PROCESS AMENABILITY TEST OF LOW GRADE IRON ORE

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ABSTRACT: Utilisation of Low-Grade Iron Ore Fines after concentration not only helps in conservation of the mineral wealth, but also substantially improves the economics of iron ore mining. There has been need to develop suitable beneficiation process for upgradation of low-grade iron ores towards their rational utilisation. Presently the circuit adopted for processing iron ores has limitations in reduction of alumina. The depletion of high-grade reserves, utilisation of low-grade reserves coupled with increasing market pressure for improved product quality necessitates re-examination of the process flow sheets and evaluate alternative or supplemental processing routes. The main objective of the Process amenability studies for utilisation of Low-Grade Iron Ore Fines (-10mm) is to get Pellet grade concentrate with +65% Fe (min), SiO2 1.8% (max), Al2O3 1.8% (max) and other proportionate constituents by adopting suitable beneficiation techniques and to collect the relevant data (Quality and Quantity of the Products) for the process development. In an effort to formulate a conceptual process flow sheet, the Process amenability studies for utilisation of Low-Grade Iron Ore Fines (-10mm), which is lying at a mine site in India, samples were collected and taken up for the study. The efforts of R & D of NMDC are discussed in this paper. Low-Grade Iron Ore Fines (-10mm) sample assayed 60.10% Fe with 3.48% SiO2 and 4.48% Al2O3. Microscopic examination reveals that the grain sizes of the ore minerals are varying from 40 to 300 microns. The sample consists of hematite as the chief ore mineral followed by minor amounts of maghemite. The gangue minerals include quartz and ferruginous clay in which quartz occurs as medium grained where as ferruginous clay occurs as fine to sub microscopic size mineral. The economical processing route evolved out of the studies finally could yield a final concentrate constituting 58.63% by weight along with Iron unit's recovery of 63.51% assaying 65.10% Fe with 1.48% SiO2 and 1.85% Al2O3. The economical processing route that adopted comprises the following operations. Making slurry in a sump pump followed by grinding in close circuit with 48mesh size Screen. The – 48 mesh size product was subjected to the Cycloning to remove slimes. The Cyclone Underflow product was subjected to Floatex Density Separation (FDS) to separate fine heavy minerals from the gangue minerals. The FDS Underflow was collected as concentrate. The FDS Overflow product was further subjected with Wet High Intensity Magnetic Separation (WHIMS) to recover more Iron units as magnetics. A conceptual process flow sheet was evolved, which may become the prelude to the subsequent finalisation of the process flow sheet for commercialisation.

I.INTRODUCTION

Iron is the second most common metallic element found in the crust of the Earth andmakes up 5.6 percent of the lithosphere. Iron's most important minerals are its oxides (hematiteandmagnetite),hydroxides(limonitean dgoethite),carbonates(siderite),andsulphides.H em atite and magnetite are examples of iron oxides (pyrite). Iron, like the majority of othermetals, can only be found in the crust of the Earth in the form of an ore, which means that it iscoupled with other elements like oxygen or sulphur. Iron may be obtained from a variety ofdifferent ores, but the two most significant ones are hematite and magnetite. Hematite, on theother hand, is seen as being superior than magnetite due to the fact that it has larger deposits thanmagnetite does, and the majority of magnetite resources are located in dense forests, renderingtheminaccessible for industrialuse. The production of iron and steel starts with the most fundamental raw material: iron ore. Depending on the grade, the amount of carbon that is presentin steel may range from0.2 percentto 2.1 percent by weight. Steel isan alloy that ismostlymade up of iron. In order to extract iron from its ore, oxygen must first be removed, and then theore must be combined with a chosen chemical partner such as carbon. Smelting is the term usedtodescribethis process.

1.1 Iron OreFines:

The typical particle sizes of the ore used in rotary kilns range from 5 to 18 millimetres. Crushing and screening the lumpy ore that is obtained from the mines results in the production of this size range of the ore. As a result of this operation, practically all of the ore is generated in the form offines. Nearly 0.8 tonnes of iron ore fines are required for every tonne of sponge iron that ismanufactured.The following is an exampleof aniron orefines sieveanalysis:

1. -1mm(30-40%)

2. -3mm(35-38%)

3. +3,-5mm(28-45%)

Utilization of Iron Ore Fines:

The following is a list of potential applications for the Iron Ore Fines that are generated as awaste material: By modifying the positive size of the coal, etc., some amount of between +3 and
-5mm may be employed together with the charge in the rotary kiln. The iron ore fines may bepelletized and then used in either the blast furnace or the rotary kiln in the process of creating pigiron or sponge iron, respectively. Iron ore fines may be used to make sinters, which can then beput into the blast furnace. For use in an electric arc furnace (EAF) or an iron blast furnace,composite pre-reduced pellets (CPR) may be manufactured from coal fines and iron ore. Iron orefines in coal may be used to make various types of sponge iron products, such as rods, granules, and so on. The features of the raw materials that are used in the manufacturing of DRI are very important to consider due to the close relationship between efficiency and cost effectiveness. These aspects are controlled by the characteristics of the coal used in the process. For the purpose of selecting iron ore for the DR process, the following criteriaaretaken into consideration.

1. The Constituents of Chemicals

2. The ability to be reduced

3. Thysical Attributes (such as Height, Weight, and Strength).

Aim of Present Work and Its Scope:

AIM: Beneficiation studies were conducted onanoresamplethatweighedabout600kilogrammes and had an analysis of 40 percent iron and 36 percent silicon dioxide. The samplecame from the SanjeevarayanaKote village in the Bellary (Tq) (Dist) region of Karnataka. Thegoalofthestudieswastoproduceapelletgrade concentratethatcontainedmorethan64percentiron.

The scope of work comprises:

- A sample of the size distribution Of the feed.
- Examining the sample for its physical and chemical characteristics onceithasbeenreceived.
- Feasibility studies on mineral proces sing for the purpose of lowering the silicacontent in the as received sample as much as is humanly feasible and raising theironcontenttoalevelmorethan64percentwhile maintainingthehighestpossibleiron recovery and grade.
- Theoptimization of settingsfortheDavisTubetest,suchasthe meshof the grind,in orderto conduct astudy of percentmagnetics

 Studiesof magnetic separation using adrum first,thenstudiesof magnetic separation using a wet high intensitymagnet.

 The preparation of the material and maintenance of metallurgical balance.

Objective:

The purpose of this research is to improve the quality of low-grade magnetite ore byperforming amenability studies on the effects of particle size on magnetic separation processes.Theseprocessesincludedrummagneti cseparation,wethighandlowintensitymagnetics epa ration,andverticalpulsatinghighgradientmagnet icseparation.Theendgoalistoproduceapellet-gradeconcentrate that hasahighgradeand high recovery.

II.LITERATURE REVIEW

The characteristics of the ore deposits, in particular the grain size of the mineral value inthe ore, its dissemination in the mass of the deposit, and its association with the gangue minerals,play a significant role in determining the liberation size, the abundance of fine particles, theselection of efficient equipment, the appropriate separation method in some cases, and, as aconsequence, the entire flow sheet of ore processing. Because the minerals are freed at relativelycoarse sizes in high-grade deposits, there is no need for extensive particle size reduction to becarried out in these deposits. As a consequence of this, the proportion of tiny particles is oftenrather low, and the objective of the whole process is to achieve the greatest possible degree ofrelease while working with a particle size range that is as coarse as is practically feasible. In the event that the coarser particles cannot be effectively separated from the finer particles, the finer particles must be eliminated before the beneficiation process can begin on the coarser particles. The separation of fine particles has been the subject of intensive research for a good number ofyears [11-13]. Bandedmagnetite quartzite (BMQ) ore occurs as separate are considered to below grade iron ores with Fe content of 25–45 percent, SiO2 content of 30–60 percent, and Al2O3content of 1–5 percent. Despite the difficulty of processing fine and ultrafine nature banded magnetite quartzite (BMQ) ore occurs as separate. To date, there is not a single commercialfacility that hasbeenestablished to extract the iron values from these oresfor use in anyindustrial processes. However, because of the growing demand for high-quality iron ore from theiron and steel industries and the depletion of high-grade ores, it has become imperative tomaximise the use of low-grade ores by the use of appropriate beneficiation processes. Methodssuch as gravity concentration, magnetic separation, and flotation are often used in an effort toincrease the amount of iron that can be extracted from ores with such a low grade. Therefore, the processing of finely dispersed mineral particles requires either an upgrade or modification of thecurrent separation methods, as well as the adoption of novel approaches. This research provides asummary of the progress that has been made in the techniques of separation (physical andphysicochemical) aswellasthecreationofnewpiecesofequipmentto dealwiththechallengeof separating small particles. In the end, an investigation into the use of a variety of magneticprocessingtechniquesfor low-grademagnetite ores ispresented.

III.RAWMATERIALS

Sample of Ore The low grade iron ore sample that was utilised in this inquiry came fromSanjeevarayanaKote village in Bellary, Karnataka. It was used in this investigation since it wasavailable.As canbeseeninFigure3,this deposit isacomponentofabandediron oreformation

Fig1.Ironoresampleformstudyarea

Physical Examination:

In accordance with the findings of the physical investigation, the majority of thesample was composed of brown fines, while only a trace quantity was comprised of hard,compact chips measuring less than one millimetre in size (see Figure 4).And demonstrated aspecificgravity ofroughly 4.8andanangleofrepose of42 degrees.

Fig2.Feed Sample

Chemical Analysis.

Afterbeingreducedtotherequiredsize,arepresentativepieceofthesampleasitwasreceived was then submitted to a comprehensive chemical analysis. Figure 5 shows the findingsofthechemicalanalysisperformed onthematerial initsas-receivedstate.

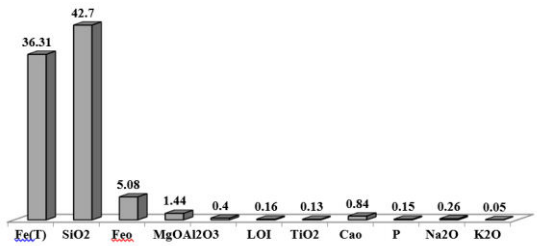

Fig3.Chemicalanalysisof asreceivedsample

Mineralogy:

The examination of the sample with a stereo microscope reveals that the sample primarily consists of hematite and martitized magnetite, along with major amounts of quartz and very minor amounts ofgoethite/limonite and ferruginous clay, as shown in figure 6. The majority of the quartz grains have fine inclusionsin them, as the studies with the stereo microscope show.

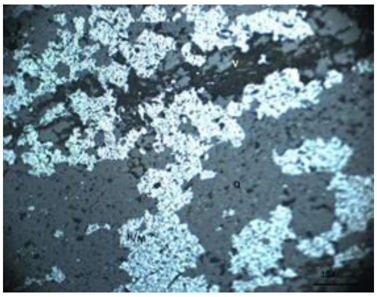

Fig.4 Stereo Micrograph of As received Sample showing Hematite/Magnetite and Quartz(10X)

Feed preparation and sampling

For the purpose of this investigation, an approximately 500-kilogram sample of thelow-gradeironorefoundinthestudyregionwascollected.AsshowninFigure7,arepresentative sub sample was taken from the bulk sample by using riffle sampling as well asconing and quartering. A subsample was taken for the experiment, and it was sieved todetermine what percentage of particles were larger than 100 mesh (150 microns). Followingthat, the sample was used for characterization studies, which included particle size analysis(dry and wet), chemical analysis, and amenability studies. The remaining sample was put touseforbeneficiation research.

Fig.5 SubSamplingofFeed

IV.RESULTS AND DISCUSSIONS

4.1Drummagnetic separation studies

The as received sample of about 600 kg was carefully mixed before being put into thedrum magnetic separation device. This was done in order to separate the magnetic fraction fromthe non-magnetic fraction inthe feed material.According tothe findings,around thirty percentof the overall volume was considered to be a non-magnetic fraction. In addition, representativesamples of Mag products totaling 250 grammes were analysed using a wet sieve in great detail.The precise size distribution as well as the amount of Fe present in each Mag product fraction isshown in Table.4. Additionally, it was discovered that almost 33 percent of the Drum magproduct is composed of +100Mesh (150 Microns). According to the findings, the grade of thedrum product is at its highest point at a finer size, namely at -200 mesh, where it contains 62percentiron.

Mesh no	microns	Wt%	Cum wt%passing	Fe%	FeDistribution	SiO2	Al2O3	LOI	FeO
+100#	150	32.37	67.63	46.35	26.98	30.84	0.11	-	5.28
+150#	106	20.28	47.35	57.06	20.81	16.23	0.10	-	6.83
+200#	75	19.26	28.09	61.00	21.13	10.92	0.08	-	5.33
+250#	63	8.120	19.97	61.75	9.01	9.37	0.08	-	5.56
+325#	53	11.68	8.29	62.98	13.23	7.94	0.08	-	6.31
+400#	45	2.45	5.84	62.94	2.77	7.87	0.09	-	6.42
-400#	38	5.73	0	58.78	6.05	12.26	0.16	0.61	7.90
Head		100.0		55.60	100.0				

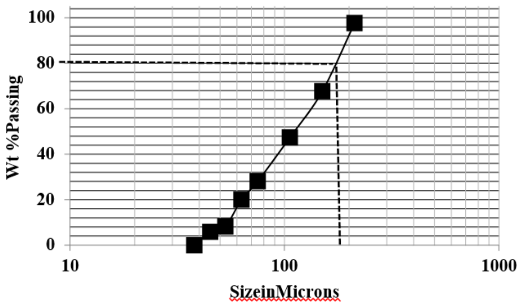

Fig.6Sizeanalysisof asreceived sample

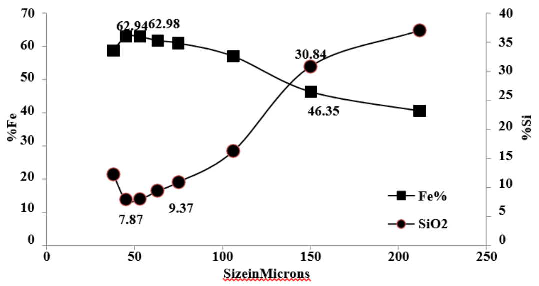

Fig.7 EffectofSizeon%Fe and%Sivaluesof feedsample

4.2 Effectof MOGonDavis TubeTest

Wet grinding was performed on a representative sample that weighed close to 200grammes of feed for a period of time that ranged from 5 to 20 minutes. The ground goods wereput through the Davis tube test, which has a water flow rate of 650cc/min and is designed tokeep the pulp level in the tube and at the poles at a constant level. The agitation rates start at30 revolutions per minute (RPM). Ten minutes had been allotted for the agitation time. Theslope angle of 45 degrees has been chosen for the investigation. The tabulated findings may beseen inTable5.

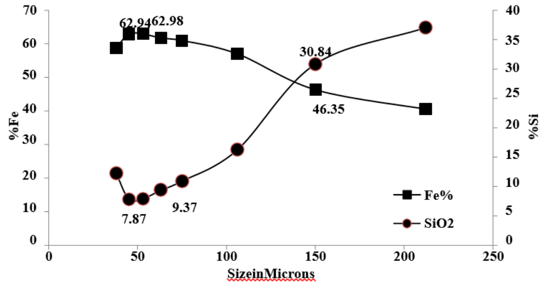

Table.Davistubetest results

Sr no	Grinding time	products	Wt in gms	Wt %	Fe%	Distn (%Fe)
1	0Min (D_{80}-1mm)	Mag	17	56.67	45.3	60.00
		Non-Mag	13	43.33	39.5	40.01
		Head	30	100	42.78	
2	5minutes (D_{80}-0.6mm)	Mag	18.5	61.67	47.8	65.36
		Non Mag	12.5	41.67	40.2	37.14
		Head	30	100	45.1	
3	10minutes (D_{80}-0.3mm)	Mag	15.8	52.67	55.9	58.24
		Non Mag	14.2	47.33	39.7	37.17
		Head	30	100	50.55	
4	15minutes (D_{80}-0.1mm)	Mag	14	46.67	62.8	52.31
		NonMag	16	53.33	40.2	38.27
		Head	30	100	56.02	
5	20minutes (D_{80}-0.075mm)	Mag	13.5	45.00	64.5	49.64
		Non Mag	17.5	58.33	40.4	40.31
		Head	30	100	58.47	

V.SUMMARY AND CONCLUSION

A Banded Magnetite Quartzite (BMQ) sample with a number of -150# was obtained from the SanjeevarayanaKote hamlet in the Bellary area. This sample was used in a process evolution toget concentrate with an assay of Fe>65 percent. The pre-concentrated sample had an analysis of37 percent Fe(T) and 42 percent silica content, with the majority of the silica coming from finegrind magnetite and fine grind quartz. The process amenability test suggested that a MOG with afiner particle size than -100 # should be separated using magnetic forces in order to create the concentrate of the required grade.

The exploratory Davis tube test provided confirmation of the result of the amenability test inrelation to MOG. The results of the tabling test on extremely MOG revealed that the necessarygrade concentrate could be generated only at MOG finer than -150 mesh, despite the fact thatrecovery was low. In a similar manner, LIMS confirming -100# MOG results in 66.6% Fe with74.6%Distribution.

According to the findings of the research relevant to LIMS non mag that was submitted toWMIMS validating MOG, -200#, MOG is necessary for the production of the required gradeconcentrate.

The VPHGMS test is carried out with the goal of recovering the tiny Magnetic fractions from thetails of the whole process, which gives a total of 49 percent Fe with 23 percent dispersion.

Thefinalflowsheetisillustratedinfigure,anditproducesaconcentratethathasaFecontentof 64.67 percent, with a Fe distribution of roughly 70 percent at a Wt percent yield of 74. Theproduct satisfies the requirements of the given standard in addition to those of the metallurgicalindustry(with referenceto Fe)and the Heavymedia specification.

It is advised that a detailed combination test on a continuous pilot scale test be performed for thepurposeofconfirmingtheprocess,enhancingit,andcollectingengineeringdatafortheconceptual pla nt. In light of the fact that the material investigation of amenability processing.

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