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Beneficiation and Sinter Amenability Study of Iron Ore Slime of Bolani Mines

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Abstract

The iron ore processing plant at Bolani mines of Steel Authority of India Ltd., India generates about 20-25% of ROM as slimes during wet operation. These slimes are very fine in nature (-0.5mm) and its average iron content ranges between 52-55%. This material is presently being discarded as process waste due to its inferior grade.

The beneficiation and enrichment tests on Bolani iron ore slime showed the possibility of upgrading the slime from 53.71% Fe, 5.25% SiO_2 and 6.25% Al_2O_3 to 63.5% Fe, 1.8 SiO_2 and 2.8%Al_2O_3 with 31.1% product recovery by 2 stage hydrocycloning

The sintering test on the beneficiated slime as per Durgapur Steel Plant condition of 1200 mm suction and 600 mm bed height showed that the beneficiated slime up to 10% can be used in sinter iron ore burden without affecting the present level of sinter plant productivity of 1.28 in Durgapur Steel Plant (2003-04). The sinter produced with 10% slime mixed with 2% lime in ore burden had shatter strength of 72%(yield of +5mm), tumbler strength index of 56%(yield of +6.5mm) and improved productivity of 1.34.

The result showed the possibility of slime enrichment of Bolani iron ore mines and its use in sinter making. An industrial scheme for beneficiation and recovery of enriched grade fines from slime for the Bolani iron ore mines has been proposed.

INTRODUCTION

The iron ore processing plant of Bolani has throughput capacity of 3.44 million tones/year. The run of mines (r.o.m.) ore is crushed in two stages, primary and secondary to reduce the r.o.m 1800 mm to 200 mm by primary crushing and then to 50 mm by secondary crushing. The secondary crushed product –50 mm is screened over 10mm to separate –40+10mm BF lump and –10mm sinter fines for Durgapur Steel Plant, India. The plant has two processing line which can be operated either in dry or wet mode. The low-grade beneficiable ore is treated in wet processing mode whereas high-grade ore is treated in dry processing mode.

During wet process operation, the secondary crushed B.O. grade ore of size –50mm is directed to drum scrubber and scrubbed product is wet screened on 10mm screen to separate washed lump – 50+10mm. The wet screened –10mm fines fraction is treated in rake classifier and the classifier underflow washed fines (-10+0.2mm) recovered over a dewatering screen (0.2mm aperture) and directed to stockpile. The classifier overflow and dewatering screen underflow materials considered as generated slime at 20-25% of r.o.m. input to plant. This slime in slurry form (20% solids) is directed to thickener where flocculants are added for settlement of fine iron particles and recovery of re-circulating water. The settled slime at thicker bottom having about 40% solid is directed to tailing pond for disposal. (Figure-1).

These slimes are very fine in nature and its average iron content ranges between 52-55% which are unsuitable for sinter making due to its inferior grade and being discarded as process waste. The

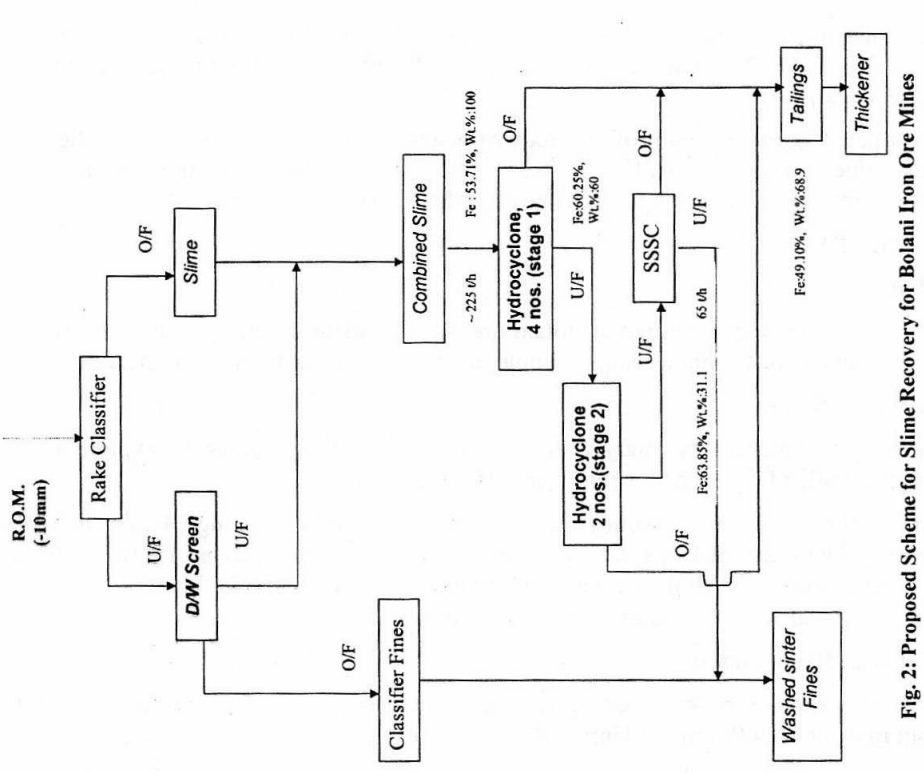

Fig. 2: Proposed Scheme for Slime Recovery for Bolani Iron Ore Mines

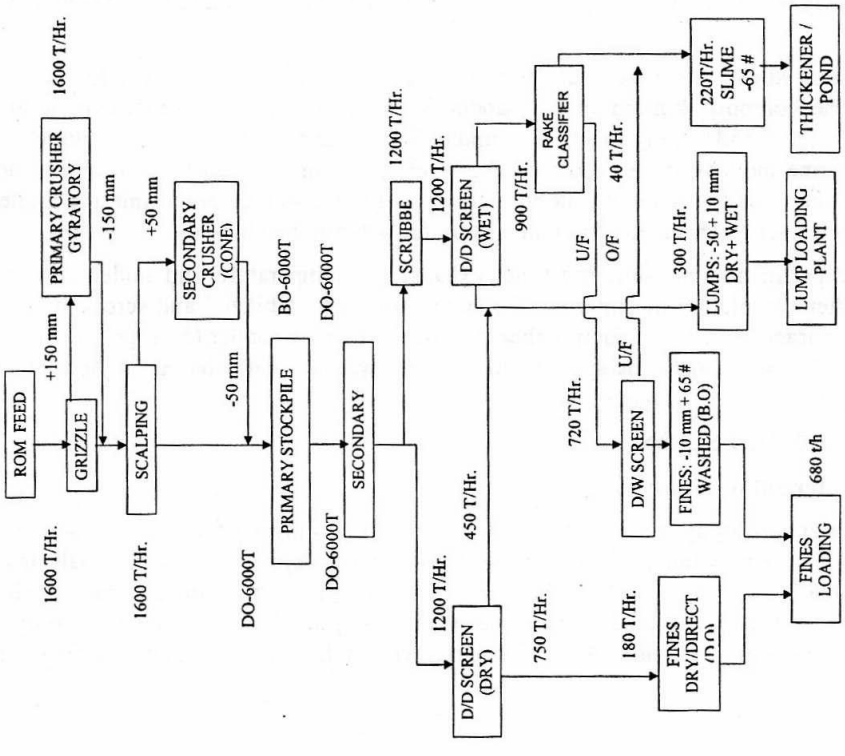

Fig. 1: Existing Iron Ore Processing Flowsheet of Bolani Mines

various possible methods of slime recovery has been discussed by few authors in the recent past (Rakhsit, 1997; Pradip, 2003) and some studies have also been carried out on sinterability of iron ore ultra fines (Bhagat, 2001).

The present paper gives the result of the study of beneficiation amenability of the collected slime of the Bolani mines analyzing 53.71% Fe, 5.25% SiO_2 and 6.25% Al_2O_3 and the suitability of the beneficiated slime in sinter making as per Durgapur Steel Plant condition.

EXPERIMENTAL

Slime Characterisation

The iron ore slimes being generated at Bolani ore washing plant during wet operation was examined for its composite chemistry, mineralogical component and grade of the various fractions.

Beneficiation of Slime

The beneficiation amenability study was carried out in the laboratory to explore possibility of improving the grade of the slime by employing Hydrocyclone.

The slime in slurry form (20% solid) was tested in hydrocyclone using Mozley make laboratory model test rig. The slurry at 10 psi inlet pressure was fed to cyclone having 15 mm apex and 22 mm vortex dia. After the test, both the cyclone underflow concentrate and overflow tailings were collected and analysed for their chemical grade and mass recovery.

Sinterability of Beneficiated Slime

The sinterability tests on beneficiated slime concentrate generated from hydrocyclone test work were carried out in laboratory Pot Sinter Unit of 85 kg capacity.

The sintering tests were conducted as per Durgapur Steel Plant(DSP) condition. The sinter burden materials namely ore fines, flux fines, coke fines, return sinter fines, mill scale etc were collected from DSP.

The beneficiated slime was mixed at 10 and 20% of ore burden and two levels of tests were conducted. The composit burden mix of about 85 kg was prepared with required moisture and subjected for mixing and balling in a mixing and balling drum for 6 minutes along with 2% lime at 35 rpm and 2 degree inclination. A separate base level sinter mix burden without slime addition was prepared. All the three types sinter mix burden was put in the pot sintering unit and ignited from the top and subjected for sintering at 1200 mm suction for 600 mm bed height.

During the experimentation, sintering time, exhaust gas temperature and under grate suction was measured. After completion of sintering, the sinter cake was stabilized and screened to estimate the yield of +5mm fraction after conducting the strength test by both shatter (5 drops) and tumbler test (10 minute) as per IS 9495-1964. The specific productivity was calculated based on yield of +5mm sinter under balanced return sinter regime.

RESULT AND DISCUSSION

Slime Characterization Study

The characterization study showed the presence of iron minerals namely, hematite, martite and goethite and gangue minerals namely,gibbsite, chlorite and kaolinite. The assay analysis of the slime showed it contains 53.71% Fe, 5.24% SiO_2, 6.25% Al_2O_3. The granulometry analysis showed about 59% of the material is below 0.038 mm and is of inferior grade having iron content only 50.0%. The fraction above 0.038mm constitute 41% of material with higher iron content above 56% (Table-1).

Table 1: Characteristics of Iron Ore Slimes of Bolani Mines

Size,mm	% Yield	Fe	SiO_2	Al_2O_3	Remark
0.20	3.2	56.69	3.54	4.46	Materials collected at Bolani mines in January'04.
0.15	5.6	57.91	3.61	4.16	
0.075	10.8	57.91	3.20	4.61	
0.044	10.6	59.58	2.98	4.00	
0.038	10.8	87.75	3.69	4.53	
0.038	59.0	50.19	5.96	6.73	
Composite	100.00	53.71	5.24	6.25	

Hydrocylone Test

The Hydrocyclone test result showed that initial desliming by first stage cone hydrocyclone enables recovery 52.17% of concentrate assaying 60.25%Fe, 2.9%SiO_2, 3.99% Al_2O_3 and second stage stub cyclone resulted in recovery of final concentrate assaying 63.85%Fe,1.8% SiO_2 and 3.2 % Al_2O_3 with 31.1% product recovery(Table-2).

Table 2: Hydrocyclone Test Result with Bolani Slime (Feed Fe= 53.71 , by 2 Stage Cycloning)

Product	% Yield	Grade		
		Fe%	SiO_{2}%	Al_2O_3 %
Cylone concentrate U/F	31.3	63.85	1.74	2.80
Cyclone tails O/F	68.7	49.10	5.60	6.41
Feed	100.00	53.71	5.24	6.25
Test condition	Feed % solid : 15, Feed pressure 10 psi, Time : 10 sec., Apex dia 15 mm, vortex dia :15mm, Cyclone type : Normal cone(1^{st} stage) and Stub(2^{nd} stage)			

Sinterability Test on Beneficiated Slime

The sintering test result showed that the beneficiated slime can be used in sinter making. This can be added upto 10% in normal ore fines burden along with 2% lime without affecting the sinter productivity. The base level test on the sinter produced (without slime and lime addition) had 51% tumbler index and 1.1 productivity. The sinter produced with 10% slime with 2 % lime slime addition showed better shatter test index of 72, tumbler index of 56 and productivity of 1.34 t/m2/hr which is better than that of the sinter plant productivity of 1.28 during 2003-04 period. However, When the slime content is raised to 20%, the tumbler index lowers to 52.3% and productivity goes down (owing to lowering of bed permeability) even at 2% lime dosing (Table-3). The test with lime addition in the

Table 3: Sintering Test Result with Beneficiated Bolani Slime Mixed with Iron Ore Fines and Sinter Burden From DSP

% of beneficiated slime mixed in iron ore sinter fines	Productivity $t/m^2/h$	Vertical sintering speed Mm/min.	Yield of +5mm (%) shatter index	Sinter strength (yield of +6.5mm in %) Tumbler index
0% (Without lime)	1.1	17.9	63.2	51.0
0% (with2% lime)	1.38	18.4	77.4	57.6
10% (with2% lime)	1.34	19.2	72.0	56.0
20%	0.90	12.72	70.9	52.3
Test condition	Ore size:-10mm;Bed height:600 m; Suction : 1200 mm wc; Basicity : 1.8; Lime during balling : 2%; Sinter mass : 85 kg.			

burden mix has been restricted up to 2% in consideration of lime calcination capacity and availability of surplus lime at DSP.

CONCLUSION

The beneficiation tests on Bolani iron ore slime by hydrocyclone showed the possibility of upgrading the slime to 63.5%Fe, 1.8 SiO_2 and 2.8%Al_2O_3 with 31.1% product recovery from the slime feed assaying 53.71% Fe, 5.25% SiO_2 and 6.25% Al_2O_3 by 2 stage cycloning.

The pot sintering test as per Durgapur Steel Plant (Sinter Plant-2) condition at 1200 mm suction and 600 mm bed height showed that the beneficiated slime up to 10% of ore burden can be used without affecting the present level of sinter plant productivity of 1.28 (2003-04). Moreover, the sinter produced with 10%slime mixed with 2% lime has better shatter strength of 72%(yield of +5mm), tumbler strength index of 56%(yield of +6.5mm) and improved productivity of 1.34.

An industrial scheme for recovery of enriched grade fines by hydrocyclone and Slow Speed Spiral Classifier (SSSC) for the Bolani iron ore washing plant has been proposed. The reason can be attributed on the role fusion and bonding fluxed ultrafines in high suction machine.

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REFERENCES

[1] Pradip, 1994, "Beneficiation of alumina rich Indian iron ore slimes", Metals, Materials and Processess, 6(3), pp 170-194.

[2] Rakhsit, K., 1997, "Recovery of iron values from slimes and dewatering of concentrate", Proc., PROF-97, NML, Jamshedpur, pp 77-83.

[3] Bhagat, R.P., Saha, P., Bhattacharya, K.K., Sarkhel, B.R., Chatterjee, U.S., Sil, S.K., Srivastava, J.P., and Moulik, S.C., 2001," Technology development in iron ore sintering : Recent studies at NML", Proc. Conference Raw Material and Sintering, RDCIS, Ranchi, pp 289-298.

[4] RDCIS, SAIL Study report 2004, Iron ore slimes of Bolani mines, No.12/02/3360/02/2004.