + 65	6.69	10.72
– 65 + 100	12.52	18.36
– 100 + 150	16.84	14.18
– 150 + 200	12.44	6.87
– 200	50.52	13.93

It is evident that the amount of finer particles i. e. –100 mesh fraction, in cyclone underflow is about 35%. If recirculation of these particles to mill can be reduced then circulating loads on mill will reduce, resulting in reduction in overgrinding and hence increase in throughput to mill.

In Rakha concentrator to recover finer particles from cyclone underflow and for reduction of circulation load, the concept of secondary classification has been studied in detail (Ref : 1)

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and it is now being used successfully on one stream. A reduction in circulating load from 300—400 percent to 200—250 percent has been achieved, resulting net increase of about 8—10% in mill throughput. Table—2 shows the analysis of cyclone overflow of secondary classification system at feed rate of 25 MT/hr.

Table—2 : Sieve analysis of cyclone overflow of multiple classification system

Mesh	Weight percent retained		
	Primary cyclone overflow	Secondary cyclone overflow	Combined cyclone overflow
+48	0.33	0.69	0.50
−48 +65	1.45	4.38	2.81
−65 +100	14.38	23.07	18.41
−100+150	17.52	19.91	18.63
−150+200	11.59	10.83	11.24
−200	54.73	41.12	48.42

It can be observed in Table—2 that with secondary classification system in circuit the amount of −200 mesh fraction decreases and simultaneously +100 mesh fraction increases slightly. The original idea of this study was to see the effect of coarseness thus imparted to flotation feed on flotation characteristics of Rakha ore (Ref : 2). It has been proved theoritically and also from operating experience that, this much increase in coarseness does not effect the flotation system significantly. After that the study has been extended to find out the limit of coarseness of flotation feed which can be imparted without sacrificing recovery and grade, so that mill throughput can be increased.

EXPERIMENT AND DATA ANALYSIS :

Flotation tests were carried out in laboratory for studying the possibility of flotation of coarse ground ore. The feed of various coarseness for batch flotation tests have been obtained from laboratory ball mill. The plant mill feed samples have been collected and they were crushed to 100 percent passing 14 mesh in laboratory roll crusher, and then ground in laboratory batch ball mill at 70% solids for different grind times. The time versus grind was standardised for this particular batch ball mill for subsequent use. Table—3 shows the grind obtained at various grind times.

Table—3 : Sieve analysis of product from laboratory batch ball mill

Grind time (min)	10	8	6	4
Mesh	Weight percent retained			
+48	0.23	0.52	1.05	2.68
−48 +65	1.79	3.05	6.19	10.86
−65 +100	3.85	6.82	8.61	9.56
−100+150	22.99	24.46	24.44	23.54
−150+200	16.34	13.62	13.95	13.09
−200	54.80	51.53	45.76	40.27

Kinetic flotation tests were then conducted with these samples of various grind size and mix in a laboratory batch cell with volume make up. Initial pulp density in the batch cell was kept at 21% solids. The collector used was Sodium isopropyl xanthate and frother was pine oil. The amount of collector used was 6 cc of one percent solution of xanthate and the amount of frother was 6 drops. The concentrate collected at different time intervals and the final tailings was then assayed for the copper content.

The data thus obtained was used to calculate recoveries and grades obtained at different time intervals for different grind times is given in Table—4.

Table—4 : Cumulative recovery & grade at different times

Flotation Time (min) →		0.5	1.5	3.5	7.5
Grind time 4 mins	Cumulative Recovery	85.62	93.17	95.34	96.78
	Cumulative Grade	21.40	18.25	14.70	12.34
Grind time 6 mins	Cumulative Recovery	86.59	93.44	95.71	97.08
	Cumulative Grade	22.98	20.49	17.97	15.49
Grind time 8 mins	Cumulative Recovery	81.29	91.98	94.95	96.76
	Cumulative Grade	24.40	21.61	18.83	16.22
Grind time 10 mins	Cumulative Recovery	81.66	91.41	94.31	96.17
	Cumulative Grade	23.43	20.92	18.42	15.63

DISCUSSION :

The time VS recovery studies shows that for different grind times though the end recoveries are in close range, there is a recovery improvement at short flotation time for lower grind time. Also it can be observed that the maximum overall recovery possible for different grind times are close and all are above 97 percent.Table 5 shows the different values of R max (maximum overall recovery possible) for different grind times :

Table—5 : Values of R max for different grind times

Grind Time (Mins)	R max
4	97.56
6	97.81
8	97.84
10	97.19

The above fact implies that a desirable recovery, which is in case of Rakha concentrator is 95.5%—96.5% is possible even with coarser grind.

It can be observed from Table—4 that for a coarser grind, the grade falls slightly. The difference of grades at lower recovery range is more compared to higher recovery zone. If the above is due to more scavanging at shorter period, it can be taken care of in cleaning stage, but if it is due to more gangue recovary, regrinding may be required. But no definite modification can be designed before studying the plant flotation circuit completely. A plan for studying the flotation circuit has already been chalked out, and the study is in progress.

SUMMARY AND CONCLUSION :

1. Present milling practice is to grind 50 percent passing 200 mesh for efficient flotation.
2. Grinding consumes about 30 percent of total power and its operational cost is also about 30 percent of total cost. Hence any improvement in grinding throughput will improve the overall economy to a great extent. It can be safely assumed that if further coarseness does not effect the flotation system a 10% increase in throughput can be achieved without any substantial capital expenditure and enhanced operating cost which means about Rs. 1.50 can be saved for each ton of ore milled.
3. Batch flotation study shows that desired recovery is possible with coarser grind.
4. The study is now being extended to the plant. Extension of this may give the scope of improving throughput by minor modification in grinding and flotation circuit.
5. To analyse large volume of data with sufficient speed and accuracy, aid of computer is desirable.

REFERENCES :

1. Rao T. C., Bandyopadhyay A, and Khare R. N.
"Improvement in mill-cyclone classifier circuit — a case study" IVth International Mineral Processing Congress, Toronto 1982, Paper-III-7.

2. Kudbi G. K., Sanyal P. and Saha S. K.
"Studies on Rakha ore flotation at coarser grind with use of models".
National symposium on Mineral Beneficiation, 28th and 29th April 1983, Khetrinagar (Rajasthan), organised by IIM, Paper - 7.

DISCUSSION :

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Question 1 : Recoveries are almost same from 4 to 10 minutes of grinding. Have you carried out studies at 2 minutes grinding ? If so, what is the recovery ?

Author : No test has been carried out at 2 minutes grind; however such studies have been planned for broader understanding of flotation behaviour.

Question 2 : As the recoveries are same, how could you optimise the grinding time ?

Author : Recovery is not the only parameter for optimisation of grinding flotation operation, the grade of concentrate also plays an important role. The exact optimisation relationship has not yet been established, but the study is in progress.

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Question : When we compare recoveries against time of grind that amounts to fineness of product only. Why 'time of grinding' is considered more important parameter, than "product size" of mill ?

Author : Here the grinding time is used as a measure of fineness and size distribution of ground product; in other words, the grind time was standardised to produce a particular product size and mix (Table—3).
