Sponge Iron Industry in India

Gearing up to meet growing metalliks requirement

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Introduction

Iron ore is the major input for BF-BOF steelmaking which still has a high share of 63 percent in the global production of crude steel. However, the process requires various treatments of raw materials, involves high capital costs, substantial investment on infrastructure and has a long gestation period. It also leads to various environmental problems.

To find a way out of these shortcomings of the BF-BOF process, EAF steelmaking was introduced decades ago. The share of EAF steelmaking in the global crude steel production has increased substantially from 26.6 per cent in 1988 to 33.1 per cent in 2003.

The increasing trend in steel scrap prices and its short supply has resulted in the increased use of sponge iron / direct reduce iron (DRI) in the feed stock of EAFs, blast furnaces and other iron and steelmaking process. The Hot Briquetted Iron (HBI) is a denser and compacted form of DRI designed for easy handling for shipping and storage. DRI can be used in steel units where the DRI reduction unit is located at the site of the steelmaking plant.

DRI is now recognized as a high quality, high purity charge – material, the world over. In comparison with scrap, the use of DRI / HBI offers consistency in composition, low trace elements due to its porous nature and environment – friendliness.

Growth of Indian Sponge Iron Industry

Sponge Iron India Ltd. (SIIL) was the first sponge iron plant in the country which was set up at Polancha in Andhra Pradesh in 1980 with an initial capacity of 0.3 Mtpy. Since coal was adequately available in India, production of coal – based sponge iron was considered as a feasible option. The growth of the Indian DRI industry till the mid-eighties was constrained by the restrictive licensing policies of the government. It was only after delicencing in 1985, that the industry started growing up. By 1988, three coal based sponge iron plants were installed. These were Orissa Sponge Iron with a capacity of 0.1 Mtpy. Ipita Sponge Iron (Now Tata Sponge Iron Ltd.) with a capacity of 0.9 Mtpy and Sunflag Iron and Steel Ltd. with a capacity of 0.15 Mtpy. All these plants were set up to produce sponge iron for captive consumption. In 1989, the first merchant sponge iron plant was set up viz. Bihar Sponge Iron Ltd. with a capacity of 0.15 Mtpy.

In the late eighties, Indian producers became enthusiastic in setting up gas – based sponge iron plants due to the discovery of large scale reserves of natural gas in the country. The first gas – based sponge iron plant was started up at Hazira in Gujrat by Essar Steel in 1990.

Among the three gas based sponge iron producers, Essar Steel has set up the world's largest capacity HBI plant (present capacity 3.4 Mtpy). Ispat Industries was first in the world to set up a Megomod Midrex Unit – world's largest single module sponge iron plant with a capacity of 1.1 Mtpy at Dolvi in Maharashtra. Grasim Industries Ltd. set up its gas – based Vikram Ispat Sponge Iron Plant located on the western coast at Salav in Maharashtra with a capacity of 0.9 Mtpy. It was globally the first plant to install the HYL III technology from HYL SA of Mexico.

India is the highest producer of coal-based sponge iron in the world. Jindal Steel and Power Ltd. (JSPL) is the highest producer in Asia and second in the world of coal-based iron. Its plant a Raigarh has the world's largest capacity of 650,000 tpy which is being expanded to 1.3 Mtpy level.

No. of Units

In 2003, as per SIMA sources, there were about 82 sponge iron units (3 gas-based 79 coal-based) in operation and another 85 units were in various stages of planning, construction and commissioning. Out of the 79 coal-based units in operation in 2003, about 50 units were mini sponge iron plants having capacities between 15,000 to 30,000 tonnes per years.

However, according to Shri N. K. Das, Director, Orissa Sponge Manufacturer's Association as mentioned in JPC Bulletin May, 2004, there were 104 operating units in India and another 117 units were in the pipeline.

The state wise distribution of number of Sponge Iron units in India are furnished in Table – 1. As mentioned earlier more than 50 per cent of the 104 operating in India were mini sponge Iron units with capacities up to 30,000 per year.

Table –1 : Sponge Iron Units in India – State wise

State	Operating Units	Total (including pipeline projects)
Orissa	36	66
Goa	18	18
Chattisgarh	15	53
West Bengal	15	41
Jharkhand	11	34
Maharashtra	4	-
Andhra Pradesh	3	7
Tamil Nadu	1	1
Gujarat	1	1
Total	104	221

Source : JPC Bulletin, May, 2004
N. B. Units coming up in Karnataka has not been shown.

Production of DRI in India

The production of Sponge Iron / HBI in India between 1992-93 and 2004 – 05 is presented in Table – 2.

Table – 2 : Production of DRI/HBI in India : 1992-93 to 2004-05 ('000 tonnes)

Year	Production	Y-O-Y Growth (%)
1992-93	1504	-
1993-94	2420	60.90
1994-95	3386	39.92
1995-96	4326	27.76
1996-97	5009	15.79
1997-98	5345	6.70
1998-99	5180	(-)3.09
1999-2000	5340	3.09
2000-01	5481	2.64
2001-02	5658	3.23
2002-03	6909	22.11
2003-04	8085	17.02
2004-05 (P)	10,000	23.69

(P) = Provisional Data Source : JPC

It is evident from the above table that the yearly rate of growth was negative in 1998-99 and that remains low in the next three years. However, between 2002-03 and 2004-05, the rate of growth in production increased significantly.

Producer wise output of sponge iron

Producer wise output of sponge iron between 2001-02 and 2003-04 are presented in table – 3.

Import and Export of Sponge Iron

Import and Export figures of Sponge Iron by India

Table – 3 Producer wise output of Sponge Iron in India ('000 tonnes)

Producers	2001-02	2002-03	2003-04
A. Gas Based			
Essar Steel Ltd	1648.7	1976.2	2232.0
Ispat Industries Ltd.	961.1	1035.5	1056.5
Vikram Ispat Ltd.	561.6	612.9	687.3
Total - A	**3171.4**	**3624.6**	**3975.8**
B. Coal – Based			
Adhunik Corpn. P. Ltd.	-	18.0	36.8
Ambey Metallics Ltd.	-	-	25.4
Aryavarta Trading Co.	-	-	3.3
Ashirwad Steel Ind. Ltd.	32.3	36.0	36.8
Bellary Steel & Alloys Ltd.	55.8	91.7	76.6
Bihar Sponge Iron Ltd.	151.4	153.8	153.7
Deepak Steel & Power Ltd.	28.1	49.3	63.7
HEG Ltd.	72.4	41.2	66.7
Howrah Gases Ltd.	-	26.2	16.8
Ispat Godwari Ltd.	-	74.4	69.7
Jai Balaji Sponge Ltd.	-	-	37.9
JSPL	561.5	590.2	579.2
Kusum Powermet (P) Ltd.	14.4	25.1	28.3
Lloyds Metals Engg.	107.5	107.5	120.4
Monnet Ispat Ltd.	132.4	195.1	204.2
Nalwa Sponge Iron	-	-	153.3
Nepaz Metallics Ltd	-	-	44.3
Orissa Sponge Iron Ltd.	101.3	112.7	110.0
Prakash Inds. Ltd.	163.2	222.0	280.0
Raipur Alloy Ltd.	67.4	64.2	64.3
Rashmi Cement Ltd.	-	-	9.1
Rashmi Ispat (P) Ltd.	-	-	20.5
Rexon Strips Ltd.	40.4	54.3	44.7
Rungta Mines Ltd.	-	21.1	50.7
Scan Sponge Iron Ltd.	7.8	20.4	18.8
Shyam Steel Ltd.	-	22.1	44.0
Singhal Enterprises	-	-	93.8
Sponge Iron India Ltd.	64.5	71.6	69.5
Sree Metallics Ltd.	69.4	134.9	142.3
Sunflag I&S Co.	119.8	123.2	122.9
Surya Sponge Iron Ltd.	18.8	18.4	27.9
Tata Sponge Iron Ltd.	228.3	236.4	216.1
Vedanta Global (P) Ltd.	-	59.0	62.7
Others*	450.0	685.1	1015.0
Total – B	**2486.7**	**3283.9**	**4109.4**
Grand Total (A+B)	**5658.1**	**6908.5**	**8085.2**

Source : SIAM * Includes non-member units between 1996-97 and 2002-03 are shown in Table – 4.

During 2003-04 and 2004-05, there was no import or export of sponge iron by India.

Table – 4 : Import and Export of Sponge Iron ('000 tonnes)

Year	Import	Export
1996-97	1.1	372.4
1997-98	1.5	374.0
1998-99	1.9	168.0
1999-2000	-	53.3
2000-01	-	-
2001-02	1.0	-
2002-03	1.0	-

Data Source : JPC

It may be seen from the above table that export of DRI had sharply declined in 1998-99 and 1999-2000 and there has been no export since 2000-01. This has happened mainly due to a sharp increase in domestic consumption.

Chemical Composition of Internationally Trade DRI/HBI

The usual chemical composition of internationally trade DRI/HBI is furnished below :

Parameters	% of Content
Total Fe	93-95
Metallic Fe	85-90
Degree of Metallisation	92-95±1.2
Carbon	1.0-1.5±0.3
Phosphorus	0.02-0.09
Silica	1.00 – 2.00

Estimated installed capacity and production in India

Estimated installed capacity and production of Sponge Iron in India as worked out by SIMA are shown in Table – 5.

It may observed that total production of sponge iron in India in actual terms has been higher at 8.09 Mt in 2003-04 and 10 Mt (Provisional) in 2004-05.

Table – 5 : Installed capacity and Production of Sponge Iron – Mt

Year	Installed Capacity	Production		
		Gas-based	Coal-based	Total
2002-03	8.75	3.62	3.28	6.90
2003-04	9.50	3.60	4.00	7.60
2004-05	10.00	3.80	4.50	8.30
2005-06	11.07	3.80	5.00	8.80
2006-07	11.15	4.00	5.40	9.40
2007-08	12.80	4.40	5.60	10.00

Source : SIMA

Increased use of DRI in the Charge mix of EAFs and Ifs.

In early 2004, some Induction Furnace (IF) producers were using about 70 per cent melting scrap. Some EAF producers of Sponge Iron are now using even higher percentage of DRI in the charge mix.

According to forecast by JPC/MECON, the share of melting scrap will be reduced significantly in the various regions of the country by 2011-12. These are shown below:

By 2011-12 the percentage of DRI in the charge – mix of EAFs and IFs is likely to reach about 8.5 per cent in India.

Regions	Reduction of Meting Scrap in charge-mix
Eastern Region	From 30 per cent at present to 15 per cent in 2011-12
Western Region	From 35 per cent at present to 13 per cent in 2011-12
Nothern Region	From 35 per cent at present to 15 per cent in 2011-12
Sourthern Region	From 25 per cent at present to 10 per cent in 2011-12

DRI – A better substitute than scrap

DRI has emerged as a better substitute for scrap. Other than the drawback of relatively higher consumption of power (as compared to scrap) and higher tap-to-tap time it offers several advantages which are mentioned below :

(i) Assured quality of output, a fact that has prompted even the existing units to change their charge mix.

(ii) Its market prices are always competing with scrap

(iii) The cogeneration of power with the hot gases that comes out in the process provides the ultimate benefit, as the cost of power per unit is low in the range of Rs. 1.25 to Rs. 1.50.

(iv) Presently, integrated steel plants (ISPs) are using DRI in BFs for saving power energy and better operational efficiency.

Benefits of Using DRI in EAFs

a) **The addition of DRI in the charge – mix**

The addition of DRI in the charge – mix in an EAF process brings about a remarkable reduction of impurities such as sulphur and phosphorus. The dilution of the charge-mix decreases the refining requirements which result in the simplification of the metallurgical operation inside the furnace and in crease the furnace productivity. Very often, it has found that sufficient dilution has helped complete most of the refining in the furnace itself during the melting operation, thus further increasing the productivity.

b) **Continuous feeding of DRI**

Continuous feeding of DRI results in achieving power level higher than 100 per cent scrap charge with similar electrical settings in the EAF. Due to the heterogeneous nature of scrap and continuously varying arc length between the electrode and scrap leads to wide fluctuations in the melting scrap.

Such arc fluctuations reduce the effective power input. On the other hand, melting of continuously fed DRI helps in an increased yield of up to 15 KWh per tonne in power input.

c) **Hot charging of DRI**

Hot charging of DRI is an effective means of lowering the cost per metric ton of liquid steel produced because of the reduction of power and electrode consumption.

In addition to power consumption reduction and savings thereof, hot charging of DRI increases the EAF productivity for a meltshop designed to charge cold DRI.

Essar Steel Ltd. is using the hot charging technology which has helped achive the following benefits :

- One percent or more increase in the degree of metallisation
- No moisture (compared to 1.5 per cent in HBI)
- Very low heat loss in the 90 ton container (less than 50 C/ hr)
- Reduction of about 0.8 per cent in product fines generation
- Power savings at briquetting of 8 to 10 KWh per tonne
- Savings in the wear of briquetting die segments and its maintenance

Other Benefits :

(i) **Lower Electrode Consumption**

The use of DRI vis-à-vis scrap helps lower electrode consumption due to the following reasons :

Scrap collapse results in increased breakage which is much less in case of DRI charge.

The productivity of the furnace is high in case of DRI use

Due to high CO content in the furnace, electrode oxidation is decreased.

(ii) **Lower Oxygen Consumption**

- The need for oxygen in scrap cutting is obviated
- The oxygen input in DRI is associated with unreduced oxides
- The unreduced iron oxide in DRI is sufficient to provide the slag requirements for iron oxide.

(iii) **Reduction in lime consumption**

By using lime or dolomite bonded pellets for DRI production, the requirements for lime addition as a fluxing material can be reduced to large extent.

(iv) **Lower refractory consumption**

Maintaining a deep foomy slag during continuous feeding of DRI can minimize arc radiation and the foamy slag also increase thermal efficiency as compared to all scrap charges.

By balancing the feeding rate with power input and raising the bath temperature towards the end of the melting stage with decreased feeding rate, the refractory consumption is reduced.

Addition of MgO improves the slag basicity control and reduces the intensity of slag line attack .

Coal – Based Projects

In the last 20 years or so, coal-based sponge iron industry has made remarkable growth. At present there are about 101 coal-based sponge iron plants operating in the country. In 2003-04, coal-based plants had a share of about 50.8 per cent in the total production of sponge iron in India. More than 55 per cent of these plants are mini-sponge iron units having an annual capacity up to 30-35 tonnes per year.

Due to high price of natural gas and its inadequate supply, the gas-based projects are finding difficulties to generate sufficient margin. Setting up of new gas – based projects has now become a remote possibility.

Some of the key innovations in the coal-based technology are mentioned below :

(a) **Capital requirement reduced**

Up to 1998, nearly 80 per cent of the equipment was being imported presently, for a 120,000 tpy module, 100 per cent indigenous equipment is available and for a 150,000 tpy module only the kiln tyres and support roller are imported. The capital expenses related cost has, thus, been reduced from Rs. 75. crore to Rs. 40 crore after 1998 for a 120,000 tpy module while the same for a 150,000 tpy module has come down from Rs. 110 crore to Rs. 60 crore.

(b) **Raw materials**

The main raw materials required for a coal-based plant are iron ore, suitable coal, dolomite and power.

(i) Iron Ore – Iron ore with a Fe-content of 62-66 percent (hematite) is used. Earlier, the ore size kept at 5.20 mm and was washed in a scrubber. But at present 5-18 mm size ore are used as a feed for large kiln without scrubbing and / or washing. This led to the reduction of DRI consumption from 1.6 to 1.5 Mt per tonne of hot metal.

(ii) Coal- Due to non-availability of 'B' grade coal from Coal India, presently 'C' and 'D' grades coal are being used. The industry has successfully adopted measures to utilize these grades through better process control and the cost has been reduced by about 20-30 per cent as compared to 'B' grade coal used earlier.

(iii) Dolomite – Earlier dolomite of 1-4 mm size was being used. At present, the use of 4-8 mm size dolomite has reduced the consumption by about 50 per cent by minimizing a significant loss of dolerite fines through through waste gases.

(iv) Power - Previously, the power consumption per tonne of sponge iron produced was about 110-130 units. But with the advent of dry gas cleaning system through electro-static precipitator, programmable logic operator drivers and computer control, the power consumption has been reduced to 80-90 units per tonne of sponge iron produced.

All the above innovations have resulted in a better capacity utilization from 85-90 per cent to over 100 per cent in the well-established plants.

New units / Expansions

SAIL is planning to set up a sponge iron unit at one of its four major ISPs. Mecon is preparing the feasibility report.

MSP steel will set up two sponge iron plants in Chattisargh and Orissa

(i) It will install a 350 tpd coal – based sponge iron plant and a 12 MW captive power plant at Raigarh in Chattisargh in two phased. The first phase may be completed by mid – 2006.

(ii) MSP will also set up a 300tpd coal – based sponge iron plant and a 12 mw captive power plant at Jharasguda in Orissa. The project will be completed in two phases.

- Essar Steel Ltd. has already commissioned the 4th DRI module of one Mtpy capacity at Hazira. Technology for the hot DRI was developed in-house. The sponge iron capacity of the company now stands at 3.4 Mtpy.
- Tata Sponge Iron Ltd. has undertaken capacity expansion of sponge iron from 240,00 tpy to 390,000 and an increase in power generation capacity from 7.5 MW to 26 MW with an investment of Rs. 170 crore at Deongarh Bilaipara in the Keonjhar District of Orissa. Completion of work is scheduled by the first quarter of 2006.
- Visa Industries Ltd. is setting up a DRI plant and captive power plant of 120 MW capacity in connection with the installation of its 1.5 Mtpy integrated steel plant at Kalingangar industrial area in the Jajpur district of Orissa.
- Real Ispat is setting up a 2x100 tpd sponge iron plant at Raipur in chattisgarh state with an investment of Rs. 65 crore.
- Mahesh Sponge Iron & Power Ltd. is planning to install a 30,000 tpy sponge iron plant at Belgal in the Bellary district of Karnataka. The work is likely to be completed by end 2005.
- Ispat Domodar is planning to set up a 200,000 tpy sponge iron and a 300,000 tpy pig iron plant at Nethuria in the purulia district of West Bengal at an investment of Rs. 110 crore.
- Vistar Venture has announced plans to set up a 100 tpd sponge iron plant a Dharwad in Karnataka at an investment of Rs. 16 crore.
- Shyam steel Ltd. is setting up an integrated steel plant at Durgapur in West Bengal. The company is investing Rs. 110 crore for setting up a 100,000 tpy sponge iron plant, rolling mill, 110,000 tpy billet unit and 10MW waste heat based captive power plant.
- Navbharat Group of Industries is planning a 100,000 tpy coal-based sponge iron plant at Raipur in Chattisargh at an investment of Rs. 75 crore.
- Scaw Industries Ltd. will set up a 0.1 Mtpy capacity coal-based sponge iron plant in the Dhenkanad district of Orissa in phase – I and has plans for another 0.45 Mtpy plant in Phase-II
- Sundar Ispat is setting up a 100 tpd coal-based sponge iron plant at Mehaboobnagar in Andhra Pradesh. The company intends to reach an ultimate capacity of 300 tpd by mid – 2006.
- Druvdesh Metal Steel is setting up a 30,000 tpy coal-based sponge iron plant at Koppal in the Bellary district of Karnataka.

Role of Sponge Iron Manufacturer's Association (SIMA)

In its multi dimensional role, SIMA provides a common platform of the sponge iron producers for regular interface with the Government and other regulatory authorities and helps with the right feedback for formation of necessary policies for the long term development of the industry. SIMA also helps a major role in compilation and information essentially required for right decision making and realistic future projection and monitoring market trend.

Conclusion

The Indian sponge iron industry has recorded a very impressive growth in recent years. India has been the highest producer of DRI in the world since 2001 except in 2002 when it became the second highest producer. Major producers and new units are introducing modern technologies for achieving higher production in cost effective and environment friendly manner.

The National Steel Policy has visualized market demand of finished steel of 60 Mt by 2011-12. If all the announcement of expansion of capacities by the existing producers and installation of new steel plants take shape, India is expected to produce about 70/80 Mt of crude steel by 2011-12. Sponge Iron industry has to gear up to supply the metalliks required for such a huge growth.

The Government should take realistic and pragmatic steps in consultation with SIMA for the further development of the industry which has played a great role in helping the growth of Indian steel industry.

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