Processing of Indian iron ores

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Introduction

India has a vast reserve of high grade iron ore estimated at about 17.5 billion tonnes of which hematite ore alone constitutes about 11.5 billion tonnes and the rest is magnetite ore as shown in Table — 1.

Table — 1 : IRON ORE RESERVES

(Million Tonnes)

	Proved	Probable	Possible	Total	Iron%
Hematite	4,652	4,136	2,682	11,470	+58
Magnetite	1,398	1,865	2,840	6,103	30-40

The total available production capacity is about 70 million tonnes per year. However, due to recession, only 41.6 million tonnes of iron ore was produced during 1982-83 out of which 22.2 million tonnes of ore was exported and the rest consumed within the country as shown in Table — 2.

Table —2 : PRODUCTION OF IRON ORE

Million Tonnes/Million Rs.

Year	Production	Export	Value
79-80	39.2	24.9	2822
80-81	42.2	24.5	3192
81-82	40.8	26.0	3862
82-83	41.6	22.2	4005

Depending on the type of consumption, all the iron ore mines in the country are broadly classified into two major groups, i. e., export oriented and steel plant owned. In the export oriented mines, the quality of the ore greatly depends on the specifications laid out by the buyers. In case of mechanised mines, the owners like NMDC Ltd., undertake bulk mining followed by processing of iron ores. However, small private mine owners catering to export demand, adopt selective mining of rich ore deposits involving manual mining and sorting of the ore.

The captive mines belonging to the steel plants are operated to produce ore meeting its own specifications.

Beneficiation — The need :

Initially, the trend was to go for selective mining of rich iron ores. Thus, the ores of high grades are becoming gradually depleted necessitating the mining of leaner ores also. Moreover, in mechanised mining there is hardly any scope for selective exploitation. During mining of high grade ores also, mixing of low grade ores, which may be present as overburden, with high grade ores takes place. This admixture becomes inevitable where large scale mechanised mining is resorted to.

Thus, in most cases some kind of beneficiation of run of mine ore has to be adopted to ensure acceptable and consistent quality of iron ore. The prepared burden for iron smelting is of paramount importance, necessitating size reduction, screening and beneficiation. The ore processing technique depends on the general specifications of the desirable products as shown in Table — 3.

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Table — 3 : GENERAL SPECIFICATIONS OF PRODUCTS

	Lumps			Fines			KIOCL	
	I	II	III	I	II	III	Conc	Pellets
Iron (Fe) %	67/65	65/63	62/60	66/64	63/61	62/60	67	66
Silica + Alumina %	5	7	9	5.5	7	8	3.25	3.25
Alumina (max) %	2.5	3.0	4.5	3.0	3.5	3.50	0.50	0.50
Phos %	0.08	0.10	0.10	0.08	0.08	0.10	0.02	0.02
Sul %	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
Size (mm)	10—200, 10—30,	10—150/100 6—30		—10			—100 mesh (95%) —325 mesh (55—70%)	9—16

Beneficiation — The Process :

Different beneficiation techniques are employed to suit a particular ore, depending upon its mineralogical characteristics. The techniques include crushing, grinding, sizing, washing and wet screening, gravity treatment, magnetic separation etc. The overall beneficiation flowsheet may include the use of one or more of the different methods depending on the mineralogical composition.

Cost control aspects :

With the need for beneficiation/processing of iron ores, it is imperative to ensure economic viability of the mining/processing plants. With the off-take limited to a particular category of product, say lumps, the cost of production of the specified product becomes quite high considering the cost of mining and processing of the total ore. Therefore, any effort aimed at utilising other products, i. e., fines and superfines will greatly enhace the economic viability of the total operations including the processing plants.

Wet operations, generally employed in India for processing iron ores, result in the rejection of 15 to 25 % of ore processed in the form of slimes (material finer than 0.15 mm in size). Studies in R & D laboratories of NMDC and other National laboratories have shown that by beneficiation using cyclone, about 60 to 70% of these slimes can be recovered, with an iron content of over 65%. Use of these upgraded slimes along with the natural —10 mm fines for sintering should be explored. Also, in Indian hematite ore deposits, substantial quantities of naturally occurring iron ore super-fines, i. e. blue dust are encountered. Till recently these high grade super-fines are left unused for want of market.

Previously, the use of these super-fines was thought of for pelletisation. However, with the increase in operating costs, pelletisation is not being adopted. Therefore, the other alternative, i. e., sintering has to be seriously evaluated so that these fines could be utilised effectively.

Studies on sintering with blue dust and other super-fines carried out by various institutions have shown that these super-fines (blue dust) could be easily utilised to the extent upto 40% along with the fines for sintering without any adverse effects on productivity and quality as shown in Table — 4.

Table — 4 : SINTERING TESTS

Moisture = 7.5 %
Coke = 5.6 %
Ret. Sinter = 33 %
Ore mix = 60 % Fines + 40 % blue dust

Basicity $\frac{CaO+MgO}{SiO_2+Al_2O_3}$	With microballing			Without microballing		
	Productivity t/m^2 / h	Tumbler Index %	Reducibility %	Productivity t/m^2 / h	Tumbler Index %	Reducibility %
1.27	1.27	57.0		1.12	55.3	
1.47	1.12	58.0		0.98	51.0	
1.67	1.28	61.0		1.06	45.3	
1.87	1.44	69.3	47.1	1.08	49.3	
2.07	1.45	72.7		1.14	56.0	48.3
2.27	1.60	76.0		1.44	76.0	51.0

The basicity of about 2.0 $\left(\frac{CaO + MgO}{SiO_2+Al_2O_3}\right)$ required for sintering of these super-fines would also be most suitable for Indian iron & steel plants to take care of the high ash content in Indian coke.

Thus, the present conservative approach in restricting super-fines content to 10% in the iron ore feed for sintering needs revision.

With the utilisation of blue dust and upgraded slimes in sintering, the rejects from processing would be considerably reduced leading to conservation of minerals apart from improving the viability of processing operations and minimising the pollution effects of the mining operations.