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BENCH SCALE AND PILOT PLANT BENEFICIATION OF CHICHALI IRON ORE

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The Chichali iron bearing material contains 32 percent Fe, 22.4% SiO_2, 5.8% Al_2O_3, 3.0% CaO, 3.2% MgO, 2.34% K_2O, 1.58% S and 0.34% P. The ore tends to disintegrate on wet grinding producing excessive amount of slime. The material has bond work index of 11 to 14. Controlled grinding of the ore in a rod mill in close circuit with a hydrocyclone produced 20 percent slime (-20 micron) and 27-29 percent fine (-250 mesh) fraction. Desliming was effectively carried out in a hydroclassifier using 200 g/t sodium silicate as dispersant and 250 g/t sodium hexametaphosphate as depressant for silicates. The deslimed sand was floated in bench flotation cell (Denver D 12) and in a sub pilot plant (a bank of 4 cells, Denver No. 12).

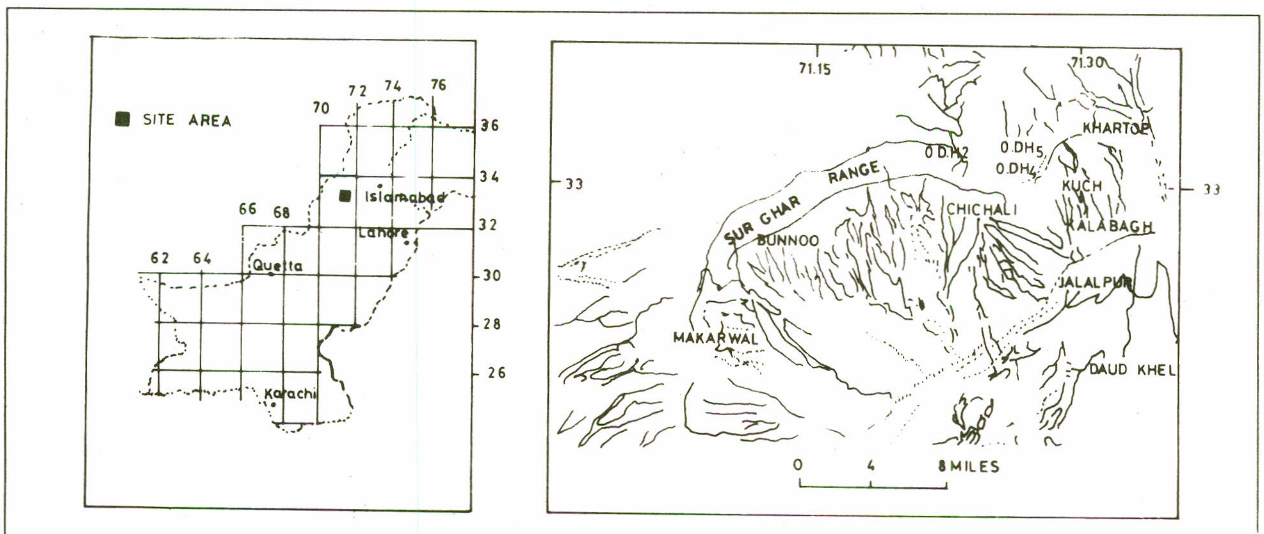
Tall oil fatty acid at 500 g/t was found to be an effective collector for the iron minerals. The rougher concentrate after cleaning was passed through a high intensity wet magnetic separator (ERIEZ). The cleaner concentrate containing 40.67 percent Fe and 6.82% SiO_2 corresponding to 51.68 and 12.57 percent recovery of Fe and SiO_2 respectively. The concentrate on pelletization and induration yielded 56.5 percent Fe, 8.5% SiO_2, 3.4% CaO, 2.4% MgO, 0.16% P and 0.12% S.

Key words: Beneficiation, Chichali, Iron Ore.

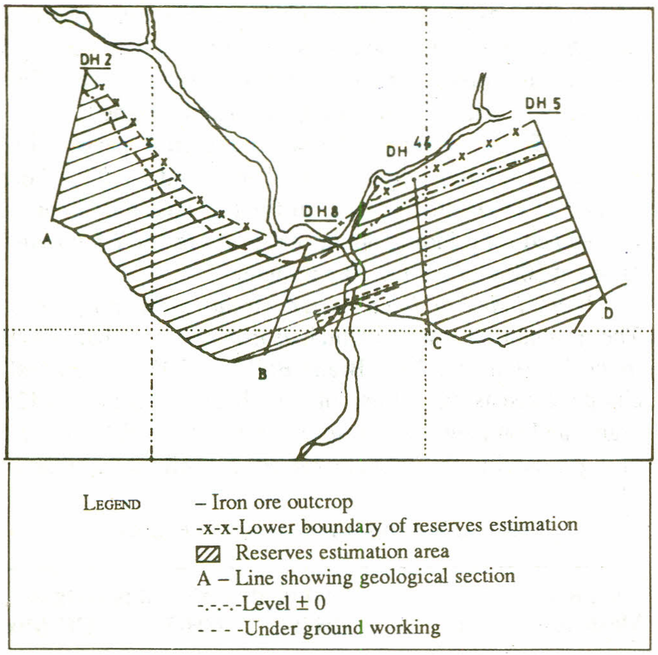
Introduction

The reserves of Chichali iron ore in Pakistan are estimated about 300 million tonnes. The ore contains about 32 percent iron and 22 percent silica besides prohibitive amounts of other impurities such as soda, potash, phosphorus, sulphur, etc. The ore is low grade and cannot be used for iron and steel manufacture, without prior beneficiation. The earlier studies [1, 2] on technico-economic feasibilities on its direct use are economically unfavourable especially due to energy crisis.

There has been increasing interest and activity in the flotation of many of the iron oxide ores, especially in the US and Canada. Earlier studies [3-6] on the possibilities of beneficiating Kalabagh iron ores, however, were sceptical because of fine distribution of iron minerals such as siderite and goethite in the gangue matrix composed of chamosite, glauconite and quartz. It was not until 1973 that physical method of beneficiation were demonstrated to be applicable to Chichali ore. The concentration tests [6] carried out by the Mineral Resource Research Centre (MRRC), Minnesota revealed that the best results of flotation of goethite and siderite were obtained using fatty acid as collector at 95°. Khan and Qazi [7] separated mineral phases by density gradient technique using clerici solution and described mesh of liberation and flotation at room temperature. It may be appreciated that the preliminary beneficiation studies have demonstrated that silica content in the concentrate was considerably reduced so that after calcination and agglomeration an acceptable grade of iron for Pakistan Steel Mills may be obtained [8-11].



Schematic Map of Chichali Iron Ore Deposit. Scale = 1:40000



Dwelling on the initial success on the possibilities of improving the grade of the ore, detailed bench and pilot plant work was carried out. Different variables influencing the grade/recovery of iron concentrate were investigated in endeavour to form the basis for its commercial exploitation. This paper describes the results of different conditions required for pilot plant scale beneficiation of Chichali iron ore.

Experimental

The iron ore bodies in the area are not homogeneous. However, the samples were chosen to represent all ore types. Bulk samples were collected from western main adit of Chichali pass exploratory mine, which have been driven horizontally following the strike direction. Three samples representing the upper horizon (UH), lower horizon (LH) and mixed ore (Mix) of Chichali area were taken from cross cut No. 4 weighing 1, 1 and 10 tonnes respectively. These samples were collected from a channel running horizontally across the rocks in the tunnel and cross cuts.

Mineralogy. A combination of techniques were employed to study the mineralogy using petrography, XRD, DTA and TGA. A large variation is seen in relative proportions of minerals in different samples, however, the chief minerals remains the same i.e. siderite, chamosite, glauconite and goethite. The upper horizon rocks consist of siderite and chamosite in major amounts and quartz, goethite/limonite and glauconite in minor amounts. In thin sections, greenish brown, greenish yellow and dirty green coloured iron silicate mineral is present as large irregular shaped grains. Aggregate of small grained colourless to pale coloured siderite is present in matrix. Fine grained reddish to opaque minerals of iron oxide are disseminated in the matrix in association with siderite. Minor amounts of quartz and traces of calcite, apatite, pyrite, feldspar and clay minerals are also noticed. The overall texture of the rock is mossaic with low grain cohesion index due to the setting of large crystals in fine grained matrix and will, therefore, tend to be easily crushed on milling.

The rocks in the lower horizon are yellowish brown to dark greenish brown and consist of siderite-goethite/limonite, chamosite, glauconite mineral assemblage. The rocks are massive with significant proportion of brown to opaque iron oxide association with iron silicate and iron carbonate minerals. In thin section large size opaque reddish brown goethite crystalloids are observed alongwith small size green birefringent iron silicate minerals, light coloured aggregate of small siderite crystals and dispersed quartz in matrix. The crystalloids of goethite has pseudospherical granular texture and are pseudomorphic to chamosite, having been changed by later decomposition or replacement as indicated by in relict structure. The original chamosite is larger in size than the fresh looking small grained iron silicate minerals of secondary origin. The general grain size variation of different minerals in microns were as follows:

Chamosite	Lower horizon Size range	Lower horizon Common size	Upper horizon Size range	Upper horizon Common size	
Chamosite	150-800	300	100-350	200	Siderite
Siderite	50-200	100	50-150	Variable	aggregate
Quartz	50-200	150	50-300	150	of 700
Goethite	25-100	25	150-500	300	

The mineralogical split on desliming the ore were investigated using DTA/TGA techniques. The loss in weight at 300-750 representing goethite and siderite which are the chief iron ore minerals were found less than 20 percent in slime as compared with the ore.

Comminution studies: The Chichali iron ore samples were fragile and tend to disintegrate with the action of water producing excessive amount of slime on secondary grinding. Necessity of careful grinding in close circuit with classifier which generated minimum amount of fines was recognised during the mineralogical tests [8] on the ore sample. Systematic grinding study was, therefore, undertaken to find the parameters to obtain a suitable particle size range which would be required for beneficiation using close circuit grinding of the ore.

The samples used in grindability studies were reduced in size, in a jaw crusher, with 1.2 cm opening and then crushed through rolls (size 30 cm x 20 cm Denver) set at 2 mm opening. Size analyses of roll product of UH, LH and Mix ore are given in Table 1 and plotted in Fig. 1, which shows that the cumulative percent passing curve tend to superimpose on each other this indicates that the crushing behaviour of the individual and the mixed sample is somewhat similar.

The roll product was then subjected to grinding, using both dry and wet conditions, in a ball mill (30 cm laboratory pot mill Denver Co.) and also in a rod mill (20 x 50 cm laboratory mill Denver Co.). The results of the ball mill grinding of the ore for 29-60 minutes are summarized in Table 2 for UH ore and Fig. 2 for Mix. and LH ore. The examination of the results has revealed that:

(a) Ball milling produces considerable of fines in the product ranging from 20 to 45 percent by weight.

(b) The weight percent of –100 +250 fraction remains almost constant on dry grinding of UH ore from 20 to 40 minutes. The increase in grinding time only increases 250 mesh fraction at the expense of 100 mesh fraction.

The wet grinding experiments were carried out in a rod mill which produced relatively uniform sizes of the product and lesser amount of slime as compared with the ball mill grinding.

The product was screened using BSS in wet conditions. A batch of 50 grams of representative sample was passed through BSS sieves of 60, 72, 100, 150, 200 and 250 mesh sizes, by agitation with water. The top most fraction placed in the sieve was washed with distilled water and the residual water percolated through finer sieves. The product was dried under infrared lamp and weighed.

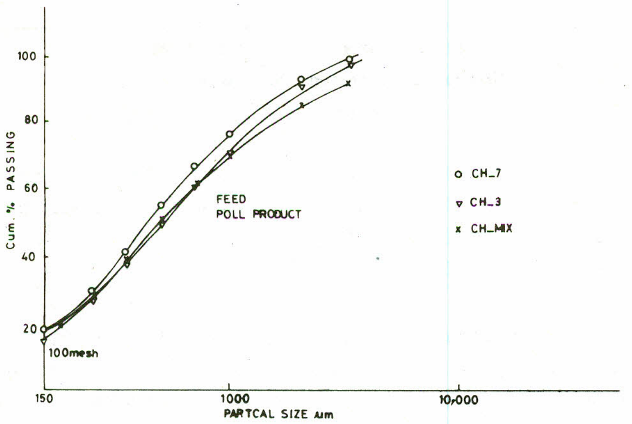


Fig. 1. Sizing of roll product of Chichali ore sample. (Long normal plot).

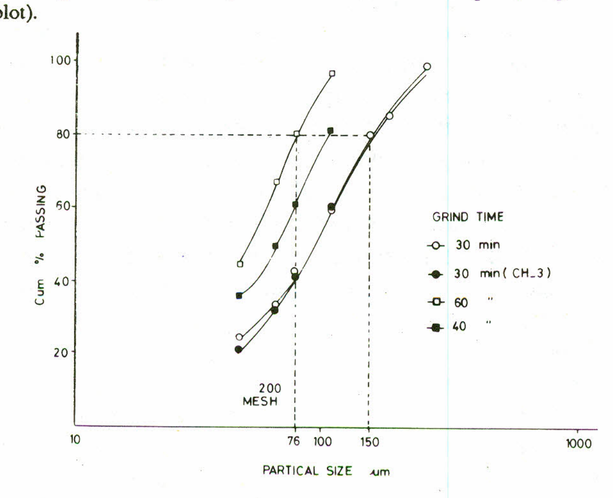


Fig. 2. Sizing analysis of Chichali compost ore sample. Dry ball milling of CH Mix ore.

The Fig. 5 is the plot of weight fraction passing 150 mesh (105 microns) against grind time and weight of ore ground. It shows that 80 percent fraction passing 150 mesh is obtained on grinding about 300 g of ore for 7.5 minutes or about 500 g of ore for 10.5 minutes.

Work index or bond closed circuit grindability tests. The grindability tests on Chichali iron ore were performed in the "FCB special Bico-Braun Ball Mill 395-50". The ball charge consists of a total of 285 balls weighing 20.125 grams and ranging in diameter from 1/2" to 1-1/2". The ball mill grindability test was conducted in a mill of 12" diame-

TABLE 1. SIZE ANALYSIS OF ROLLS PRODUCT.

Sample No. Mesh size	µm	CH-3	CH-7	CH-Mix
		Cumulative percent passing in		
+5	3350	97.4	98.51	91.84
8	2000	90.4	93.06	84.02
16	1000	70.8	76.27	68.82
22	710	60.0	66.29	60.26
30	500	49.5	54.81	49.74
44	355	37.4	40.85	36.94
60	250	26.4	28.86	26.66
100	150	14.4	17.74	15.49
150	106	9.9	10.89	10.49
200	75	5.0	7.27	7.28
–250	60	–	–	0

TABLE 2. RESULTS OF THE SCREEN ANALYSES OF DRY BALL MILL GRINDING PRODUCTS, USING A CHARGE OF 500 g ORE FOR VARIOUS TIME INTERVALS.

Sample No.	UH	Mix	Mix	Mix
Grind time (min.)	30	30	40	60
Mesh size (microns)	Cumulative percent passing			
60 (250)	96.2	98.3	–	–
80 (180)	84.2	85.3	–	–
100 (150)	78.2	80.0	–	–
150 (106)	60.0	59.5	80.8	96.7
200 (75)	41.1	42.2	61.3	80.6
250 (60)	31.3	33.5	49.0	67.1
340 (43)	21.2	24.0	23.1	44.8
Fraction	Weight percent			
+100	21.8	20.0	–	–
-100+250	46.9	46.5	51.0	32.9
-250	31.3	33.5	49.0	67.1

ter by 12" long (inside dimension) horizontal axis with rounded corners and a smooth lining. The mill rotate at 70 rpm. The work indices for Chichali iron ore were found to be as follows:

(a) UH ore 11.13
(b) LH ore 13.83
(c) Mix. ore 14.00

Desliming studies. A technique based on hydroseparation evolved for desliming of rod mill product of Chichali ore was found more simple efficient and adaptable for large scale operation as compared to the technique reported by MRRC [6] using agitation in presence of dispersant, settling and siphoning off slimes of certain micron size. In the hitherto used technique, the rod mill product constituting more than 80 percent fraction below 100 mesh size was subjected to desliming in a cylinderical vessel. Water was so introduced that it agitated the particles at the bottom and carried only slime alongwith it. Repeated tests gave almost

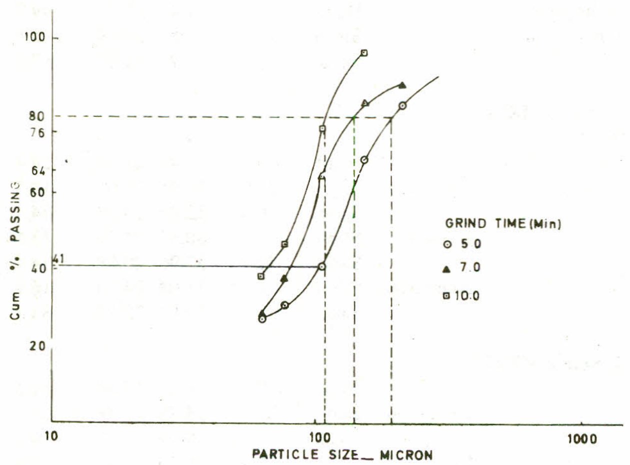


Fig. 3. Effect of grind time on the wet rod milling of 500 g of Chichali Mix ore.

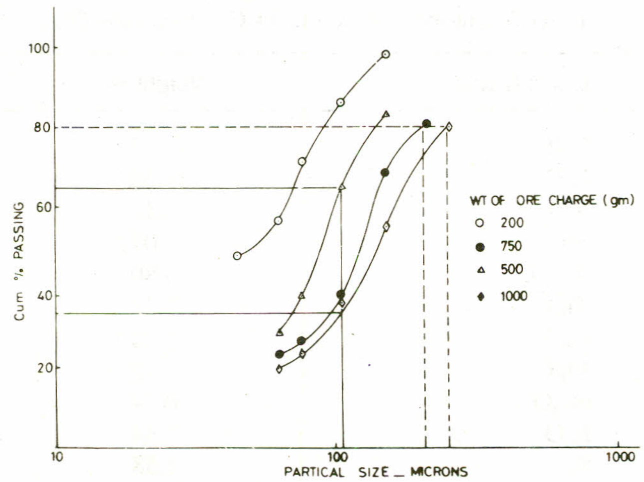


Fig. 4. Effect of wt. of ore charge on the wet rod milling of Chichali Mix ore.40% solid and grind time 7.5 min.

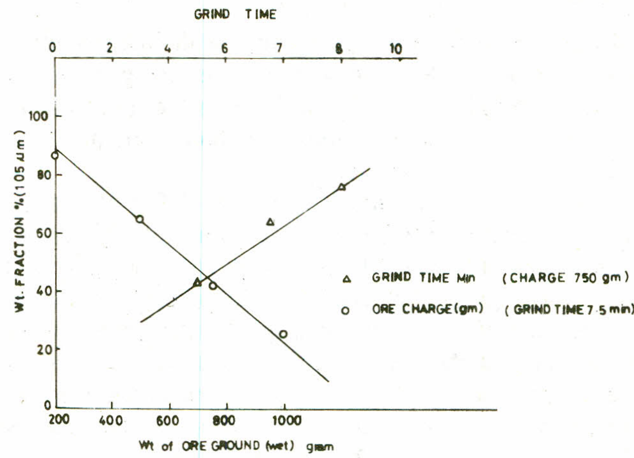


Fig. 5. Weight fraction passing 105 μm as function of ore charge or grind time.

TABLE 3. RESULT OF THE SCREEN ANALYSIS OF ROD MILL PRODUCT (WET GRINDING) AT 40% PULP DENSITY.

Sample No.	Mix	Mix	Mix	Mix	Mix	Mix
Charge weight(kg)	500	500	500	200	750	1000
Time (min).	5	7.5	10.0	7.5	7.5	7.5
Mesh size	Cumulative percent passing					
60	–	–	–	–	–	80.0
72	83.2	88.6	–	–	80.8	–
100	69.1	83.3	96.7	98.1	64.3	55.0
150	41.0	64.6	77.1	86.2	38.1	36.1
200	30.9	38.0	46.7	71.3	26.7	23.8
250	27.1	29.0	38.2	56.5	23.5	19.8
Fraction	Weight percent					
+100	30.9	16.7	3.3	1.9	35.7	45.0
-100+250	42.0	54.3	58.5	41.6	40.8	35.2
-250	27.1	29.0	38.2	56.5	23.5	19.8

TABLE 4. FATTY ACID FLOTATION OF MIX ORE.

Test No.	Product	Reagents used (kg/t)	Wt. %	(Grade %) Fe	SiO_2	(Recovery %) Fe	SiO_2
1.	R. Conc.	Fatty acid (0.8)	58.5	39.2	15.5	62.2	43.4
	R. Tail	–	20.5	34.6	35.0	19.4	33.6
	Slime	–	21.0	32.4	22.6	18.4	23.0
2.	R.Conc.	Fatty acid	23.2	39.8	5.4	25.0	6.3
	Middling 1	(0.5)	20.0	40.6	13.5	22.1	13.0
	Middling 2	Sod. silicate (0.25)	8.0	39.2	20.3	8.5	9.1
	Tail	–	22.8	33.6	33.2	20.8	36.8
	Slime	–	26.0	33.5	27.6	23.6	34.8
3.	R.Conc.	Fatty acid (0.5)	46.8	36.1	8.8	53.0	23.5
	R. Tail	–	25.7	30.8	28.9	24.1	42.4
	Slime	Sod. silicate (0.25) $AlCl_3$ (0.25)	26.5	29.4	22.6	22.9	34.1

20 weight percent values of the slime with 30.8 percent Fe and 24.98 percent SiO_2, showing that desliming resulted in upgradation to an extent. Table 5 shows the results of hydro-separation technique alongwith those carried out by MRRC.

In a series of wet rod milling tests 200 g of Mix ore was subjected to grinding at 40 percent pulp density for various time intervals. The results of sizing are plotted in Fig. 6. The ground material was subjected to desliming. The amount of slime generated for various grind times is plotted against the percent fraction passing 150 mesh in Fig. 7. It can be seen that at 6 minutes grind time, when 80 percent of the fraction passing 150 mesh is obtained, the slime generated is about 20 percent. These grinding conditions have been chosen to be optimum for the subsequent beneficiation studies.

Beneficiation studies. Based upon the appreciable beneficiation achieved in the heavy liquid separation [12], preliminary bench scale beneficiation studies were conducted using heavy media separation. The heavy media of specific gravity of 3.0 was prepared using magnetite and galena of 300 mesh size. Such a study, however, suffered due to the high viscosity of media and fine particle size requirements for the mineral liberation of Chichali ore. Further work on this aspect was accordingly, terminated and beneficiation was conducted by flotation.

Flotation studies. The flotation studies were carried out on Mix ore using fatty acids, salts of fatty acids and amines. The effect of several operating variables including pH, pulp density, conditioning time, concentration of surfactants, depressant and modifier were investigated at room temperature.

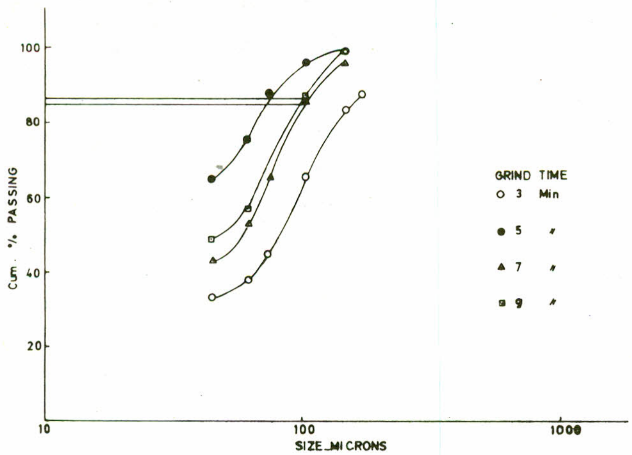


Fig. 6. Wet rod milling of CH ore. (Ore 200 g, water 300 g).

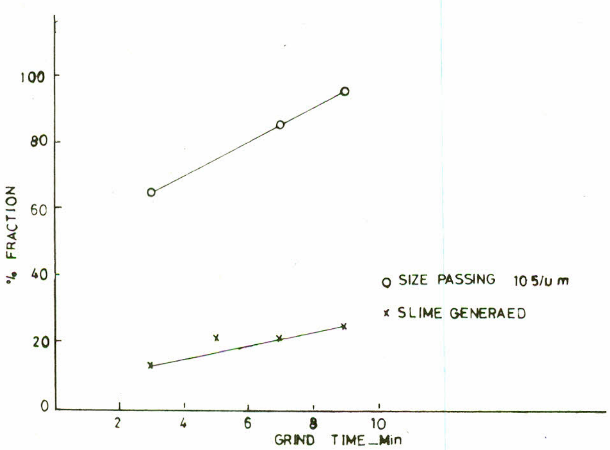


Fig. 7. Fraction as function of grind time on wet rod milling the CH-Mix ore.

TABLE 5. RESULTS OF DESLIMING BY HYDROSEPARATION AND MRRC METHOD.

Method	Size of split	Product	Wt. %	Fe(t) %	SiO_2 %	Calculated siderite %
Mix						
Hydroseparation technique		Head	100	31.4	20.72	49.9
		Slime	22	30.8	24.98	45.5
		Sand	78	31.7	19.52	57.9
Sample 1 MRRC						
MRRC technique 200 mesh grind		Head	100	32.40	21.64	28.4
	10 microns	Slime	23.96	30.95	25.62	10.5
		Sand	76.04	32.86	20.39	34.1
	15 microns	Slime	27.30	30.91	24.59	13.6
		Sand	72.70	32.96	20.53	34.0
	20 microns	Slime	34.07	31.04	24.50	16.9
		Sand	65.97	33.00	20.17	34.3
Sample 2 MRRC						
		Head	100	29.23	17.84	51.5
	10 microns	Slime	28.84	24.89	27.88	31.0
		Sand	71.16	30.99	13.77	59.8
	15 microns	Slime	41.45	26.50	21.58	39.8
		Sand	58.55	31.16	15.19	59.8
	20 microns	Slime	51.01	27.62	23.04	42.3
		Sand	48.94	30.91	12.42	61.1

TABLE 6. CHEMICAL ANALYSIS OF CHICHALI IRON ORE.

Constituents	Weight %
Fe(t)	32.55
FeO	14.30
SiO_2	22.40
Mn	0.012
Al_2O_3	5.80
TiO_2	0.28
CaO	3.00
MgO	3.20
Na_2O	0.14
K_2O	2.34
S	1.58
P	0.34
Loss on ignition	15.90

About 2 kg of Chichali iron ore, crushed through jaw and rolls of 12" x 8" size and screened through 6 mm size mesh, was charged into a 200 x 500 mm batch type rod mill (Denver Laboratory batch mill), with tap water to give 40 percent pulp density. Also 6 g sodium silicate and 5 g sodium hexametaphosphate were added in these tests in contrast to laboratory tests, into the mill as dispersants. The mill was run for pre-determined time in order to achieve over 80 percent material passing 150 mesh (105 µm). The mill was emptied into a laboratory hydroclassifier (Denver). The water and impeller speed was adjusted so that particles upto 20 µm were discharged from the overflow vier. The slime was well dispersed and was collected in a bucket. The sands were collected from the bottom of the classifier. These sands were used in the subsequent flotation tests.

A portion of sands was mixed with water in a 1 liter cell so that a pulp density of 20 percent was obtained. Flotation was carried out using Denver D-12 laboratory flotation machines. The effect of several variables, such as (a) amount of collector (which was tall oil fatty acid raw or distilled, amines, etc.) (b) pH, (c) flotation time (d) depressants etc., on the grade and recovery of the concentrate was investigated. Based on the tangible results on the bench scale, trials on a pilot plant of capacity 5 tonnes per day were conducted.

Pilot plant trial. The crushed ore (passing 6 mm), was continuously fed into a 600 x 1200 mm over flow rod mill (Denver) alongwith water to maintain a pulp density of 40 percent solid. Sodium silicate and sodium hexametaphosphate at the rate of 300 g and 250 g per tonne were added as dispersant for the slimes and depressant for silicate. The rod mill was working in closed circuit with a hydrocyclone (Kreb, 75 mm) and a sump pump (SALA). The overflow of the hydrocyclone had particle size fraction 90 percent passing 150 mesh (105 µm). The underflow of the hydrocyclone was fed back into the rod mill alongwith the new feed so that a circulating load of about 50 percent was achieved. The over flow fed into the sump of a desliming hydrocyclone (size 75 mm by Liquid Solid Separation Ltd., London) at a feed rate so that the over flow contained about 90 percent particles corresponding to 20 micron size. The underflow was fed to a bank of 4 cell flotation machines (Denver No. 12, 200 litre capacity). A pulp density of 25 percent was maintained. The collector, tall oil fatty acid 500 g/t and the depressant sodium silicate (200 g/t) were fed into the first cell. The rougher concentrate froth, collected in the launder, was thickened in a rake thickner and was fed into a twin cells (Denver No. 8) flotation machine for cleaning. The cleaner concentrate was passed through a high intensity wet magnetic separator H1WCF-5 (ERIEZ-USA). The cleaner tail was cleaned in a twin cells (Denver No. 8) scavanging circuit. The scavanger cleaner concentrate was reground to 95 percent passing 105 µm in a 600 x 1200 mm rod mill working with a hydrocyclone. The overflow was floated in a single cell (Denver No.8) flotation machine. The scavanger cleaner concentrate was added to the cleaner concentrate and passed through the high intensity magnetic separator. The concentration on pelletization and in duration yielded 56.5 percent Fe, 8.5% SiO_2, 3.4% CaO, 2.4% MgO, 0.16% P and 0.12% S.

The material balance of the pilot plant trial is shown in Fig. 8 and Table 7.

The final concentrate may comprise of cleaner concentrate and scavanger cleaner concentrate, making 45.6 percent of the weight recovery corresponding to 53.24% Fe recovery or High Intensity Magnetic Separator concentrate corresponding to 41.6% weight recovery and 51.7% iron recovery. The later step is introduced if the flotation concentrate have excessive amount of alkalis and phosphorus.

Discussion

Investigation on the behaviour of the ore on grinding and desliming has shown, that controlled grinding and desliming, to the mesh of liberation (125 microns) of iron ore

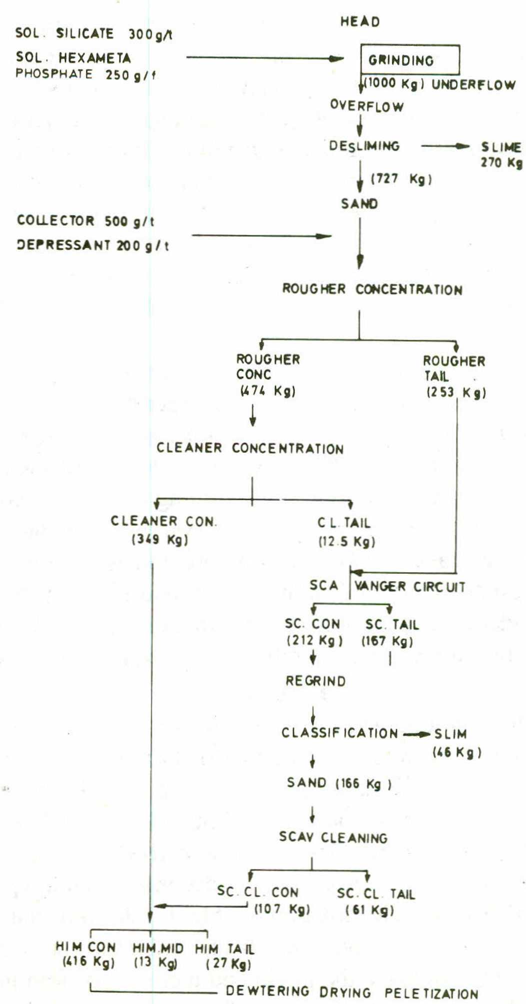


Fig. 8. Chichali iron ore beneficiation flowsheet.

minerals, could reduce the slime generated to 20 percent which mostly contained gangue materials, such as chamosite and glauconite.

The Batch Ball and Rod Mills (Denver) were used as these made possible simulation of grinding in a ball mill classifier circuit. Grinding was conducted for a fixed time, then the material was discharged and classified. The material was then returned to the mill for further grinding. The grinding behaviour of the different ore samples was found to be similar (Fig. 1). By the experiments, it was also found that dry ball milling produced excess amount of fines as compared with wet rod milling (Table 2 and 3), with longer time of grinding. Optimum time required for grinding 500 grams of ore in a ball mill was 30 minutes producing 33.5 percent minus 250 fraction and 46.5 percent 100-250 fraction. Whereas on rod milling 500 grams ore for 7.5 minutes. An amount of 29 percent of minus 250 fraction and 54.3 percent 100-250 fraction was produced. The value of 100-250 fraction was taken for comparison of the product size as this fraction contained liberated ore and gangue minerals. In practice the weight percent of fine size slime is further reduced by desliming 10-25 micron size particles.

It will be seen that the ore produced large amount of slime due to the presence of glauconite and chamosite most of which in the presence of water distintegrate into particles of subsieve sizes. The abrasion grinding action also reduces the particle size of siderite mineral, a part of which was lost in the slimes. Closed grinding classification circuit used in the pilot plant test reduced the slime practice to about 21 percent and increased the iron recovery to about 5 percent as against 40-50 percent loss of ore as slime, reported by MRRC.

The results of controlled grinding technique used in pilot plant tests, and stage grinding experiments at bench scale as well as the desliming in pilot plant operation and hydro-separation in batch test, were in close agreement. It is obvious that careful grinding/desliming operation plays a major role for subsequent grade/recovery of iron ore and may be the reason of poor results previously obtained by some workers. Careful grinding was found not only essential for adequate liberation of ore minerals but also for obtaining optimum slime/sand ratio for subsequent flotation.

Results

Significant upgradation of iron minerals in the concentrate at low silica was achieved by flotation. In a typical series of bench scale tests on Mix ore, using tall oil fatty acid, a rougher concentrate containing about 39 percent Fe, 7.0-9.5 percent SiO_2 were obtained. This corresponds to 55 to 60 percent recovery of iron in the concentrate. Some typical results of bench scale flotation (Table 4), showed that the amount of fatty acid and that silicate and addition of aluminium salts influence the grade and recovery of iron minerals in the concentrate. In test 2, fatty acid was used periodically to obtain middling fractions I and II. Further addition of surfactant did not yield any iron minerals in the froth. Microscopic examination of various fractions revealed that the rougher concentrate constituted essentially of siderite, goethite and calcite alongwith small proportion of locked silicate minerals. The middlings contained locked iron chlorite particles, suggesting that they required regrinding.

The present test gave 36.39 percent Fe and 5.4-13.0 percent SiO_2 in the rougher concentrate with 53-62 percent iron recovery. The low iron content in test 1 (Table 4) could be attributed to the co-flotation of calcium and magnesium, which was accumulated in the product to an extent of 5.1 percent CaO and 4.8 percent MgO. The use of calcium silicate and salt of aluminium showed significant effect in depressing the free calcite.

The result obtained using a semi-continuous type pilot plant capable of processing 3-5 tonnes ore per day is given in Table 7. The concentratation on pelletization and induration yielded a product with 56.5 percent Fe, 8.5 SiO_2, 3.4 CaO, 2.4 MgO, 0.16 P and 0.12 S.

TABLE 7. MATERIAL BALANCE OF CHICHALI IRON ORE BENEFICIATION.

Fractions	Wt. (%)	Fe (%)	SiO_2 (%)	Distribution % Fe	Distribution % SiO_2
1. Head sample	100	32.55	22.4	100.00	100.00
2. Slime	27.3	30.34	24.88	24.45	30.32
3. Sand	72.7	33.37	21.46	74.55	69.68
4. R. Conc.	47.4	35.82	16.58	52.24	35.08
5. Tail	25.3	28.81	30.60	22.31	34.60
6. Cl. Con.	34.9	39.04	6.13	41.80	9.52
7. C1. Tail	12.5	26.87	45.45	10.44	25.56
8. Sc. Con.	21.2	31.29	23.82	20.41	22.54
9. Sc. Tail	16.7	24.15	50.38	12.41	18.00
10. Reg. Slime	4.6	30.42	24.92	4.30	5.12
11. Reg. Sand	16.6	31.54	23.52	16.11	17.43
12. Sc.Cl.Con.	10.7	35.40	15.70	11.44	7.36
13. Sc. Cl. Tail.	6.1	24.87	36.98	4.67	10.07
14. HIM Con.	41.6	40.67	6.82	51.68	12.57
15. HIM Mid.	1.3	24.74	15.51	1.00	0.90
16. HIM Tail	2.7	6.87	22.02	0.57	2.60

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