# Sponge Iron Industry in India

- N. M. Rao

## Product, Applications and Specifications

Sponge iron is the product obtained when iron ore is reduced to metallic iron at temperatures below the melting point of iron. Reduction may be carried out by solid fuel (Coal) or gaseous fuel (reformed natural gas). Oxygen removed from the ore causes micro pores in the ore body making it porous and a spongy mass. Hence the product is known as sponge iron or Direct reduced Iron (DRI). Gas based sponge iron, if briquetted, is known as Hot Briquetted Iron (HBI). Since there is no melting, gangue in the ore cannot be removed and hence passes on to the sponge iron. Sponge iron is a raw material for steel making through electric arc furnace and induction furnace. Initially it was used as a substitute for scrap due to high price and inconsistent quality of scrap. It has now established itself as an important input due to following advantages over scrap.

## Continuous and Hot Charging

- Reduced flicker and noise level
- Reduced Nitrogen and Hydrogen contents
- Better bath stirring
- Foamy slag
- Negligible tramp elements
- Higher bulk density and easier handling

However, higher usage of coal based DRI (> 60%) will lead to higher consumption of power & refractories and lower yield. Use of high proportion of coal based DRI is economical in case of integrated plants with captive DRI units along with facilities for power generation from off gases. Coal based plants generate considerable quantities of waste products like dolo char, kiln accretions, ESP dust etc. Recycling/utilisation of these products is essential to get satisfactory economic benefits from this process. Therefore, extent of use of coal based DRI, particularly in case of steel plants not having captive DRI plants, depends on prevailing market prices for the two materials. In case of gas based DRI, there are no such problems and integrated plants use 80% or more DRI and rest scrap.

The blast furnace process is dependent on high quality coking coal, which is not available in India. Australia being the main source for import of coking coal, both availability and price are uncertain. Coking coal reserves, all over the World are depleting fast. Besides, BF-BOF process generates more greenhouse gas emissions compared to DRI-EAF route. Therefore, more than 50% of crude steel in India is made through electric route. Between 2006-07 and 2016-17, crude steel production through electric process has doubled from 25.41 MT to 50.27 MT. Major steel plants like Essar, JSW Dolvi, JSPL, Bhushan steel, BPSL etc. are based on EAF; there are about 50 other EAF based plants and 1350 induction furnace units with a total capacity of over 70 million tonnes. Induction furnaces account for over 30% crude steel production in India.

Investment costs are low in DRI plants since they are not built on enormous scale like BF plants and there is no need for coke oven plants.

They have a short gestation period and have great flexibility in production scheduling. Investment costs are low in case of induction furnaces also.

Indian specification for sponge iron is BIS: 15774-2007. This standard covers sponge iron DRI, HBI and cold briquettes. As per this standard read with amendment No 1 issued in June, 2010, this material is for use in Electric Arc Furnaces and can also be used in Blast furnaces and BOF converters. Various parameters as per this standard are shown in Table-1.

**TABLE - 1**

| Parameter | Coal Based | Gas Based |
|---|---|---|
| Fe (Total), % | 89-93 | 89-93 |
| Fe (Metallic), % | 80 minimum | 80 minimum |
| Metallisation, % | 88 minimum | 88 minimum |
| Sulphur, % | 0.03 max | 0.005 max |
| Phosphorous, % | 0.06 max | 0.06 max |
| Carbon, % | 0.08 to 0.12 | 1.5 max (DRI)# 1.1 min (HBI) |
| Gangue, % | 6.0 | 6.0 |
| Total of Pb, Zn, Cu, Sn, Cr, Ni and As, % max | 0.01 | 0.01 |
| Non-magnetic, % | 1 to 2 | == |
| Size, mm | 3 to 20 + 20 mm-5% max and -5mm 5% max | 110 x 60 x 30 or 90 x 60 x 30 for HBI. For DRI same as coal based |
| Bulk Density, T/M³ | 1.8 | 2.4 minimum |

*# higher carbon content may also be supplied.*

A comparison of merits/demerits of coal based DRI and gas based DRI/HBI is shown in Table-2 (Source: www.scribd.com).

**TABLE - 2**

| Particulars | Gas Based DRI/HBI | Coal Based DRI |
|---|---|---|
| Metallisation, % | Up to 93 | 92 maximum |
| Carbon, % | 1.2 to 2.5 | 0.2 to 0.25 |
| Size of the product | Mostly uniform | Wide variation |
| Stability | Resistant to degradation | Easily degradable |
| Bulk Density, T/M³ | 1.6 to 2.0 | 1.8 to 2.5 |
| Recitation | Prone for re-oxidation unless briquetted | Relatively more stable |
| Melting in EAF | High carbon is advantageous for reducing residual Iron Oxide in DRI/HBI | Extra carbon is required for reducing residual iron oxide in DRI |
| Melting in BOF | Carbon content will be high | Carbon in liquid metal is reduced by FeO in DRI |

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## Industry Structure and Performance

There are five gas based plants; three of them use natural gas, one coal synthesis gas and the other COREX off gases. India is the largest sponge iron producer in the World and in 2015, India's share was 28%. The gas based plants are located at Hazira, Gujarat (Essar Steel), Dolvi, Maharashtra (JSW Steel), Salav, Maharashtra (Welspunmax Steel- taken over by JSW Steel), Vijayanagar, Karnataka (JSW Steel) and Anugul, Odisha (JSPL). Dolvi plant can use coke oven gas also. It is first DRI plant in the world to use coke oven gas. DRI plant of JSPL at Anugul, based on synthesis gas from coal gasification, is the first such plant in the world. DRI plant of JSW Steel at Vijayanagar, based on Corex off gases, is the second such plant in the world; the first being Arcelor Mittals's plant at Saldanha, South Africa. Gas based plants are eco-friendly and energy efficient.

There are about 450 coal based sponge iron plants in India; individual unit capacity ranging between 30,000 TPA and 1.3 MTPA. Coal based sponge iron plants are mostly located in six states. Chhattisgarh and Odisha are the largest producers (share 18% each) followed by Jharkhand, West Bengal, Karnataka and Maharashtra. Approximate capacity wise distribution of coal based plants is: Up to 30,000 TPA- 18%, 30,000 TO 60,000 TPA- 5%, 60,000 to 100,000 TPA- 2%, 100,000 to 150,000 TPA- 9% and >150,000 TPA-66%. However number wise, several of them are 50 to 100 TPD and some are 100 to 200 TPD. Coal based DRI plants are energy intensive and cause atmospheric pollution.

Capacity and production of gas based and coal based units during the last seven years is shown in Table-3. Figures for capacity and production are in million tonnes while capacity utilisation is in %.

Major steel companies like Essar, JSW Steel, JSPL, Bhushan Steel, BPSL, Monnet Ispat, BMM Ispat, LLyod Metals, Jai Balaji, Adhunik Metaliks, Jayaswal NECO, Sunflag I&S, Visa steel, Sarada energy etc. have captive DRI plants. Merchant DRI plants account for about one-fourth of the total DRI capacity.

Capacity of individual gas based plants and select coal based plants is shown in Table-4.

Production started declining from 2011-12 and the capacity utilisation declined from 65% to 30% (or even lower) in case of gas based units and from 70% to 40% in case of coal based units. In 2015-16, production dropped by over 23% compared to the peak achieved in 2010-11 (23.25 MT). Major reasons for this decline are:

- Shortage and higher price of iron ore due to ban on iron ore mining in the states of Karnataka & Goa and restrictions on mining in Odisha & Jharkhand.
- Coal Shortage for coal based plants. CIL and SCCL are together able to supply only about

| | | |
|---|---|---|
| Non Magnetic material, % | Nil | 1 to 2 |
| Yield of liquid Steel | 1 to 2% more compared to coal based DRI | 1 to 2% less compared to gas based DRI/HBI |
| Usage in EAF, % | Up to 80 | 30-60 |

**TABLE - 3**

| Particulars | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 |
|---|---|---|---|---|---|---|---|
| **Gas Based Units** | | | | | | | |
| Production | 6.17 | 6.19 | 5.15 | 3.93 | 2.61 | 3.14 | 3.92 |
| Installed Capacity | 9.6 | 9.6 | 9.6 | 9.6 | 9.6 | 12.6 | 12.6 |
| Capacity Utilisation | 64.3 | 64.5 | 53.6 | 40.9 | 27.19 | 24.92 | 31.1 |
| **Coal Based Units** | | | | | | | |
| Production | 16.82 | 17.06 | 15.41 | 14.74 | 15.49 | 14.32 | 13.95 |
| Installed Capacity | 23.81 | 25.34 | 25.71 | 27.71 | 28.06 | 36.03 | 36.03 |
| Capacity Utilisation | 70.6 | 67.3 | 59.9 | 53.2 | 55.2 | 39.7 | 38.7 |
| **Total** | | | | | | | |
| Production | 22.99 | 23.25 | 20.56 | 18.67 | 18.10 | 17.46 | 17.87 |
| Installed Capacity | 33.41 | 34.94 | 35.31 | 37.31 | 37.66 | 48.63 | 48.63 |
| Capacity Utilisation | 68.8 | 66.5 | 58.2 | 50.0 | 48.1 | 35.9 | 36.7 |

*Source : www.spongeironindia.in*

**TABLE - 4**

| Name of the Company/Plant | Location | Capacity, '000 T |
|---|---|---|
| **Gas Based Units** | | |
| Essar Steel Limited | Hazira, Gujarat | 6800 (6 modules) |
| JSW Steel Limited | Dolvi, Maharashtra | 1600 |
| Welspun maxsteel Ltd (JSW) | Salav, Maharashtra | 1200 |
| Jindal Steel & Power Ltd | Anugul, Odisha | 1800 |
| JSW Steel Limited | Vijayanagar, Karnataka | 1200 |
| **Coal Based Units** | | |
| Jindal Steel & Power Ltd | Raigarh, Chhattisgarh | 1320 (6 x 300 TPD & 4 x 500 TPD) |
| Bhushan Steel Limited | Meramandali, Odisha | 1500 (10 x 500 TPD) |
| Bhushan Power & Steel Ltd | Jharsuguda, Odisha | 1200 (8 x 500 TPD) |
| Monnet Ispat & Energy Ltd | Chhattisgarh | 860 |
| Prakash Industries Limited | Chhattisgarh | 750 (5 x 500 TPD) |
| BMM Ispat Limited | Hospet, Karnataka | 660 (2 x 100 TPD & 4 x 500 TPD) |
| Tata Sponge Iron Limited | Odisha | 390 (3 x 400 TPD & 1 x 500 TPD) |
| Sarada Energy & Minerals | Chhattisgarh | 360 (2 x100 TPD & 2 x 500 TPD) |
| Lloyds Metals & Energy Ltd | Maharashtra | 270 (4 x 100 TPD & 1 x 500 TPD) |

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| | | |
|---|---|---|
| Godawari Power & Ispat Ltd | Chhattisgarh | 555 (1 x 350 TPD & 3 x 500 TPD) |
| Jai Balaji Industries Ltd | West Bengal | 345 |
| Adhunik Metallics Ltd | Odisha | 300 |
| Jayaswal Neco Industries Ltd | Chhattisgarh | 255 (1 x 350 TPD & 1 x 500 TPD) |
| Rungta Mines Limited | Odisha | 330 |
| SKS Ispat Limited | Odisha | 270 (2 x 100 TPD & 2 x 350 TPD) |
| Sunflag Iron & Steel Ltd | Maharashtra | 262 |
| Visa Steel Limited | Odisha | 300 (2 x 500 TPD) |
| Bihar Sponge Iron Ltd | Jharkhand | 210 |
| Orissa Sponge Iron Ltd | Odisha | 250 |
| Vandana Global Limited | Odisha | 231 |
| SAL Steel Limited | Gujarat | 180 (2 x 300 TPD) |
| Welspun Steel Limited | Maharashtra | 120 (4 x 100 TPD) |

***Source : Web Sites of the Companies***

10 million tonnes against the requirement of about 50 million tonnes. Sponge iron industry procures some quantity through e-auctions and imports.

- Shortage of natural gas for gas based plants. Against a requirement of 7.64 mmscmd, allocation is 5.36 mmscmd and actual availability is 1.14 mmscmd or only about 15% of requirement. Price of imported LNG was very high till recently.
- Low offtake by Steel industry due to sluggish domestic demand for steel products and surge in cheap imports from China, Japan, South Korea, Russia etc.

Due to decline in sponge iron production, scrap imports trebled during the period 2006-07 (2.185 MT) to 2015-16 (6.627 MT). In 2012-13, scrap imports were 8 MT. Average imports of DRI during the period 2011-12 to 2013-14 were 500,000 TPA. Some EAF/IF units increased the usage of BF hot metal/solid pig iron.

## Raw Materials and Energy

Iron ore is the principal raw material for sponge iron manufacture. Iron ore requirement is about 1.6 T/T (if only calibrated ore is used). Indian iron ores contain 60 to 65% iron (preferable: 64-67), around 5 to 6% gangue (preferable: 2-4), 0.02% sulphur and 0.04% phosphorous, Size used is 5 to 20 mm or 6 to 40mm. Desirable physical and metallurgical properties are: shatter strength-95%, tumbler index- +88%, abrasion index- % -0.5mm-5% max, thermal degradation index-5 max and reducibility index- +94% (Source: www.diva-portal.org).

The reserves of high grade iron ore are depleting fast. Low grade iron ore (including BHQ/BHJ) is available. There is considerable generation of fines during mining and handling. Besides, conventional iron ore processing generates slime to the tune of 10 to 15% of ROM. Fines/Slime occupy space and cause environmental and ecological problems. It is therefore necessary to beneficiate the iron ore fines and pelletise the beneficiated ore/slime. Use of pellets in place of iron ore offers following advantages in the manufacture of DRI/HBI.

- Specific iron consumption is reduced by 20 to 25%.
- Production of DRI in rotary kilns increases by 10 to 15%.
- Specific coal consumption reduces by 10 to 15%
- Specific power consumption reduces by 10%
- Non-Magnetic particles in DRI will not exceed 1%
- Accretion formation in DRI Kilns is reduced by 50% thus increasing the campaign life
- Metallisation will be higher
- Generation of fines will be much lower
- Pellets can be transported easily over long distances due to its resistance to abrasion

Several companies like Essar Steel, JSPL, Godawari Power, BMM Ispat, JSW Steel (both at Vijayanagar and Dolvi) etc. have set up their own pellet plants. Some companies like Sarada Energy, Monnet Ispat, Bhushan Steel, BPSL, JSW Ispat, Jayaswal Neco, Adhunik Metallics etc. are in the process of setting up pellet plants. At the end of 2014-15, Pellet capacity in India reached 91.2 MT, with Odisha accounting for 40% (source: www.news.steel-360.com).

However, capacity utilisation is low due to poor offtake. Coal based plants can use up to 60% pellets and gas based plants 80% or more. Typical pellet quality is: Fe- 64 to 67%, SiO2 + Al2O3- 4 to 6% (preferable: 2-4%), CaO + MgO- 1 to 3%, Sulphur- 0.005 to 0.01%, Phosphorous- 0.04 to 0.05%, Size- 8 to 16 mm, Cold crushing strength- 250 to 300 Kg/cm², bulk density- 2.2 T/M³, Tumbler index- 92 to 95%, Abrasion index- % -0.5mm- 5 max, Porosity- 17 to 25, Reducibility index- 92 to 96% and Swelling Index- 15 to 20. Pellets can be used in blast furnaces also.

Non-coking coal is the reductant in coal based process. It also supplies the required heat. Desirable coal quality is 8% maximum moisture, 23 to 25% ash, 25 to 30% VM, Fixed Carbon- +40%, Size: -20mm, Ash softening temperature- 1250°C, Calorific Value- 5200 Kcal/Kg and reactivity- 2.2 CO/gm°C.

However, Indian coals have high ash content and low calorific value. In some coal fields like Talcher, ash is even higher than 40%, fixed carbon below 30% and calorific value less than 3500 Kcal/Kg. India has adequate reserves of non-coking coal, but for good process efficiency, Indian coal has to be either washed or blended with coal imported from Indonesia/South Africa. Depending on the quality of coal used, coal

consumption varies between 1.2 kg/T and 1.5 kg/T of DRI in case of indigenous coal. This will reduce to 0.9 Kg/T to 1.15 Kg/T with South African coal.

The three gas based sponge iron plants use reformed natural gas as fuel and reductant. All these plants are located in the west coast, since natural gas is available there. Typical analysis of natural gas is: Nitrogen- 0.3 to 1.0%, Carbon Dioxide- 0.1 to 5%, Methane- 85 to 93%, Ethane- 3 to 8% and propane 1 to 4%. After reformation, CO2 + H2 should be + 90%. Calorific value of the gas is about 10,000 Kcal/SCM. Consumption of natural gas is in the range of 250 to 275 SCM/T HBI. Reserves of natural gas are estimated at 1354.76 billion cubic metres. However, natural gas production has declined from 52.22 billion cubic metres in 2010-11 to 31.73 billion cubic metres in 2015-16 mainly due to fall in production from KG basin. Supply to DRI plants is only about 15% of requirement. Capacity utilisation of gas based plants was between 25% and 30% in the last three years. India imported 19.946 million tonnes of LNG in 2015-16. The price was high till recently.

Dolomite is used in sponge iron process as a desulphuriser. It removes sulphur from the feed mix. Consumption of dolomite is about 50 Kg/T DRI. Required quality and quantity of dolomite is available in India.

Electrical energy is also an important input in sponge iron manufacture. Consumption is in the range of 80 Kwh/T to 130 Kwh/T. This requirement can be met from in house generation through waste heat recovery boilers.

Energy demand is about 9.6 GJ/T with 100% natural gas, 10.4 GJ/T with synthesis gas and 15 to 20 GJ/T in case of coal (up to 25 GJ/T with Indian coals) (source: www.ietd.iipnetwork.org). CO2 emissions are high in case of coal based plants. 60% of the heat from coal is used in the process while the balance 40% is discharged with waste gases.

## Process and Technology

SL/RN and its variations like CODIR, ACCAR, OSIL etc. is the standard process adopted in India for coal based sponge iron manufacture. Jindal and Tatas have made minor variations in the process. In this technology, the process is carried out in a horizontal rotary kiln which rotates at a pre-determined speed. Temperature is in the range of 800 to 1050°C along the length of the kiln. Hot DRI and semi burnt coal discharged from the kiln are cooled in a cylindrical rotary cooler to 100-200°C. Sponge iron, char and other contaminations discharged from cooler pass through magnetic separators to separate sponge iron from impurities. Sponge iron is screened to separate +3mm and -3mm fractions. +3mm fraction is directly used in EAF/EIF while -3mm fraction is usually briquetted using molasses and hydrated lime as binders. As per BIS: 15774, Cold briquettes of grade 1 quality should have >88% Fe (T), 78% min Fe (M), 88 to 92% metallisation, Carbon-0.3% (coal based) and 1.3% (gas based), sulphur-0.04% max, phosphorous-0.06% max, 8% max gangue, 0.015% max other metals, min 2.2 T/M³ bulk density and 64x30x20 or 44x38x19 mm size. Heat available from the kiln gases is used for power generation. A 500,000 MTPA plant can support a 30 MW plant. Power generation is approximately 500 units per tonne of sponge iron. About 70 % of the power generated can be sold in case of merchant plants. For environment control, dust suppression system, bag filters, scrubbers and dry electro static precipitators are used.

Second generation technologies based on SL/RN have been developed for small size plants to reduce capital costs. These are of sub optimal design resulting in frequent breakdowns. Due to this, it becomes necessary to undertake capital repairs once in 10 to 15 years. Besides, these small size plants (50 TPD and 100 TPD) have limitation in exploring inferior grades of iron ore and coal. They are highly polluting and energy intensive. They are not adaptable to waste heat recovery boilers. In view of the competition that has now set in and stringent pollution control standards, these small size plants will find it difficult to survive. Presently standard sizes of coal based plants are 300 TPD, 350 TPD and 500 TPD. 1000 TPD module has been developed by Outotec. This will further improve the economics. Rotary hearth furnaces and Vertical shaft furnaces are other technical developments. Inferior quality raw materials can be used and technological limitations of present DR technology can be overcome with these technologies.

Gas based sponge iron is manufactured in Vertical kilns and standard technologies are Midrex, HYL-1 and HYL-III. Worldwide, around 60% of DRI is gas based. Gas based sponge iron is not subjected to magnetic separation since contamination with non-magnetics is not possible in the process. It is cooled indirectly or briquetted in hot condition to get hot briquetted iron. Gas based plants are eco-friendly and energy efficient. Reducing gas for the process is generated from natural gas. Natural gas is first desulphurised (S < 0.1 ppm) and then mixed with super-heated steam. Alternatives to natural gas are synthesis gas from coal gasification, Corex off gases, coke oven gas etc.

Coal gasification is a flexible, reliable and clean energy technology that can turn low quality coal into high value gas and help reduce our dependence on imported oil and natural gas. In this process, coal and oxygen are fed to a gasifier and the raw gas is fed to a cleaning plant where sulphur is removed. CO2 is removed in a converter. A gasification plant of 120,000 NM³/hr of raw gas capacity would require 2500 TPD coal (35% ash) and 25-27 TPD oxygen (99.5% pure). It will produce 2.1 million NM³ of reducing gas (CV: 3400-3700 Kcal/NM³) for DRI, 2700- 3000 TPA sulphur, 6500-7000 TPA ammonia, 10000 TPA aromic naphtha and 18000 TPA pitch + oil. This size of gasification plant can support 800000 TPA DRI plant. (Source: www.gasification.org and www.lurgi.com). Coal gasification based sponge iron plant (225x10³ NM³/hr gasification plant and 1.8 MTPA DRI plant) has been commissioned by Jindal Steel and Power Limited at Anugul in Odisha. In 2015-16, the plant produced about 0.9 MT. Cost of synthesis gas and efficient running of gasifiers will be key to the success of this process. Bhushan Steel has also plans to set up coal gas based DRI plant as a part of its steel plant at Meramandali in Odisha.

Another development in DRI sector is ENERGIRON process. The process has been developed by HYL. Module sizes available range

between 250,000 TPA and 2,500,000 TPA. Tenova HYL and Danieli have entered into a JV for technology, design and construction. This is a pressurised operation (6 to 8 bars) while conventional processes operate at ambient pressure. For the same capacity, plant and equipment sizes are smaller. This process achieves 94% metallisation and the product is discharged at 700°C. The product contains 3.5% carbon. Energy consumption in the process is 2.3 to 2.4 G Cal/T as gas and 60 to 80 Kwh/T electricity. JSPL is planning to set up a 2.5 MTPA DRI plant based on this technology. The company has tied up with HYL for using coke oven gas. A thermal reactor system is used where coke oven gas is converted to high quality, high temperature syn gas through innovative partial oxidation technology. Approximately 500 $NM^3$ of coke oven gas is required to produce 1 tonne of DRI. JSW Steel has set up a 1.2 MTPA DRI plant at Vijayanagar in Karnataka based on Corex off gases. The gas is processed to obtain 0.5 to 0.6 H2/CO. (Source: www.spongeironindia.in). Due to non-availability of natural gas, JSW steel has made necessary changes to use coke oven gas also in its DRI plant at Dolvi in Maharashtra.

## Environmental Control

Sponge iron industry, particularly coal based plants, has earned a bad name since it causes high atmospheric pollution. Centre for Science and Environment has made adverse remarks in their report submitted in 2012. This is mainly because of small size coal based plants, who have not installed required pollution control equipment and they are not WHRB complaint.

Central Pollution Control Board vide its notification dated 30-05-2008, has prescribed the following environmental standards.

1. Emission standards: Particulate matter in $mg/NM^3$ (normalised at 12% CO2 in stack emission)- 100 (coal based) and 50 (gas based)

2. Carbon Monoxide (Vol/Vol)- 1% for both coal and gas based plants

3. De-dusting Unit: Particulate matter ($mg/NM^3$)- 100 (existing) and 50 (new)

4. Fugitive emissions: Particulate matter ($\mu g/NM^3$) - 3000 (existing) and 2000 (new). This should be monitored at a distance of 10m from source.

5. Effluent Standards: PH- 5.5 to 9.0, Total suspended solids- 100 mg/l, Oil & grease-10 mg/l and Chemical oxygen- 250 mg/l

6. Utilisation of waste products:

Char- This should be mixed with coal or coal washery rejects and used as power plant fuel or for making briquettes.

Kiln accretions- To be used as sub base material for road making or land fill

Flue dust/sludge from GCP- This should be compacted and reused in the process.

Tata Sponge iron limited has achieved following in respect of energy and environment in FY 2015-16 (source: www.tatasponge.com)

- Specific energy consumption: 497 TOE/T
- C/Fe ratio: 0.45-0.47
- Specific Power Consumption: <120 Kwh/T
- Specific water consumption: 5KL/T
- Dust emission: 40 $mg/NM^3$
- Solid waste generation: ~40 Kg/T
- CO2 emission: ~2.0T/T

## Conclusion

As per draft national steel policy, Crude steel capacity will be 300 MT in 2025-26 and production will be about 270 MT. However, considering the present scenario, it may be difficult to achieve this. A CAGR of 8.5% is required to achieve a production of 200 MT in 2025-26, considering 2015-16 as the base. Assuming that this growth rate is achievable, sponge iron required in 2025-26 is 57 MT considering liquid steel/metaliks as 88% and proportion of Sponge iron in total metaliks as 25%. In 2015-16, these figures (provisional) are 87% and 17% respectively. If a capacity utilisation of 90% is achieved, capacity required is 63.5 MT. Current capacity is 48.63 MT. Presently, energy prices are low. Natural gas prices are around $ 4.2-4.5/MMBTU. This was as high as $17 in 2014. Government of India has reduced the price of natural gas supplied to gas companies like ONGC and Reliance Industries from $4.66/mmbtu in April,2015 to $3.82/mmbtu in October, 2015 and $3.06/mmbtu in April, 2016 (on GCV basis). This is likely to be further reduced to $2.45/mmbtu in October, 2016. Coal price is around $60/T and that of iron ore about $56/T. Indian prices of coal and iron ore are Rs 1500 to 2000/T ( Coal India-depending on CV) and Rs 1800/T (NMDC lumps-June, 2016) respectively. This is a great opportunity for sponge iron industry to improve the margins. Further, following measures will enable sponge iron industry to fully meet the requirements of EAF and IF segments of steel industry and reduce dependence on imported scrap.

- Sponge iron plants (of ISPs) having own coal blocks should set up Coal washeries to ensure that ash in coal used is 35% maximum
- Coal based merchant sponge iron plants should use at least 50% pellets. Required pellet capacity is available in the country.
- Future addition to capacity in respect of coal based industry should be through large modules (500 TPD)
- There is a demand supply gap of 4 MT in respect of coal. However, CIL could sell only 2.05 MT, against the offer of 3.78 MT, in the first trenche of coal linkage auctions in June, 2016. This could be due to iron ore shortage and problems related to coal quality and transportation. Since these issues are now being taken care, CIL/SCCL should conduct another round of auctions for at least 2 MT after a couple of months. Even at current price, South African coal is Rs 1,000 to 1,500/T costlier.
- Industry should introduce ore pre-heating, air pre-heating, heat recovery from exhaust gases and Char recirculation to reduce energy intensity.
- Industry should take necessary measures to maximise campaign life, reduce accretions and for control of C/Fe ratio.
- Char could be used in AFBC boilers along with coal washery rejects. Such power plants are in operation in JSPL, Prakash Industries, Sunflag etc. Tata sponge will be installing them shortly. ESP dust can be used for brick manufacturing.
- Sponge iron industry should set up required pollution control equipment in all plants and ensure that standards set by Central/State Pollution control boards are achieved on regular basis. In this connection, small capacity coal based plants (less than 300 TPD) have to decide whether they can continue to be in business.
- Since domestic natural gas availability for sponge iron sector is uncertain (not withstanding recent find in Bay of Bengal) and imported LNG prices are fluctuating, it may be better to base the future gas based plants on coal gasification and Corex/Finex off gases or coke oven gas, if available.