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Utilization Strategy of Lean Grade Magnetite for Pellet Making

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Abstract – *A low grade Magnetite of Banded Nature (BMQ) with considerable amount of fines from Belagal Range, Bellary district, Karnataka state, India was subjected to process evolution study for producing pellet grade concentrate assaying min 65% Fe [T]. The feed sample assayed 35.19% Fe[T], 42.70%, SiO_2 and 5.08% FeO. The sample Contain hematite and fine grained Magnetite interlocked with Quartz in major amounts. Mineralogical studies reveals that, Feldspar and gibbsite were found in minor to trace amounts and process diagnostic amenability tests to size, specific gravity and magnetic separation indicate that the sample is amenable to gravity separation at fine sizes. The final process comprises of Gravity concentration by shaking table at 150 mesh, d_{80} 67microns producing a concentrate assaying 66.73%Fe with 49.5% Fe distribution at 26.6 wt% yield meeting the specification of pellets as well as heavy media for coal washeries.*

Key Words: *Magnetite, Shaking Table, Magnetics, Pellets, gravity separation*

1. INTRODUCTION

Due to the increasing demand of quality iron ore for iron and steel industries and depletion of high grade ores, it becomes mandatory to exploit the low grade ores by suitable beneficiation techniques [1]. Recovery of iron values from such low-grade ores is generally attempted by gravity concentration, magnetic separation and flotation techniques [1 to 5]. Vast amount of Banded Magnetite Quartzite's (BMQ) are available they are not mined as most of them are located in forests and environmental regulations will not permit their mining and extraction. On the other hand since, the ore grade is very low, no attenion was payed on it in the past years. However, in recent years, with the increasing demond on the mineral resources, more and more lean magnetite was used to cover the enormous insufficiency. To utilized this resources reseanablely, attempt has been made to beneficiate the lean grade magnetite ore sample from Belagal Range, Bellary district to produce pellet grade/ Heavy media concentrates assaying > 65%Fe, SG > 4.7 & <0.1mm some experiments was carried out in laboratory. Considering the relative low ore grade of the magnetite, prelimenary magnetic separation on the lump is performed to cut down the recycling amount. The experimentl result shows that this step of saparation is necessary to meet the subsequent requirements[1].

2 EXPERIMENTAL.

2.1 Materials

The lean grade magnetite sample from Belagal Range of Ballari district, Karnataka, India 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 collected samples were subjected to standard feed preparation and sampling method. The original sample was subjected to detailed Chemical analysis. A particle size measurement of crushed and ground (<3mm) BMQ sample was performed using the standard laboratory sieve shaker and with standard sieves. The sized fractions were also used for Diagnostic Amenability studies and beneficiation using hand Bi pole bar magnet, Davis tube, Dry drum magnetic separator, Wet medium intensity magnetic separator.

3 RESULTS AND DISCUSSION

The experimental results comprises of characterization of feed samples furnishing the physical, chemical, mineralogical data followed by amenability of sample to gravity and magnetic concentration varying material and machine parameters.

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 35.19% Fe[T], 42.70%, SiO_2 , 5.08% FeO and 0.16% LOI. The sample contained very fine grained Magnetite and Quartz in major amounts. Feldspar and gibbsite were found in minor to trace amounts necessitating fine size liberation of -60 mesh (Refer Fig 1).

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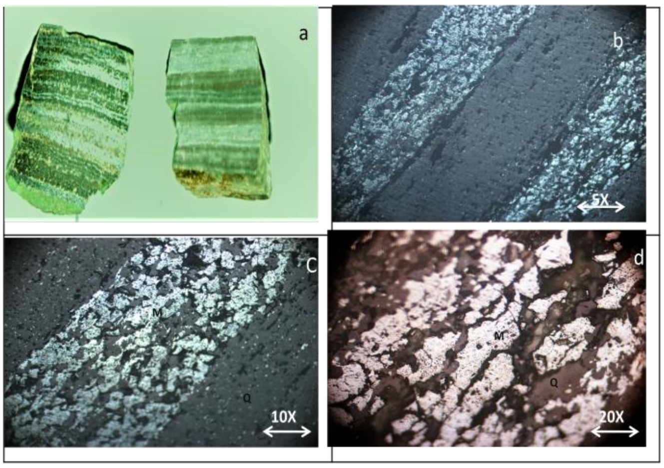

Fig 1 Inclusions of Magnetite in silicates

3.2 Effect of MOG on dry magnetic separation amenability test

The representative portion sample subjected to dry magnetic separator using Bi-pole hand magnet with field intensity of 1000 and 10000 gauss varying the field MOG from-30/-60/-100/-150 mesh .The results are given in shown in table 1. The results indicates that the grade concentrate increases with finer of size. The concentrate assaying 46.09 % Fe and distribution 40.6 was obtained at -150 mesh grind .This may be attributed necessity to find grind of -150 mesh to liberate very finely inter ground fine grind magnetite with fine grind quartz.

Table 1: Effect of MOG on magnetic separation

MOG	Product	Wt%	Fe %	
			Assay	Dist
-30#	Low intensity mag	43.9	38.60	46.76
	High intensity mag	52.1	37.90	51.35
	Non – mag	4.0	27.13	1.9
	Head	100	36.23	100
-60#	Low intensity mag	41.2	40.01	47.24
	High intensity mag	43.5	32.34	44.23
	Non – mag	15.3	20.84	9.11
	Head	100	34.96	100
-100#	Low intensity mag	28.9	35.46	29.2
	High intensity mag	57.8	36.72	60.5
	Non – mag	13.3	27.0	10.3
	Head	100	35.07	100
-150#	Low intensity mag	31.6	46.09	40.6
	High intensity mag	55.5	31.9	49.3
	Non – mag	12.9	28.3	10.2
	Head	100	35.92	100

3.3 Effect of MOG on Davis tube wet low intensity amenability Test:

The ferro-magnetic mineral concentration employing Davis tube test was carried out varying the MOG from -60/-100/-150 mesh, the test was conducted .the conditions and the results of the Davis test. The result shown in Table 2 indicates that the grade and recovery of ferro magnetic concentration increases gradually and attains a maximum at -100mesh their after falls with further increasing fineness of grind. The optimum results were obtained ar-100mesh, 2000gauss yielding concentrate assaying 64.0% Fe with 19.56 % Fe distribution at weight % yield 10.71 the poor performance extreme sizes may be attributed to inter locking at coarse size resulting in tail loss and slimes generation and its interference (Refer Fig1).

Table 2. Effect of MOG Davis tube Test.

MOG	Product	Wt%	Fe %	
			Assay	Dist
-60#	Mag	7.48	56.43	12.3
	Non – mag	92.52	32.46	87.7
	Head	100	34.32	100
-100#	**Mag**	**10.71**	**64.00**	**19.56**
	Non – mag	89.29	31.57	80.44
	Head	100	35.05	100
-150#	Mag	6.13	64.00	11.6
	Non – mag	3.87	32.07	88.4
	Head	100	34.06	100

3.4 Effect of MOG dry magnetic drum separation

Since the sample is very fine grind hard and compact magnetite, pre-concentration test were attempted employing laboratory model dry LIMS separators. The MOG was varied from -5mm/-10/-30/mesh and results are given in Table 3. Pre concentration by DLIM drum separator indicated optimum value at -30mesh producing concentrate assaying 39.25% Fe grade with 88.4% recovery at weight % of 76. The lack of selectivity at size coarser than -30mesh, was attributed to inter locking. The fall in grade at fine size may be attributed to low pinning factor of powder due to low RPM.

Table 3: Effect of MOG on dry magnetic drum separation

MOG	Product	Wt%	Assay	Fe Dist
-5mm	Mag	59.5	40.93	68.1
	Non – mag	41.5	27.92	31.9
	Head	100	34.94	100
-10#	Mag	68	38.42	73.86
	Non – mag	32	28.88	26.14
	Head	100	35.36	100
-30#	Mag	**76**	**39.25**	**88.4**
	Non – mag	24	22.35	11.6
	Head	100	35.19	100

3.5 Effect of MOG on Wet Medium Intensity Magnetic Separation

WMIS tests were done in lab model WMIMS [Ferrous wheel type] varying the mesh of grind 30/-60/-100/-150mesh. The results in table 4 indicate the tails losses are high at extreme sizes, probably due to interlocking at coarse size and slims losses in fine sizes. -100 mesh size was found to be optimum. The increase in recovery with the use of fine matrix may be attributed to enhanced gradient with fine ball matrix. Similar result was obtained by previous workers while working on magnetites of Karnataka [3 and 4]

Table 4: Effect of MOG on Wet Medium Intensity Magnetic Separation test

Product	6mm Dia ball matrix			10mm Dia ball Matrix		
	Wt%	Fe %		Wt%	Fe %	
		Assay	Dist		Assay	Dist
-60#Conc	85.7	40.9	96.0	85.6	40.00	95.4
-60#Tails	14.3	10.07	4.0	14.4	11.4	4.6
Head	**100**	**36.49**	**100**	**100**	**35.94**	**100**
-100#Conc	**86.7**	**40.72**	**97.8**	**78.8**	**42.15**	**96.6**
-100#Tails	13.4	6.00	2.2	21.2	6.00	3.4
Head	**100**	**36.1**	**100**	**100**	**34.39**	**100**
-150#Conc	84.1	38.08	92.4	74.7	41.85	91.7
-150#Tails	19.9	29.94	7.6	25.3	12.11	8.3
Head	**100**	**34.61**	**100**	**100**	**34.33**	**100**

3.6 Effect of MOG on Tabling

The since concentration criteria between magnetite and quartz is more than 2.3 the tabling test were conducted varies MOG (-30/-60/-100/-150mesh), the results pertain into effect of MOG on tabling. The result shown in table 5 indicates the grade of concentrate increases with increasing fines of MOG. The optimum result was obtained at -60 mesh, MOG producing concentration analyzing 62.57%Fe(T) with 51.13% Fe distribution at wt% of 28.7, narrowly missing the BF grade. The increasing grade of concentrate and tails with increase in fineness of MOG is attributed to liberation of magnetite and slimes interferences. Previous works indicated that gravity concentration by tabling produced quality concentrates vis-à-vis WLIMS [3] similar to our findings probably due to concentration of finely interlocked silicate grains in magnetic separation (Refer Fig 1).

Table 5: Effect of MOG on Tabling

MOG	Products	Wt %	% Fe	
			Assay	Dist
-30# 710 microns	Conc	45.6	50.22	62.3
	middling	44.9	26.04	31.8
	Tail	9.5	22.78	5.85
	Head	100	36.75	100
-60# 250 microns	Conc	**28.7**	**62.57**	**51.13**
	middling	66.2	24.16	45.22
	Tail	5.2	21.57	2.2
	Head	100	35.07	100
-100# 150 microns	Conc	25.9	57.81	42.8
	middling	64.5	28.43	52.4
	Tail	9.9	17.2	4.9
	Head	100	35.01	100
150# 105 microns	Conc	26.6	66.1	43.9
	middling	63.9	28.45	50.8
	Tail	9.4	20.54	5.4
	Head	100	35.84	100

3.7 Final test under optimum conditions

The final test comprises of proven conventional process of stage grinding to -150 mesh D_{80} 67 microns; followed by tabling yielded a table concentrate assaying 66.73%Fe, 4.8SG with 49.5% Fe distribution at 26.6 wt% yield, meeting the specification. (Refer Table 6)

Table 6: Final test under optimum Conditions

MOG	Products	Wt %	Assay% Fe	Dist% Fe
-150# 67 microns	Concentrate	**26.6**	**66.73**	**49.5**
	Middling	53.9	28.45	42.8
	Tail	19.4	14.20	7.7
	Head	100	35.84	100

4 CONCLUSIONS

A magnetite (BMQ) sample from Belagal Range, Bellary district Karnataka, India was received for process evolution to obtain concentrate assaying Fe>66%.The sample analyzed 35% Fe(T), 42% SiO_2 containing mainly fine grained magnetite and quartz. The process amenability test indicated a MOG finer than -150# for gravity separation to produce the concentrate of stipulated grade. The final test comprising of tabling at MOG of -150 mesh, d_{80} 67microns yielded a concentrate assaying 66.73%Fe, SG 4.8, -0.1mm, with 49.5% Fe distribution at 26.6 wt% yield meeting the stipulated specification of metallurgical grade and Heavy media weighting grade.

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