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Pelletisation in Indian context – need of the hour

As India progresses towards higher level of growth and more emphasis is being given in the development of infrastructure and manufacturing sector, the iron and steel industry is poised for a rapid growth in years to come. The demand for steel is increasing at a rate of 10%. The domestic production capacity is required to be higher than 110Mt/Yr and it is expected to rise up to 150Mt/Yr by the year 2016-17. Alternative iron making processes to produce steel may change the pattern of use of material inputs and cause a significant shift in the share of lumps and agglomerated ore i.e. sinter and pellets. As fines constitute around 50% of total iron ore produced, pelletisation is the need of the hour.

Keywords: *Iron, steel, sinter, pellet, pelletisation.*

Introduction

As India progresses towards higher level of growth and more emphasis is being given in the development of infrastructure and manufacturing sector, the iron and steel industry is poised for a rapid growth in years to come. The demand for steel is increasing at a rate of 10%. Iron ore forms basic raw material for iron and steel industry. India has large reserves of good quality iron ore which can meet the growing demand of domestic iron and steel industry and can also sustain considerable external trade. United States Geological Survey (USGS) has estimated that the world resources are estimated to exceed 800 billion tonnes of crude ore containing more than 230 billion tonnes of iron (USGS Mineral Commodity Summaries, 2006; www.fedmin.com, 2008). India is one of the leading producers as well as exporter of iron ore in the world. India possesses hematite resources of 11,426 million tonnes of which 6,025 million tonnes are reserves and 5,401 million tonnes are remaining resources (Table 1) (Indian Mineral Year Book, 2006). About 2,823 million tonnes (25%) are medium grade lumpy ore resources while 915 million tonnes (8%) are high-grade lumpy ore. Out of the fines resources about 2,507 million tonnes (22%) are medium grade ore, 39 million tonnes (1%) are high-grade ore and 17 million tonnes (1%) resources are of blue dust variety. The remaining are low grade, unclassified resources of lumps and fines or high, medium, low or unclassified grades of lumps and fines mixed etc (Fig.1). Major resources of hematite iron ore are located in Odisha (3,789 million tonnes (33%)), Jharkhand (3,044 million tonnes (27%)), Chhattisgarh (2,120 million tonnes (19%)), Karnataka (1,148 million tonnes (10%)) and Goa (642 million tonnes (16%)). The balance 4% resources are spread in Maharashtra, Andhra Pradesh and Madhya Pradesh.

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The domestic production capacity is required to be higher than 110Mt/yr and it is expected to rise up to 150Mt/yr by the year 2016-17. India exported about 117Mts of iron ore in 2009-10 out of which 93% is in the form of fines. The high level of export indicates non-availability of adequate steel making and agglomeration capacity and high price of iron ore in the international market

The following features of iron ore scenario in India need to be known:

- Five states namely Jharkhand, Chhattisgarh, Karnataka, Goa and Odisha contribute 96% of the total production.
- 65% of total iron production is accounted from the four districts namely Keonjhar (Odisha), Bellary (Karnataka), Singhbhum (Jharkhand) and Dantewada (Chhattisgarh).
- Public sector and private sector contribute 27% and 73% of iron ore respectively.

The overall percentage of lumps usage in steel making is around 47% which is quite high in comparison with other countries. Ours is the only country where over 30% of steel comes from induction furnace using sponge iron.

Occurrence of iron ores in India

The entire country is divided into five zones with respect to iron ore occurrences (www.nmdc.co.in, 2008) as indicated below (Fig.2).

Zone-A Odisha and Jharkhand

Zone-B Chhattisgarh and Maharashtra

Zone-C Karnataka

Zone-D Goa and Redi, and

Zone-E Kudremukh, Bababudan and Kudachadri of Karnataka.

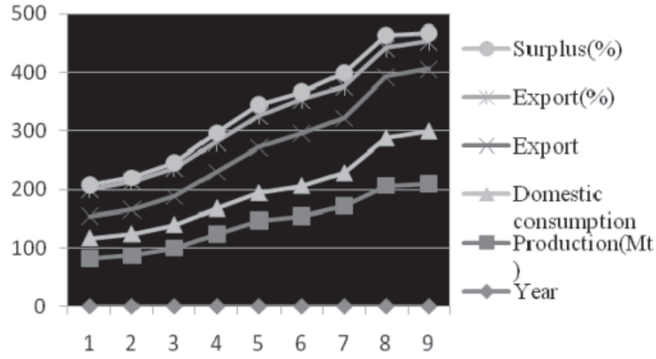

Fig.1 Production, consumption, export, surplus of iron ore of India Source: FIMI (Ref IBM, Nagpur; JPC, Kolkata; MMTC, New Delhi; GMOEA, Panjim)

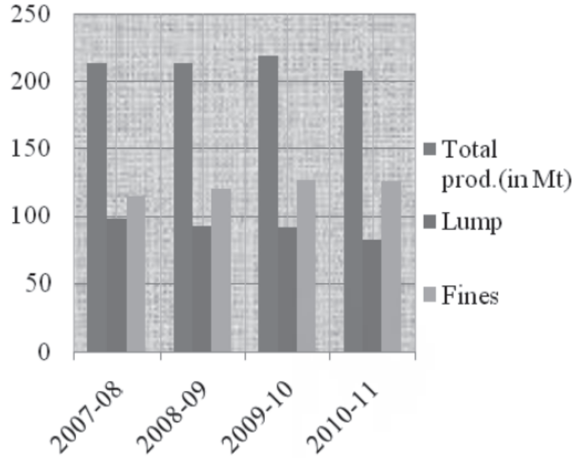

Fig:2 Iron ore production (lump, fines) in India from 2007-11)

Need of pelletisation

The life indices of iron ore show that the very long term forecast of iron and steel production and the consequent demand for iron ore made on optimistic assumptions also show that the steel industry can be comfortable with domestic iron ore supplies. The life of high grade lumpy ore will be 10 years. About 60% of production comes in the form of fines (including concentrates) during the course of mining operations itself. Further, 10-12% lumps become fines while handling, loading/unloading and while converting them into calibrated lump ore (CLO) for sponge/pig iron plants/exports. On an average 2.5 tonnes of run-of-mines (ROM) are required to get one tonne of CLO.

Lump and fines ratios in Indian iron ore deposits are almost 50:50 but only 12.3% of these reserves belong to high grade category while 48% belong to medium grade, 26% to low grade and rest to unclassified categories. Iron ore, range in size from less than 8 mm to 0.15 mm are designated as fines, whereas, the ore below 0.15 mm are known as slime and slimes are generated in the washing plant.

Unless fines find an outlet directly or through conversion into sinters/pellets, these will go on accumulating at mine sites. This will create the following economic, social and environmental problems.

- Affect mining operations because fines will occupy space.
- Affect agricultural fields or other areas or water bodies during rainy season when fines are washed out by water will spill over all around.
- Increase the percentage of ambient/suspended particles.

It will affect production of lumps; unless fines find outlet, no further production of lumps can take place. If the fines are not utilized, the entire cost of production will be loaded on lumps which will make steel more costly and mines unviable.

The fines may be utilized either by sintering or pelletization. The process of of beneficiation and pelletisation of low grade iron ore and slime will play a critical role in conserving good quality of iron ore reserve. Low grade iron ore, iron ore fines and iron ore tailing/slime accumulated over the years at mine heads and generated during the existing washing process, need to be beneficiated to provide concentrates of required quality to the Indian steel plants. These concentrates are too fine in size to be used directly in the existing iron making process. For utilizing this fine concentrate, pelletisation is the only alternative available.

Advantages of pellets

Iron ore pellets are being used for long in blast furnaces in many countries where lump iron ore is not available. The excessive fines generated from the iron ore mining and crushing units for sizing the feed for blast furnace and sponge iron ore plants are mostly unutilized.

- Good reducibility:

  Because of their high porosity that is (25-30%), pellets are usually reduced considerably faster than hard burden sinter or hard natural ores/lump ores.

  Uniform chemical composition and very loss on ignition make them cost-effective.
- Good bed permeability:

  The spherical shape and open pores give pellets good bed permeability.
- Less heat consumption than sintering, approximately 35-40% less heat is required than sintering.

Feed preparation

- For the feed preparation, a proper proportion of iron ore powder and Bentonite is put in the horizontal mixer.

Green ball production

- Green ball production takes place by adding proper amount of water to the feed during balling in disc pelletizer. The size of pellets after balling should be in the range of 8-20 mm. The undersize and oversize pellets are sent back to the mixer.

Green ball induration

- Drying and preheating of pellets take place in grate kiln with the help of fuel coming from rotary kiln. Heating of already preheated pellets takes place in rotary kiln through burner where combustion of pulverized coal takes place to generate working temperature of 1200-1250ºC. The pellets become hard and strong after heating.

COOLING OF HARDENED PELLETS

- Cooling of hardened pellets takes place with the help of annular cooler where cooling is carried out with the blast of cold air. Cooled product is stocked in open yard for dispatch. The system has adequate de-dusting and heat recovery provisions.

GOVERNMENT POLICY AND DIRECTIVES

- The government is likely to clamp down restrictions on exports of iron ore in a bid to augment the supply of raw materials to domestic steel producers at cheaper costs and promote export of value-added products instead of primary commodities.

ENERGY SAVING

- It has reported in various studies on the existing pellet based units that pellets reduce coke consumption by more than 50 kg per tonne in blast furnace operating with 100% pellets. The pellets are energy saving and environment friendly raw materials vis-à-vis iron ore.

REQUIREMENT OF HIGH IRON CONTENT RAW MATERIAL

- It has been reported that the low iron content ores/fines remain unutilized at various mines which ultimately lead to deposition of iron ore waste at mining site. With conversion of iron ore fines/lumps (low grade Fe content) into pellets, the mining waste can be better utilized. It also fetches a good price in the market.

REQUIREMENT FOR LOW LEVEL OF IMPURITIES IN RAW MATERIAL

- Occasionally, the iron and steel units using iron ore as raw material face problems due to high level of impurities in iron ore. Pelletization is one of the best options to reduce the impurity levels in iron ore. There is a great demand among steel/iron manufacturing units for high quality raw material like pellets to compete in steel export market.

Status of pellet plants in India

The use of pellet in the blast furnace is very limited in India. Pellets bear only 30% of the blast furnace burden in JSW where as sinter comprises 70%. However in COREX and gas based DRI units pellets constitutes 70-80% burden.

Existing pellet plants in India

At present there are four manufacturing units of iron ore pellets, viz. Hy-Grade Pellets Ltd. (Essar Group), Mandovi Pellets Limited, Jindal Vijaynagar Steel Ltd. and Kudremukh Iron Ore Company Limited producing pellets in India. The installed capacity of these units is indicated in Table 2. At present the total installed capacity of iron ore pellet in India is 12.1Mts. In such a condition, there will be requirement of additional pellet manufacturing units to meet the estimated pellet demand.

TABLE 1: ESTIMATED FUTURE DEMAND FOR IRON PELLETS IN INDIA (IN MT) [SOURCE: DMM ESTIMATES]

Year	Estimated demand for iron ore	Future production for iron ore pellets
2003-04	106.24	10
2004-05	116.41	11.64
2005-06	127.55	12.76
2006-07	139.76	13.98
2007-08	153.14	15.31
2008-09	167.80	16.78
2009-10	183.86	18.39
2010-11	201.46	20.15
2011-12	220.74	22.07
2012-13	241.87	24.19
2013-14	265.02	26.50
2014-15	290.38	29.04

TABLE 2: INSTALLED CAPACITIES OF PELLETISATION UNITS

Name of the unit	Installed capacity (Mt)
Hy-Grade Pellets Ltd. (Essar Group)	3.3
Mandovi Pellets Limited (MPL)	1.8
Jindal Vijaynagar Steel Ltd.	3
Kudremukh Iron Ore Company Limited	4
Total	12.1

HY-GRADE PELLETS LIMITED (ESSAR GROUP)

The Essar Group is one of India's largest corporate houses, with an asset base of Rs.170 billion (US $ 3.5 billion). The activities of the group include both the manufacturing and service sectors in steel, telecom, shipping, oil, power, and constructions.

Pelletization Plant: Essar has set up a 3.3 million TPA pelletization plant at Vishakhapatnam (Vizag) to supply high quality iron ore pellets at competitive prices to its hot briquetted iron (HBI) plant. Essar Steel consumes about half the production of this plant. The world-renowned steel trading company Stemcor of the UK has a 51% stake in this pelletization company.

JINDAL VIJAYNAGAR STEEL LTD.

Jindal Vijaynagar Steel Ltd. (JVSL) was incorporated on 15th March 1994. The company is promoted by the Jindal group with participation from Karnataka State Industrial Investment and Development Corporation Ltd. The company entered into a technical collaboration with Voest Alpine for technical details with respect to productivity etc. The company also entered into joint venture agreements for power supply, oxygen plant and mining. JVSL is one of the few steel manufacturers in the world to follow the Corex process for production of hot metal. JVSL produced 6, 60,000 tones of hot metal in the first year of production compared to Posco's production of 5, 00,000 tones and Saldanha's production of 4, 50,000 tones. Posco and Saldanha are two other companies using the Corex process.

JVSL has the capacity to produce 1.6 million TPA hot rolled coils. Around 50-55 % of the company’s production is sold to group company Jindal Iron and Steel Company for further processing into cold rolled coils and galvanized products. The Corex process, as adopted by the company for steel making is expected to keep the company's cost of production low in comparison with other producers. The 3 million TPA pelletisation plant was installed and started production in 2000. The commissioning of the pellet plant has reduced JVSL's cost of production by Rs.1000/tonne.

MANDOVI PELLETS LTD.

Mandovi Pellets Limited (MPL), Goa is a joint venture company floated by Government of India through National Mineral Development Corporation Ltd. and Chowgule & Co. Pvt. Ltd. (CCPL), a private sector company. The company has its pellet plant in Goa with an annual capacity of 1.8 million tonnes, which was commissioned in 1979 for supply of blast furnace grade pellets to Japanese Steel Mills (JSM) under a 10 years contract. It is located in Shiroda in Goa, 25 km inland from Mormugoa harbour and enjoys the benefit of inland waterways to receive iron ore fines and for dispatch of pellets. The pellets plant has consistently supplied blast furnace (BF) grade pellets fully complying with the strict quality specifications of the Japanese Steel Mills. The contract between JSVL and MPL having expired, the MPL has diversified its production to other markets.

Availability of iron ore fines as raw material

India has the advantage of having the raw material for the iron and steel sector which can be used for making the value added raw material for domestic market and exports. The iron ore produced, meets the requirements of domestic steel industry and exports. The demand of iron ore has been increasing to meet domestic consumption and exports. After liberalization in 1990, a large number of pig iron plants, sponge iron plants and integrated steel plants have been set up by many private companies. The proportion of different products during mining of iron ore is generally 50% lumps, 30-35 % as fines and nearly 15-20% slimes. This proportion varies depending on the nature of mined ore fed to the plants. As on today, there is nearly 125 million tonnes of accumulated unutilized fines at various mines and generation of about 8 million tonnes of slimes (below 0.2 mm) annually containing 14-60% Fe ore lost as tailings in beneficiation/washing plants. In Odisha, approximately, 5.5 million tonnes of iron ore fines are produced per year. Availability of such a huge quantity of iron ore fines in India and Odisha justify the establishment of pelletisation units based on regular supply of raw material to sustain the unit’s functionality. Table 3 presents the estimated availability of fines in Zone A.

TABLE 3: ESTIMATED AVAILABILITY OF FINES IN ZONE A (MTS)

Years	Total production of iron ore	Production		
		Lumps	Fines	Concentrate
2002	27.40	13.70	9.59	4.11
2003	28.23	14.12	9.88	4.23
2004	29.09	14.55	10.18	4.36
2005	29.98	14.99	10.49	4.50
2006	30.89	15.45	10.81	4.63
2007	31.84	15.92	11.14	4.78
2008	32.81	16.40	11.48	4.92
2009	33.81	16.90	11.83	5.07
2010	34.84	17.42	12.19	5.23
2011	35.90	17.95	12.57	5.39
2012	37.00	18.50	12.95	5.55
2013	38.12	19.06	13.34	5.72
2014	39.29	19.64	13.75	5.89
2015	40.48	20.24	14.17	6.07

Source: DMM Estimates

ZONE - A

Odisha

The iron ore deposits in Odisha are found in the districts of Keonjhar, Sundargarh, Mayurbhanj, Koraput, Sambalpur and Dhenkanal. Of these, deposits of Keonjhar and Sundargarh districts are worth mentioning. The important deposits containing large reserves of high grade (55% to 69% Fe) are in Thakurani, Joda, Banspani, Joruri, Malangtoli, Khandadhar, Kalmang, Barsua, Bolani, and Kalta. Malangtoli is the largest deposit containing high reserves with Fe content varying from (55% to 63% Fe). Gandhmardhan is another large deposit in terms of size and grade. Odisha contributes about 50 million tonnes of iron ore production per annum.

Jharkhand

In Jharkhand state, hematite deposits occur in a number of prominent hills in Singhbhum district (east and west Singhbhum). The significant deposits of this district are located in Noamundi, Gua, Barajamda, Kiriburu, Meghahatuburu, Manoharpur and Chiria. The Chiria deposit is reported to be the single largest deposit in the country. The annual production from Jharkhand at present is around 18 million tonnes.

Techno-economic issues

- As per the National Steel policy, the country's iron ore requirement will increase substantially to 340Mt/yr by the year 2020. Availability of limited reserve of high grade lumpy ore will pose a great challenge in long term sustainability of iron ore and steel industry. The only solution remains is the beneficiation which will help in utilization of the low grade ores/slimes by enhancing its

Fe content as well as mitigate the environmental hazard caused due to large scale stockpiling of slimes/rejects.

- New and modern beneficiation techniques are required for up gradation of low grade iron ores with high yield. With varying mineralogical characters, specific beneficiation techniques are needed to be developed for recovery of ultra-fines.
- Looking at the sponge iron industry, strategy should be made for the efficient replacement of lumps by pellets in respect of DRI units.
- The establishment of pelletization plants viz. manufacture of iron pellets does not require an Industrial License from the GoI. However one has to submit the information on the project in the form IEM (Industrial Entrepreneurs Memorandum) to the Secretariat for Industrial Approvals (SLA).
- The end products i.e. iron ore pellets can be freely imported into India. The export of iron ore pellets is canalized through MMTC (Minerals and Metals Trading Corporation). However iron ore pellets (up to 64% iron content) are allowed to be exported freely.
- The standard rate of applicable import duty on the plant and machinery and the product during the last few years is given in Table 4.

TABLE 4: RATE OF IMPORT DUTY

	Description	2001-02	2002-03	2003-04	2004-05
1	Iron ore pellets	5%	5%	5%	5%
2	Iron ore fines (iron content 62% and above)	5%	5%	5%	5%
3	Plant and machinery	25%	25%	25%	25%

Conclusions

Lump ores are naturally mined ores that are crushed and screened to a certain grain size before their use. However, as a result of preparation and enrichment processes in the iron ore mines to increase the Fe content, very fine-grained ores increasingly accumulate which undergo agglomeration. The agglomeration is done by means of pelletizing and sintering. Pelletizing involves forming of ore fines (pellet feed) and concentrates with grain sizes of well under 1 mm into pellets measuring around 10 to 15 mm in diameter. The forms that affect blast furnace productivity-fines (fine ores), lump, and pellets-are also the primary market products. Minor quantities of iron ore concentrates are also sold. Fines are iron-ores with particles measuring less than 4.75 millimeters diameter and lumps are iron ores with majority of individual particles measuring more than 4.75 millimeters diameter. Fines and lumps are produced from the same ore and are separated by screening and sorting. Neither product is concentrated. Pellets, the third product type (form), begin as a fined-grained concentrate. A binder, often bentonite clay, is added to the concentrate, which is then rolled into balls. The balls then pass through a furnace where they are indurated and become pellets, usually measuring from 9.55 to 16.0 millimeters (3/8-5/8 inch).

Beneficiation of low grade ores, mostly at micro-fines level, provides concentrate which can be used in iron making in the form of pellets. Therefore, pelletisation technology will have a predominant role in supplying the prepared burden for iron making. Adoption of suitable pelletisation technology of varying capacity is encouraged to meet specific needs with respect to availability and type of iron ore fines/ concentrate in the country.

Major efforts are going on to develop new cost-effective hot metal/steel production technologies based on utilization of iron ore fines/slimes and non-coking coal. Some of these are – Hismelt technology, Finnex technology, Romelt technology etc. There is need to encourage adoption of some of these technologies taking into account of Indian raw materials. This will not only lead maximum utilization of fines but will conserve our natural resources.

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