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Studies on the Gravity Processing of Low Grade Manganese Ore Fines RMK and KVH Mines, Sandur, Karnataka.

[1]Vinayak kumar R V, [2]Dr. M.R.Patil, & [3]Dr. B.P.Ravi
[1]Research student, Dept. of Mineral Processing, VSK University, Nandihalli - Sandur, Karnataka,
[2&3] Professor, Dept. of Mineral Processing, VSK University, Nandihalli - Sandur, Karnataka.

Abstract:- Beneficiation studies on manganese ore fines of Ramakolla and Kanavehalli mines, Sandur, Karnataka. Recent years, there is an increasing demand on manganese consumption which stems from the important role of manganese in carbon steel production. The growing need for manganese ores makes the beneficiation of low-grade manganese ore fines. In this study were carried out typical low-grade manganese ores fines, for this aim, different gravity separation methods (using jigging and shaking table) were applied. Jigging test RMK mines sample concentrate is 30.03%Mn and KVH mines sample concentrate is 31.64% and shaking table test RMK mines sample concentrate is 25.00%Mn and KVH mines sample concentrate is 28.00%Mn.

I. INTRODUCTION

Manganese ore is an important and indispensable input raw material for steel making and steel production and its consumption is among the key indicators of industrial development in any country. Manganese ore in the form of ferro and silicomanganese alloys are the most essential ingredients in the production of steel, both crude and stainless.

Manganese is a chemical element with symbol Mn and atomic number 25. It is not found as a free element in nature; it is often found in combination with iron, and in many minerals, it is a grayish-white usually hard and brittle metallic element that resembles iron but is not magnetic. Historically, manganese is named for various black minerals (such as pyrolusite) from the same region of Magnesia in Greece which gave names to similar-sounding magnesium, Mg, and magnetite, an ore of the element iron, Fe. By the mid-18th century, Swedish chemist Scheele had used pyrolusite to produce chlorine. Scheele and others were aware that pyrolusite (now known to be manganese dioxide) contained a new element.

Gravity processing studies of ferruginous Mn samples from Swamimalai forest area (SK mines area) with an aim of improving Mn grade>30% Mn/Fe ratio preferably > 1.5 to beneficiation methods like washing and jigging and as well as magnetizing roast followed by magnetic separation are being attempted.

II. MANGANESE ORE DEPOSIT IN INDIA

Odessa with 190 million tons in the total resources of the country (44.20%): Karnataka with 96.20 million tons of resources (22.37%); Madhya Pradesh 55.72 million tons (12.96%); Maharashtra 34.15 million tons (7.94%) and Andhra Pradesh 17.60 million tons (4.09%). The remaining 8.44% of total resources are contributed together by Jharkhand, Goa, Rajasthan, Gujarat and West Bengal.

III. KARNATAKA

Karnataka is the second largest state in respect of resources of manganese ore with 96.18 million tons of total resources. Out of these total resources, 16.10 million tons are reserves and 80.08 million tons are remaining resources. These resources are distributed in nine districts, namely, Belgaum, Bellary, Chikamagalur, Chitradurga, Davanagere, Gadag, North Canara, Shimoga and Tumkur

- *Sandur schist belt.*

Sandur schist belt comprises: basic igneous rock (meta basalts and pillow lava), ferruginous and manganiferous fillite/shale, younger intrusive banded ferruginous quartzite, iron, manganese ore and laterite. The manganese ore bodies are found to be associated with the phyllites and their altered products. The ore bodies are considered to be syngenetic and the later stage have undergone reconstitution by low grade metamorphism and also the supergene agencies have acted upon them to form superficial deposits at or near the surface. Manganese ore occurs at and around Deogiri forming part of the Kumarswamy range and extends further to Ramanadurga range.

IV. EXPERIMENTAL

The low grade manganese ore fines (-10 mm) sample collected from RMK (Ramakolla) and KVH (Kanavehalli) mines, Sandur, Karnataka, was use in the study. Samples were carried by coning and quartering method for mineralogical microscopic studies, sieve analysis and chemical analysis. Gravity processing tests as per the standard practice enumerated.

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V. RESULTS AND DISCUSSION

A. Characterization studies:

The representative samples from SK mines comprised of mostly black coloured fines with chips predominating over powdery material. Some brownish yellow coloured soft friable chips and coated powder grains were noticed. Mineralogical microscopic studies showed that manganese mineral Pyrolusite, Psilomelane and manganite and iron minerals hematite and goethite, clay and associated gangue mineral and the sample analyzed RMK mines sample: 19.19% Mn, 30.28% Mn/Fe ratio 0.63% and KVH mines sample: 22.47% Mn, 32.07% , Mn/Fe ratio 0.70

B. Sample sieve analysis test.

Samples were carried by coning and quartering standard method A representative sample was subjected to wet size analysis and fractions were analyses. The results are given in Table 1A&B

Size	Wt%	Assay%		Distn %		Cum. Wt% Retained	Assay%		Mn Fe Ratio	Distn Mn%
		Mn	Fe	Mn	Fe		Mn	Fe		
+10	6.18	23.18	30.46	7.46	6.21	6.18	25.58	28.24	0.91	28.89
-10+6	15.50	26.54	27.36	21.43	14.00	21.68				
-6+3	15.81	24.37	24.25	20.07	12.66	37.49	24.37	24.25	1.00	20.07
-3+2	15.92	22.69	29.31	18.81	15.40	53.40	22.96	29.33	0.78	22.30
-2+1	2.72	24.56	29.42	3.48	2.64	56.13				
-1+0.5	8.80	22.19	28.46	10.17	8.27	64.92	12.57	33.88	0.37	28.74
-0.5+0.25	5.97	18.44	29.01	5.73	5.72	70.89				
-0.25+0.15	2.72	14.99	33.43	2.13	3.01	73.61				
-0.15+0.075	5.65	8.18	47.51	2.41	8.87	79.27				
-0.075+0.045	2.93	7.96	49.42	1.22	4.78	82.20				
-0.045	17.80	7.64	31.36	7.09	18.43	100.00				
Total	100.00	19.19	30.28				19.19	30.28	0.63	100.00

Table- 1A: Sieve analysis of RMK mines sample

Size	Wt%	Assay%		Distn %		Cum. Wt% Retained	Assay%		Mn Fe Ratio	Distn Mn%
		Mn	Fe	Mn	Fe		Mn	Fe		
+10	2.29	29.60	27.39	3.02	1.96	2.29	28.55	28.16	1.01	12.29
-10+6	7.38	28.22	28.40	9.27	6.54	9.67				
-6+3	15.34	27.35	29.40	18.67	14.06	25.01	27.35	29.40	0.93	18.67
-3+2	20.32	27.76	28.63	25.10	18.14	45.33	27.86	28.39	0.98	31.30
-2+1	4.92	28.27	27.40	6.19	4.21	50.26				
-1+0.5	10.93	27.59	27.13	13.42	9.25	61.19	17.06	35.52	0.48	37.75
-0.5+0.25	7.33	23.67	27.53	7.72	6.29	68.52				
-0.25+0.15	1.72	18.62	30.14	1.42	1.61	70.23				
-0.15+0.075	8.19	10.59	43.90	3.86	11.21	78.42				
-0.075+0.045	5.78	8.21	51.13	2.11	9.22	84.20				
-0.045	15.80	13.11	35.55	9.22	17.51	100.00				
Total	100.00	22.47	32.07				22.47	32.07	0.70	100.00

Table-1B:Sieve analysis of KVH mines sample

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VI. GRAVITY PROCESS

A. Jigging Test

Effect of flow rate; The tests were conducted by using a mineral jig (hartz jig). Feed sample prepared by coning and quartering method and variation of water flow rate using in the experiments to remove the gangue minerals from ore mineral and upgrade. The results pertaining to varying water flow rate is given in Table 2A&B. The results indicate that increase in water flow rate from 3 to 6 liter per minute, decreased the Mn/Fe ratio and increased the wt% yield of concentrate. Optimum results were obtained at 4.5 minutes, 6 lpm water flow rate producing concentrate assaying RMK mines sample: 29.59%Mn, 25.19%Fe, ~1.17 Mn/Fe ratio & KVH mines sample: 31.86%Mn, 25.48%Fe, ~1.25 Mn/Fe ratio, just meeting the stipulated specification at maximum yield of RMK mines sample 54.51% (overall wt.% yield of 30.60) & KVH mines sample 48.27% (overall wt.% yield of 24.26) for the chips size.

Conditions: Feed size: -10+3 mm, Time: 4.5 minutes, Aperture 1 mm, Stoke 30mm, 250 RPM Table2A: RMK mines sample

Time	6 liter/minutes			4 liter/minutes			Total average		
Details	Wt%	Mn%	Fe%	Wt%	Mn%	Fe%	Wt%	Mn%	Fe%
Concentrate	54.51	29.59	25.19	51.59	27.90	28.12	53.42	28.50	26.92
Middling	22.70	24.06	27.32	27.88	24.92	28.75	26.37	24.37	28.40
Tailing 1	20.92	21.03	30.37	18.53	21.87	29.63	18.34	21.51	30.02
Hutch	1.87	12.73	36.92	1.99	12.85	36.03	1.88	13.37	36.09
Head cal.	100.00	26.23	26.98	100.00	25.65	28.73	100.00	25.85	28.05

Table -2: Effect of water flow rate

Time	6 liter/minutes			4 liter/minutes			3 liter/minutes		
Details	Wt%	Mn%	Fe%	Wt%	Mn%	Fe%	Wt%	Mn%	Fe%
Concentrate	48.27	31.86	25.48	47.62	30.97	26.01	41.00	30.94	26.14
Middling	23.68	29.04	27.06	27.75	27.48	28.80	30.13	28.01	28.82
Tailing 1	25.58	23.15	32.13	22.61	24.46	30.36	27.07	24.65	30.63
Hutch	2.47	19.10	36.86	2.02	17.00	36.86	1.81	15.57	37.72
Head cal.	100.00	28.65	27.83	100.00	28.25	27.99	100.00	28.08	28.37

Table2 B: KVH mines sample

- *Effect of split jigging:*

Jigging tests were carried out for 4.5 minutes, 1 mm aperture, 30mm Stroke, 250 rpm and at 6 lpm water flow rate. The results are given in table 3A&B. The results indicate that the composite sample of split jigging yielded a composite concentrate assaying Of RMK mines sample 30.03%Mn, 24.51%Fe,~1.23 Mn/Fe ratio just meeting the specification at overall wt.% yield of 29.69 with46.46% & KVH mines sample 31.64%Mn, 24.71%Fe,~1.28 Mn/Fe ratio just meeting the specification at overall wt.% yield of 23.15 with32.60% Mn overall distribution with respect to ROM feed. The jig rejects and -1 mm sample constituting final rejects assayed 15.81% Mn, 32.44% Fe, 0.49Mn/Fe ratio at 70.31 wt% yield with 57.92 % Mn distribution & 20.05% Mn, 33.68% Fe, 0.60Mn/Fe ratio at 76.84 wt% yield with 68.56 % Mn distribution of RMK and KVH mines sample.

B. Tabling Test;

The jig rejects and -1 mm sample constituting final rejects assayed 15.81% Mn, 32.44% Fe, 0.49Mn/Fe ratio at 70.31 wt% yield with 57.92 % Mn distribution & 20.05% Mn, 33.68% Fe, 0.60Mn/Fe ratio at 76.84 wt% yield with 68.56 % Mn distribution. The samples were stage crushed to -1mm and fed to Wilfley shaking table to remove ferruginous impurities. The above process yielded a concentrate assaying 25.00% Mn, 30.38% Fe, ~0.82 Mn/Fe ratio at 24.10 overall wt% yield & 28.00% Mn, 30.38% Fe, ~0.92 Mn/Fe ratio at 28.42 overall wt% yield with overall Mn recovery of. The composite process results are shown in Table 3A&B.

A combination of wet screening, split jigging of -20+1 mm fraction, followed by stage crushing of jig rejects and -1mm fraction fed to Wilfley shaking table yielded a composite concentrate assaying 27.77% Mn, 27.14% Fe, 1.02Mn/Fe ratio with 77.85% Mn distribution at 53.79 wt%

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yield & 29.63% Mn, 27.83% Fe, 1.06Mn/Fe ratio with 68.00% Mn distribution at 51.57 of wt% yield (RMK & KVH sample) meets the specifications of metallurgical industry after suitably agglomerating the concentrate. The results are similar to findings previous works.

VII. CONCLUSIONS

The low grade ferruginous Mn ore assaying 19.19%Mn and 30.28%Fe & 22.47%Mn and 32.07%Fe RMK and KVH mines of Sandur region is Gravity process of jigging, Crushed jig tails and ore fines followed by Wilfley shaking table concentrate with>30% Mn, Mn/Fe >1.25 with 68% & 77% Mn recovery, which can be used in metallurgical industry after suitable agglomeration. The ore is amenable to beneficiation.

Size range	Products	Wt%	Assay%		Mn/Fe ratio
			Mn	Fe	
-20+6 mm	Concentrate	53.80	30.08	25.12	1.20
	Middling	25.00	24.12	29.47	
	Tailing	17.90	21.97	30.19	
	Hutch	3.30	11.97	37.55	
	Head cal.	100.00	26.54	27.53	0.96
-6+3 mm	Concentrate	51.00	30.02	23.22	1.29
	Middling	25.90	23.89	28.12	
	Tailing	20.00	18.11	30.45	
	Hutch	3.10	11.57	24.13	
	Head cal.	100.00	25.48	25.96	0.98
-3+1 mm	Concentrate	53.90	29.98	25.11	1.19
	Middling	27.40	22.29	30.32	
	Tailing	15.00	19.22	30.54	
	Hutch	3.70	10.82	39.38	
	Head cal.	100.00	25.55	27.88	0.92
Com. -20+1 mm	Concentrate cal.	52.90 (29.69)	30.03	24.51	1.23
	Middling cal	26.10	23.40	29.32	
	Tailing cal	17.63	19.73	30.39	
	Hutch cal	3.37	11.43	34.10	
	Head cal.	100.00	25.86	27.12	0.95
	Jig reject [M+T+H]	47.10 (26.44)	21.1724	30.06	0.70
Com. 1 mm	-1 mm reject	43.87	12.57	33.88	0.37
Overall reject		70.31	15.81	32.44	0.49

Table 3A: RMK mines sample

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Size range	Products	Wt%	Assay%		Mn/Fe ratio
			Mn	Fe	
-20+6 mm	Concentrate	49.60	33.02	23.59	1.40
	Middling	20.80	28.64	27.38	
	Tailing	25.60	23.56	33.28	
	Hutch	4.00	16.58	38.55	
	Head cal.	100.00	29.03	27.46	1.06
-6+3 mm	Concentrate	45.80	30.98	25.55	1.21
	Middling	30.00	27.59	28.23	
	Tailing	22.00	24.55	31.55	
	Hutch	2.20	17.20	37.59	
	Head cal.	100.00	28.25	27.94	1.01
-3+1 mm	Concentrate	42.80	30.75	25.11	1.22
	Middling	30.00	26.67	28.54	
	Tailing	19.60	26.61	28.64	
	Hutch	7.60	18.22	37.69	
	Head cal.	100.00	27.76	27.79	1.00
Com. -20+1 mm	Concentrate cal.	46.07 (23.15)	31.64	24.71	1.28
	Middling cal	26.93	27.52	28.13	
	Tailing cal	22.40	24.77	31.36	
	Hutch cal	4.60	17.58	37.92	
	Head cal.	100.00	25.86	27.12	0.95
	Jig reject [M+T+H]	53.93 (27.11)	25.53	30.31	0.84
Com. 1 mm	-1 mm reject	49.74	17.06	35.52	0.48
Overall reject		76.84	20.05	33.68	0.60

Table 3B: KVH mines sample

Location	Products	Wt%	Assay%		Distn %	Mn/Fe ratio
			Mn	Fe	Mn	
RMK mines sample	Jig concentrate	29.69	30.03	24.51	46.45	1.23
	-1 mm tabling concentrate	24.10	25.00	30.38	31.40	0.82
	-1 mm tabling tailing	46.21	9.20	33.50	22.15	0.27
	Head cal.	100.00	19.19	30.08	100.00	0.64
	Final com. Mn concentrate cal.	53.79	27.77	27.14	77.85	1.02
KVH mines sample	Jig concentrate	23.15	31.64	24.71	32.60	1.28
	-1 mm tabling concentrate	28.42	28.00	30.38	35.40	0.92
	-1 mm tabling tailing	48.43	14.85	36.60	32.00	0.41
	Head cal.	100.00	22.47	32.08	100.00	0.70
	Final com. Mn concentrate cal.	51.57	29.63	27.83	68.00	1.06

Table – 4: Wet screening, split jigging, crushing to -1mm, Tabling.

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