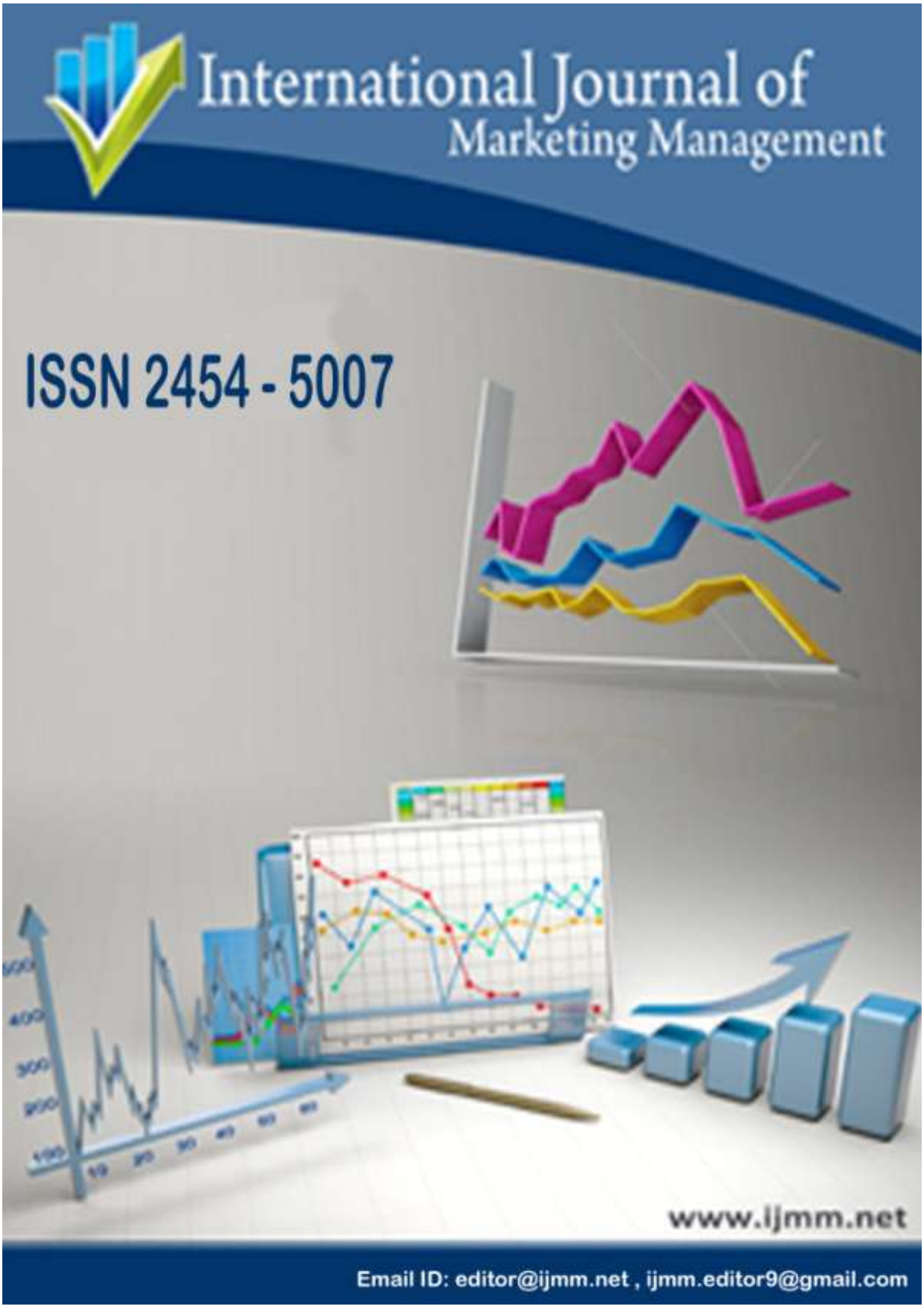

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Beneficiation of Ferruginous Manganese Ore

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Abstract:In a 50 tpd beneficiation plant, a low-grade ferruginous manganese ore sample assaying 30.83% Mn, 24.28% Fe (T), 0.05% P and a 1.27 Mn/Fe ratio was subjected to a stage crushing process to -40mm, wet washing – screening, and split Apic jigging of 40+20 and -20+5mm fractions, yielding a concentrate assaying 34.15 Using reduction roasting and magnetic separation, the jig concentrate may improve Mn quality to 40% and Mn/ Fe ratio to
2.5, with a 50 percent Mn distribution, meeting the metallurgicalgradestandardandopeningthedoortousingregionalmedium grade ferruginous manganese ores.

Keywords:ferruginousmanganeseore,,jigging,reductionroastingandmagneticconcentration

1.**INTRODUCTION**

In order to make steel, manganese is a necessary metal. Orissa has 44 percent, Karnataka has 22 percent, Madhya Pradesh has 13 percent, Maharashtra has 8 percent, Goa and Jharkhand have 3 percent of India's 142 million tons of manganese ores. The demand for metallurgical grade manganese ores has increased exponentially due to the threefold growth of India's steel industry. The supply of high-grade manganese ores is insufficient to meet the demand [less than 10%]. Due to safety and environmental concerns, the mining of manganese ores in forested regions has been halted. This means that manganese ore beneficiation is now a must for the metallurgical industry. Review of manganese beneficiation literature focuses on related gangue (IBM, 2014). By scrubbing screening and jigging of sized fractions, siliceous manganese ores from MOIL, MP mines have been improved to eliminate siliceous impurities (Narayanan) (1957). Wet high-intensity magnetic separation and reverse flotation of manganese have been used to remove phosphorus from manganese ores, respectively (IBM (2014)). Iron and manganese minerals share many chemical characteristics, so processing iron ores to improve the Mn/Fe ratio has had mixed results. The literature review on improving the Mn/Fe ratio of ferruginous manganese ores from Sandur area is limited to pilot scale research and has focused on magnetizing reduction roasting followed by magnetic separation of iron values (Narayanan (1957 and1960) and Hiremath et al (2013). Fuel and energy costs are expected to rise, making this technique unworkable for large-scale production. Mn/Fe ratios can be improved by simple jigging processes on Mn ores mined from Sandur (Krishna and others, 2017). For these reasons it has been attempted to develop an efficient method of manufacturing high quality metallurgical grade concentrates. In terms of metallurgical quality, the

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criteria are Mn>28%, preferably 40%, Fe 23%, Mn/Fe ratio >1.5 (Mn/Fe ratio of 2.5 is recommended), SiO2 20%, Al2O3 8%, and P Between 0.3% to 0.5% and in sizes of 40+3mm and 3+3mm, which is less than 10%.

II MATERIALSANDMETHODS

2.1 Material

The manganese ore sample from Deogriri, Sandur of M/s SMIORE was obtained and sub samples were drawn following homogenization, coning, and quartering. They were analyzed in terms of physical, chemical, and mineral properties.

2.2 Methods

Characterization experiments were conducted on the sub-sample, followed by wet sizing and Jigging of the sized fraction. Bateman Engineers' 4x4 m APIC pulsated pneumatic jig was used in the research. The JIGSCAN Simulator found the ideal circumstances.

RESULTSANDDISCUSSION

It comprises of characterization of feed samples furnishing the physical, chemical, and mineralogical andgranulometricdatafollowedbyjiggingstudiesunderoptimumconditionsindicatedbyJIGSCANsimulator.

3.1 Characterization

Physical, chemical, and mineralogical analyses were performed on the sub-sample that was taken from the larger sample. There are 30.83 percent Mn, 24.28 percent Fe (T), 0.01 percent P and a 1.27 Mn/Fe ratio from the particle size distribution and size fractional chemical analysis of the sample The ad samples received were black, hard, dense lumps with a few particles. There were yellow stains on a few of the lumps. Manganese minerals in the sample, as predicted by the miner, including pyrolusite and psilomelane in addition to iron oxide and clay-like laterite. It was found that washing the sample improved the Mn/Fe ratio by 0.15 in the preliminary amenability test, which was in line with the criteria. In the preliminary sink and float test using TBE, ferruginous clayey laterites were concentrated in the float, suggesting that silica, alumina, and iron values could be reduced to some extent. The -40+5mm sample was submitted to jigging tests based on the results of the previous tests and data from SMIORE in 1980.

3.2 BeneficiationstudieswithpneumaticAPICunderpulsatedjig

Bulky metallic ore jigging has been transformed thanks to the invention of the JIGSCAN simulator and a pneumatic under-pulsated APIC jig. In fact, MOIL's siliceous manganese ores are processed in similar jigging plants. APIC jig was used to separate the cleaned -40+20 fractions and -20+5 fractions because it is known that divided sized concentrations give greater selectivity. Table 1 shows the best settings for JIGSCAN software and outcomes. AnMn/Fe ratio of 1.74, with a 38.8% Mn distribution, and a 32.9 wt. percent yield of the heavy fraction indicate that the jig composite heavy fraction meets all of the standards for the metallurgical grade. If the Mn/Fe ratio is allowed to drop to 1.55, a composite heavy and middling concentrate with a 34.15% Mn, 22.022% Fe content and a 75.44% Mn distribution yields a 71.33% wt percent yield. After mixing with high Mn, low Fe, the result can be used. Lumpy ores with a high Mn/Fe ratio Hiremath et al. found a similar outcome (2013)

Table1:Resultsofjiggingtest

Product	Wt%	Mn

		Assay%	%Distn
-40+20mmjigconcentrate	17.4	36.15	19.5
-20+5mmjigconcentrate	15.6	36.52	17.6
-40+20mmjigmiddling	18.5	32.31	18.5
-20+5mmjigmiddling	19.8	32.25	19.8
-40+20mmjigtails	5.1	25.73	4.0
-20+5mmjigtails	5.5	24.96	4.3
-5+1mmsandandhutchproduct	13.0	31.20	12.6
-1mmcycloneunderflow	3.5	22.34	2.4
-1mmcycloneoverflow	1.6	27.04	1.3
Head (Cal)	100.0	32.30	100.0
Jigconcentrate(Cal)	33.0	36.32	37.1
Jigmiddling(Cal)	38.3	32.28	38.3
Comp.jigConc andMiddling (Cal)	71.3	34.15	75.4
Finalrejects	28.7	27.71	24.6

3.3 **Amenabilityofjigconcentratestoreductionroastandwlims;**

In the years 1957 and 1960, Narayanan was followed by IBM in 2014 and Hiremath et al (2013). Ferruginous manganese ores showed that roasting and magnetic separation enhanced the Mn/Fe ratio significantly. Reduction roasting was then performed on a 37.1 percent Mn jig concentrate that included 36.34 percent Mn and 20.90 percent Fe. The final product had an overall 37.1 percent Mn distribution and a wt. percent yield of 33 percent. WLIMS cobbing at 2000 guass was applied to the +15mm fraction, which was softly crushed to –15mm and water quenched. Concentrates with high selectivity index SI and weight percent yield were the goal of the trials.

3.3.1 **Effectoftemperature:**

Tests were carried out at temperatures of 500, 600, and 700 degrees Celsius while controlling for other variables. Table 2 shows the results. At 600 degrees C, saturation was found to improve the Mn/Fe ratio, the Selectivity Index, and the wt percent yield of concentrate with an increase in temperature. Concentrates with 47.94 percent Mn, 17.91 percent Fe, and a 2.68 Mn/Fe ratio were produced at 600oC with a 56.0 percent yield and a selectivity index of 1.75, with a wt..percent yield of 56.0.Table2:EffectoftemperatureonReduction roasting.

Time1hour,							
Temp^{o}C	Products	Wt%	Mn%	Fe%	Mn/Fe	Mn%Distn	SI
500	Mag	31.9	37.6	30.6	1.23	33.0	1.33
	NonMag	55.1	44.16	20.19	2.19	67.0	
	LOC	12.9					
	Head(C)	100.0	36.34	20.90	1.74	100.0	
600	Mag	27.9	34.1	39.0	0.87	26.1	1.75
	NonMag	56.0	47.94	17.91	2.68	73.9	
	LOC	16.2					
	Head(C)	100.0	36.34	20.90	1.74	100.0	
700	Mag	37.4	36.5	34.7	1.05		1.65
	NonMag	47.1	48.25	16.85	2.86	62,5	
	LOC	15.6					
	Head(C)	100.0	36.34	20.90	1.74	100.0	

3.3.2 **Effectoftime;**

Experiments at 600oC were carried out over varied periods of 0.5, 1, and 1.5 hours. To view the findings, please refer to Table 3. Concentration grade increases, wt.% concentrate yield decreases, and Mn% recovery decreases as the duration increases; the Selectivity index reaches a saturation point at 1 hour of time. Maximal yields and selectivity were achieved at a temperature of 600 degrees Celsius using concentrates that included 47.94 percent Mn, 17.91 percent Fe, a 2.68 Mn/Fe ratio, and a 73.9 percent Mn distribution with a weighted percent yield of 56.0. There was an overall wt.% yield of 18.5 and an overall Mn% recovery of 27.4 percent.

Table3:EffectoftemperatureonReductionroasting.

Time1hour,							
Timehr	Products	Wt%	Mn%	Fe%	Mn/Fe	Mn%Distn	SI
0,5	Mag	18.5	37.3	32.0	1.16	18.9	1.30
	NonMag	67.0	43.97	22.38	1.96	81.1	
	LOC	14.5					
	Head(C)	100.0	36.34	20.90	1.74	100.0	
1,0	Mag	27.9	34.1	39.0	0.87	26.1	1.75
	NonMag	56.0	47.94	17.91	2.68	73.9	
	LOC	16.2					
	Head(C)	100.0	36.34	20.90	1.74	100.0	
1,5	Mag	32.8	35.9	36.0	1,00	31.9	1.63
	NonMag	50.5	49.04	18.43	2.66	68.1	
	LOC	17.3					
	Head(C)	100.0	36.34	20.90	1,74	100.0	

Extreme temperature tests conducted for 1.5 hours at 700o C produced a concentrate with a Mn concentration of 51.89 percent and a selective index of 1.78 with a Mn distribution of 52.3% at a yield of 36.6% and a Fe content of 14.70 percent. Contrary to popular belief, reduction roasting of composite concentrate (Jig middling and concentrate) at temperatures above optimal (600oC and 1 hour) yielded a concentrate with a Mn/Fe ratio of 1.55, but with a 50 percent Mn distribution at a total weight-percent yield of 40.4 and a Mn/Fe ratio of 40 percent, 16 percent, and a Mn/Fe ratio of

IV.**CONCLUSIONS**

Stage crushing to -40mm, wet washing and screening, and split jigging of the -40+20mm and -20+5mm fractions were used to beneficiate a low-grade ferruginous manganese ore sample that included 30.83 percent Mn, 24.28 percent Fe (T0.05% P and 1.27 Mn/Fe ratio). The procedure described above produced a concentrate with a Mn/Fe ratio of 1.55, a distribution of 75.4% Mn, and a weight percent yield of 71.3, just meeting the requirements for metallurgical grade. Using Sandur region's medium grade ferruginous manganese ores was made possible thanks to the above-mentioned retrofittable technique. Mn/Fe ratio 2.5, Mn/Fe distribution 50%, and wt.% yield of 40.4 percent were all achieved by reducing roasting followed by WLIMS cobbing of the J ig composite concentrate prior to water quenching and aqueous cooling..

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