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Improving Mn/Fe ratio of Ferruginous Manganese ores from Sandur

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Abstract: *A low grade ferruginous manganese ore sample assaying 30.83% Mn, 24.28 % Fe (T), and 1.27 Mn/Fe ratio was subjected to a beneficiation process comprising stage crushing to -40mm, wet washing – screening followed by split jigging of -40+20 and -20+5mm fractions yieldilng a concentrate assaying 34.15% Mn, 22.02% Fe and Mn/Fe ratio 1.55 with 75.4% Mn distribution at wt% yield of 71.3 just meeting the metallurgical grade specifications. The above simple retrofittable process paved way for utilization of medium grade ferruginous manganese ores of Sandur region*

1. Introduction

Manganese is an indispensable metal for manufacture of steel. With the triple rate growth of Indian steel industry, the demand for metallurgical grade manganese ores has exponentially grown. The reserves of high grade manganese ores are inadequate [< 10%] to meet the demand. The mining of manganese ores in forest areas have been closed owing to environmental issues. In view of the above, the beneficiation of manganese ores meeting the metallurgical industries specification has become a necessity. The review of literature on beneficiation manganese centers on the associated gangue. Siliceous manganese ores especially from mines of MOIL, MP have been upgraded by scrubbing screening and jigging of sized fractions to remove siliceous impurities [1]. However, the processing of ferruginous manganese ores to improve Mn/Fe ratio, has given mixed results due to similar properties of Manganese and Iron minerals [1] The review of literature on improvement of Mn/Fe ratio of ferruginous manganese ores from Sandur area are limited to pilot scale research only and has centered on magnetizing reduction roasting followed by magnetic separation of iron values..[2 to 4] In view of the above, an attempt has been made to improve Mn/Fe ratio by simple process that can be adopted at site meeting the BF grade specifications of Mn >28%,Fe<23%, Mn/Fe ratio >1.55 SiO_2 < 20%, Al_2O_3 < 8% , P < 0.3% and with size -40+5mm (-5+10mm <10%)

2. Experimental

2.1 Materials

The ferruginous manganese ore sample from Deogriri, Sandur of M/s SMIORE was collected and sub samples were drawn after homogenization followed by coning and quartering method. The sub samples drawn were subjected to physical, chemical and mineralogical characterization

2.2 Method

The sub sample drawn was subjected to characterisation studies, followed by amenability of sample to wet sizing and Jigging of sized fraction. 4x4 m APIC under pulsated pneumatic jig of Bateman Engineers, was used in the study. The optimum conditions were arrived by the JIGSCAN Simulator.

3 Results and discussion

The experimental results comprises of characterization of feed samples furnishing the physical, chemical, mineralogical and granulometric data followed by jigging studies under optimum conditions indicated by JIGSCAN simulator.

3.1 Characterization studies

The sub-sample drawn from the bulk was subjected to physical, chemical and mineralogical analysis. The particle size distribution along with size fractional chemical analysis reveal that the sample analyzes 30.83% Mn, 24.28 % Fe (T, 0.05% P and 1.27 Mn/Fe ratio. The as received sample consisted of black coloured hard and compact lumps with little fines. Some of the lumps had yellowish coloured stains The sample contained mainly pyrolusite and psilomelane as manganese minerals with significant amount of hematite and ferruginous clayey laterite as gangue. Since the specifications needed, lumps only, the preliminary amenability test indicated that washing of the sample considerably improved Mn/Fe ratio by 0.15. Preliminary sink and float test using TBE indicated that ferruginous clayey laterites are concentrated in float indicating the possibility of reducing silica, alumina and iron values

to certain extent. Buoyed by the above tests, sample was subjected to jigging tests

3.2 Effect of washing, wet screening and classification.

Since the sample contained ferruginous clayey laterites and the dry screening experiment of removing fines indicated an a little improvement of Mn/Fe ratio, the -40 mm crushed sample was subjected to washing, wet screening over 20, 5 and 1 mm screens followed by de-sliming of -1mm product in 500mm hydrocyclone. Table 1 shows the results of washing, wet screening and classification. The results indicate that a -40+5mm lumpy concentrate assaying 32.35% Mn, 23.28% Fe Mn/Fe ratio 1.39 with 89.7 % Mn distribution at wt.% yield of 85.5. The results indicate that washing produced concentrates just failing to meet the specifications of the metallurgical industry especially % Fe content.

Table 1 Washing, wet screening and classification

Product	Wt%	Assay %		Mn/Fe ratio	% Distn. Mn
		Mn	Fe		
-40 +20 mm fraction	40.9	32.44	23.22	1.40	43.0
-20 +5 mm fraction	44.6	32.27	23.33	1.37	46.7
-5 + 1 mm fraction	2.0	31.20	24.36	1.28	2.0
Cyclone under flow	12.0	22.34	31.25	0.71	8.8
Cyclone over flow	0.5	27.04	28.12	0.96	0.5
Head (Cal)	100.0	30.83	24.28	1.27	100.0
-40 + 5mm washed lumpy concentrate	85.5	32.35	23.28	1.39	89.7

3.3 Beneficiation studies with pneumatic APIC under pulsated jig

The development of pneumatic under pulsated APIC jig with backup of JIGSCAN simulator has revolutionized jigging of lumpy metallic ores. Incidentally, similar jigging plants are in operation for siliceous manganese ores of MOIL [1]. The washed sized -40+20 fractions and -20+5 fractions were treated separately in APIC jig as it is established that split sized concentrations yields better performance with selectivity. The optimum conditions as per JIGSCAN software and results are shown in Table 2. The results indicate that a jig composite heavy fraction assaying 36.37% Mn,20.90 % Fe, 1.74 Mn/Fe ratio with 38.8 % Mn distribution at wt. % yield of 32.9 meeting fully the metallurgical grade specifications. However, if a slightly lower Mn/Fe ratio of 1.55 is tolerated, a composite heavy and middling concentrate assaying 34.15% Mn, 22.02% Fe with75.4 % Mn distribution at wt% yield of 71.3 is obtained and may be used after blending with high Mn, Low Fe, High Mn/Fe ratio lumpy ores

Table 2: Results of jigging test

Product	Wt%	Mn %	
		Assay	Distn
-40 + 20 mm jig concentrate	17.4	36.15	19.5
-20+ 5mm jig concentrate	15.6	36.52	17.6
-40 + 20 mm jig middling	18.5	32.31	18.5
-20+ 5mm jig middling	19.8	32.25	19.8
-40 + 20 mm jig tails	5.1	25.73	4.0
-20+ 5mm jig tails	5.5	24.96	4.3
-5 + 1mm sand and hutch product	13.0	31.20	12.6
-1 mm cyclone underflow	3.5	22.34	2.4
-1mm cyclone overflow	1.6	27.04	1.3
Head (Cal)	100.0	32.30	100.0
Jig concentrate (Cal)	33.0	36.32	37.1
Jig middling (Cal)	38.3	32.28	38.3
Comp, Jig Conc and Middling (Cal)	71.3	34.15	75.4
Final rejects	28.7	27.71	24.6

4 Conclusions

A low grade ferruginous manganese ore sample assaying 30.83% Mn, 24.28 % Fe (T), 0.05% P and 1.27 Mn/Fe ratio was subjected to a process comprising of stage crushing to -40mm, wet washing – screening followed by split jigging of -40+20 and -20+5mm fractions ,yielding a concentrate assaying 34..15% Mn, 22.02% Fe and Mn/Fe ratio 1.55 with 75.4% Mn distribution at wt% yield of 71.3 meeting the metallurgical grade specifications, paving way for utilization of medium grade ferruginous manganese ores of Sandur region

5 References

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