Raw Materials for Steel Industry

– Sanjay Sengupta

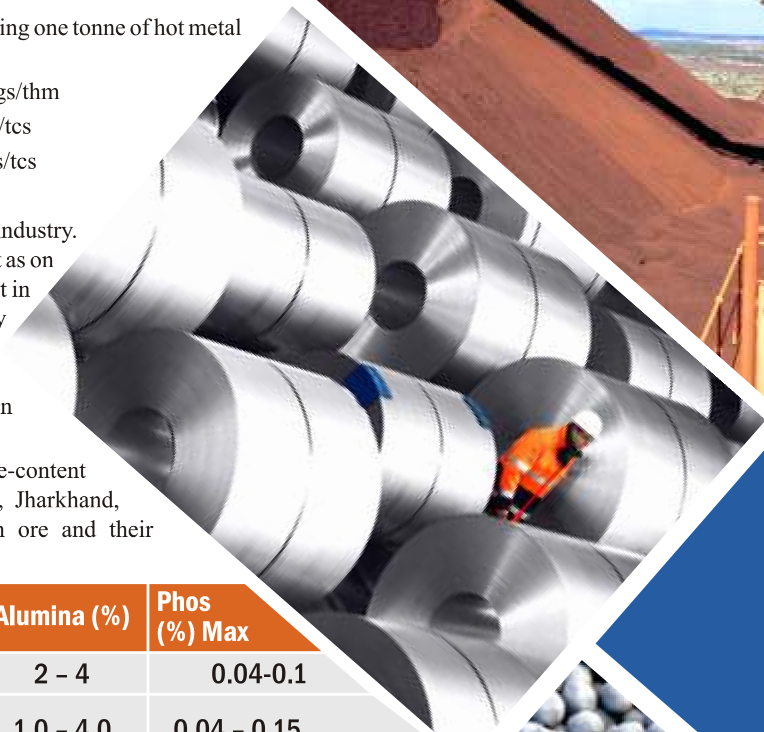
Steel is a versatile product. It is the most useful product for modern civilization. Steel's unique position among metal industries remains unchallenged even today. It has become part of our daily life. Steel is eco-friendly and recyclable. Though steel has relatively high strength to weight ratio, the alternative materials have not been able to make a significant dent on its volume of consumption.

Major Raw Materials for Iron and Steel Industry

Steel is a raw material intensive industry. Major raw materials required for iron and steel making are iron ore, coking coal, metallurgical coal, non-coking coal, melting scrap and ferro alloys. Besides these pig iron, DRI, pellets are also used as raw materials by the iron and steel industry. To these must be added fluxing materials dolomite and limestone.

According to steel technologists, the requirements for producing one tonne of hot metal are :

- Iron Ore – 1.6 Mt
- Coking Coal – 700 Kgs/thm
- Non-coking Coal – 150 Kgs/thm
- Limestone – 190 Kgs/tcs
- Dolomite – 160 Kgs/tcs
- Ferro Alloys – 15 Kgs/tcs



Iron Ore

Iron ore is the principle raw material for the iron and steel industry. Capacity of the Indian steel industry has been estimated at 105 Mt as on 31.03.2014. With an estimated crude steel production of 81.54 Mt in 2013-14, the capacity utilization for the Indian steel industry works out at 77 percent in terms of crude steel capacity. Iron ore production, consumption, imports, crude steel production and capacity utilization between 2006-07 and 2013-14 are shown in Table-1.

India has a substantial reserves of iron ore with an average Fe-content of 61 percent (WSA). Iron ore are mainly found in Odisha, Jharkhand, Chattisgarh, M.P., Maharashtra and Goa. The types of iron ore and their compositions in different states are shown below :

States	Type of Ore	Fe-Range (%)	Alumina (%)	Phos (%) Max
Odisha / Jharkhand	Hematite	62-64	2 – 4	0.04-0.1
Chattisgarh, M.P., Maharashtra	Hematite	64-66	1.0 – 4.0	0.04 – 0.15
Karnataka	Hematite	62-64	2.0 – 4.0	0.04 – 0.09
Goa	Hematite	60-63	2.0 – 4.0	0.04 – 0.07
Karnataka	Magnetite	35-45	1.0	==

Source : MECON

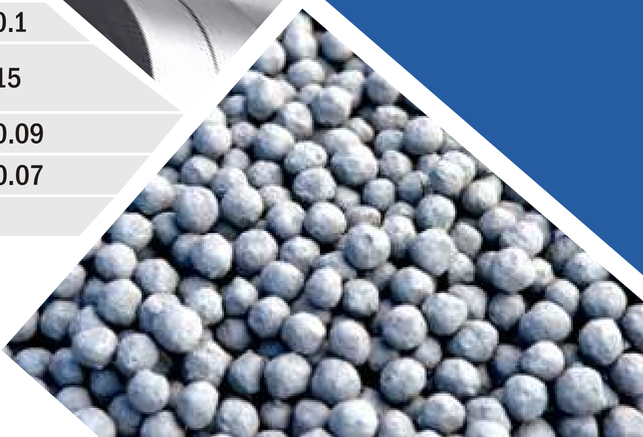


Table - 1 : Iron Ore Production, Consumption, Imports, Crude Steel Production & Capacity Utilization of Indian Steel Industry (MT)

Year	Iron Ore Production	Iron Ore Consumption	Iron Ore Import	Crude Steel Production	Crude Steel Capacity Utilisation (%)
2006-07	176.95	78.60	0.49	50.82	89
2007-08	213.23	85.28	0.29	53.86	90
2008-09	212.90	86.82	0.69	58.44	88
2009-10	218.60	96.95	0.89	65.84	88
2010-11	207.16	111.00	1.85	70.67	88
2011-12	167.29	116.30	0.87	74.29	82
2012-13	136.00	119.50	3.05	78.42	81
2013-14 (P)	144.00	126.30	0.45	81.54	77

Data Source : JPC (P) = Provisional

Iron Ore Reserves

India's iron ore reserves are estimated at 28.526 billion tonnes as on 01.04.2010 of these, Hematite are reserves are estimated at 17.882 billion tonnes and that of Magnetite ore is 10.644 billion tonnes. The Indian steel industry mainly Hematite ore. Out of a total reserve of 28.526 billion tonnes of Hematite ore, only 8.093 billion tonnes are mineable reserves (Fe cutoff limit 55%) The balance quantity is classified as "Remaining Resources". According to experts, the mineable reserve of Hematite ore will last up to 2045-2050.

Magnetite ore are not being exploited as they lie in ecologically sensitive areas. The ore is also of low grade. The mineable reserve of magnetite ore is estimated at only 22 million tonnes.

Quality of Indian Iron Ore

Indian iron ore contains less Fe-content and the ore is mixed with more gangue materials. The ore has relatively high alumina content which causes adverse slag chemistry. Also, the ores are less closely sized containing a large amount of undesirable fines than in other countries. Besides high alumina, the Indian ore is also characterized by high silica. The alumina content in Indian iron ore lies between 2-4 percent in lumps and 4-6 percent in fines. Sinter produced from such fines contains a much bigger percentage of alumina as compared to other major iron ore producing countries where it seldom exceeds 2.0 to 2.5 percent of alumina.

Measures to Improve Iron Ore Quality

RDCIS of SAIL has outlined the following measures for the improvement of the quality of Indian iron ore :

- An increase in the Fe-content of the burden by one percent will increase the productivity of hot metal by 1.5 to 2.0 percent and decrease the coke rate by 0.8 to 1.2 percent.
- Lowering of alumina content in iron ore by one percent will lead to a significant reduction in the cost of hot metal.
- Reduction in fluctuation of Fe-chemistry by one percent may bring down the cost of hot metal to a reasonable extent.
- Even with a reduction of 0.5 percent in alumina content in the iron ore burden and reduction of 5 percent in the undersize and area reasonable improvement in the physical and chemical consistency, it was expected to result in a saving of Rs. 150 crore or more for a 4-Mtpy capacity hot metal production plant in 2005. The savings is expected to go up to Rs. 500 crore today.

Exports of Indian Iron Ore

About a decade back, India was exporting huge quantities of iron ore mainly to China and Japan. In 2004-05, India exported 78 Mt of iron ore, with a share of 53.8 percent of the country's total production. Iron ore fines exported in the said year was 64.50 Mt with a share of about 82.7 percent of the total export. In 2006 calendar year, India was the third highest global exporter of iron ore (Source : IISI, Brussels). However, exports have come down remarkably in recent years. Exports in 2012-13 were 18 Mt and 14 Mt in 2013-14.

There is a debate going on about whether India would export iron ore at all. There is a lot of confusion regarding the availability of iron ore fines stock at mines. One estimate say, that are about 60 Mt. Steel industry has created considerable capacity of beneficiation of ore. Experts say capacity of over 100 Mt for sinter and about 80 Mt of pellets are already available and more capacity is in the pipeline. Together, they will consume huge quantities of iron ore fines. Pellet production in the country has reached about 50 Mtpy. Hence there will be no significant surplus of iron ore fines to be exported.

Other Iron Ore Based Inputs for Iron & Steel Making

Pig Iron

Pig Iron is mainly grouped into two major types :

- Basic grade pig iron.
- Foundry grade pig iron.

Basic pig iron conforming to IS:2842/80 stipulates that the silicon content should be restricted to 0.5 percent. Major Indian steel producers are using IS:13502/1992 for steelmaking containing silicon content 0.75 to <1.75 percent, manganese 0.5 percent to 1.5 percent, phosphorus 0.4 percent and sulphur 0.06 percent (max). The basic grade pig iron is used as a raw material for steelmaking and as a substitute for scrap in the charge – mix of EAFs / IFs. Basic grade pig iron is also used by primary producers of steel for utilization of the excess heat generated during oxygen blowing.

Foundry grade pig iron is mainly used by foundries in India. It conforms to IS:224/78 grade in which the silicon content ranges from 1.25 percent to 3.50 percent. India is a leading producer of ferrous casting in the world.

Sponge Iron

Sponge iron is obtained from the direct reduction of iron ore and usually has an iron content between 84 to 95 percent. The reduction eliminates oxygen in the iron ore leaving behind a honeycomb like porous structure which is "Spongy" in nature. Hence the name "Sponge Iron". It is usually produced in lumps or pellet form and is also available in a compacted as well as briquette from call Hot

Briquetted Iron (HBI) which is produced by compacting DRI at a temperature of 650 degree centigrade. HBI is a denser and compacted form of DRI designed for case of shipping, handling and storage.

DRI has established itself as a high purity, high quality charge material. As compared to steel scrap, the use of HBI/DRI offers more consistency in composition, low trace elements due to its porous nature and is environment friendly.

Raw materials required for production of DRI are oxides of iron in the form of lump ore, pellets, non-coking coal (with high reactivity) and fluxing materials like limestone and dolomite. Use of high purity pellets with low phosphorus content at an economic rate helps in the cost-effective production of sponge iron of desired quality.

Recently, EAFs/IFs are using 70 to 80 percent of DRI in the charge-mix with satisfactory results.

Charging of DRI in Blast Furnaces

Tata Steel was the pioneer in India in utilizing sponge iron in the Blast Furnaces. Now many major producers are doing the same. The charging of DRI into Blast Furnaces have two major advantages mentioned below :

(a) Reduction of Coke rate

(b) Increase in hot metal productivity.

Advantages of Continuous Feeding and Hot Charging of DRI

Continuous leading of DRI into EAFs results in achieving high power level than 100 percent scrap charge with similar settings in the furnace. Continuous feeding of DRI has been found to result in saving of power upto 15 Kwh per tonne of DRI produced with the use of Ultra High Power (UHP) transformers.

Hot Charging of DRI is an effective means of lowering the per tonne cost of liquid steel produced because of the reduction of power and electrode consumption. It saves about 12 Kwh of energy per tonne of DRI consumed by the EAFs with the utilization of 650 degree centigrade heat contained in the iron.

Raw Materials for Gas-Based & Coal-Based DRI Projects

Gas-Based Projects

Natural gas in the main raw material used in Gas-Based DRI Projects. Due to the shortage of natural gas for gas-based plants the production, declined from 52 billion cubic meter in 2010-11 to 41 billion cubic meter in 2012-13. Against a requirement of 8 mmscmd, the allocation to the three gas-based plants was only 0.725 mmscmd in 2013.

Capacity utilization of gas-based plants declined to 27 percent in 2013-14 from 65 percent in 2010-11. Imported LNG is not viable for the sponge iron industry since the price of imported LNG is 4 to 5 times higher than that of domestic natural gas.

Coal-Based Projects

Raw Materials Required for Coal-Based DRI Plants

Iron Ore : Hematite ore with Fe-content of 62-65 percent is usually used. These projects offer flexibility in the use of iron bearing materials and lump ore, pellets, illemenite and steel plant wastes. Presently, 5-18 mm size ore is being used for large kilns without scrubbing / washing.

Coal : Non-coking coal with high reactivity, ash softing temperature, coking, swelling indices and low sulphur content. The coal-based process can use variety of solid fuels ranging from anthracite to lignite and charcoal besides sub-bituminous coal. Non-coking coal with less than 25 percent ash content is accepted in coal-based DRI production.

Production of DRI by Coal-Based Projects

As on 31.03.2014 sponge iron production capacity of coal-based plants was 37.65 Mt and the production of DRI through this route was about 15.49 Mt in 2013-14. Production of coal-based plants are declining due to the following reasons.

- Shortage of iron ore due to lower production in Karnataka, Goa and Odisha. These three states was producing about 70 percent of India's total iron ore production. Iron ore production declined by 34 percent in 2013-14 compared to 2010-11.
- Coal shortage for coal-based plants as Coal India Ltd. (CIL) could supply only about 20 Mt as against a requirement of 50 Mt (based on capacity as on 31.03.2014). Total production on non-coking coal increased at a CAGR of only 3.9 percent between 2006-07 and 2013-14 and most of the production was utilized for power generation.

Shortage of raw materials as well as environmental problems compelled may coal-based projects to close down. Capacity utilization of coal-based units came down to 55 percent in 2013-14 as against 67 percent in 2010-11. Non-availability of adequate quantity of quality coal for DRI production has also adversely affecting production of coal-based units.

Pelletizing

Pelletizing is the process of converting iron ore fines into uniformed size iron ore pellets that can be charged into blast furnaces or for the production of Direct Reduced Iron (DRI). Pellets are of uniform size, with higher purity of 63-68 percent and contributes to faster reduction and very high metallization rates.

Pellets with high mechanical and abrasive strength is capable of increasing the production of DRI over 25 percent with the same amount of fuel.

Experts from MECON Ltd. have observed that in view of changing iron ore scenario in the country, the Indian iron ore producers must shift focus from sinter intensive blast furnaces to pellet oriented (15-20 percent) operation. Jindal South West Steel Ltd. is charging 50 percent pellets in Blast Furnaces at its Vijayanagar Steel Plant and the plant's COREX units are successfully operating with the use of 80 percent pellets in its burden.

Some big Indian steel producers are erecting state-of-the-art large size blast furnaces of 4000 cubic metre or more.

However, the use of sinter beyond 75-80 percent in such big furnaces are technically not advisable because of weaker properties of the sinter resulting in its disintegration. In such a situation the use of pellets is essential.

According to steel experts, stocks of iron ore fines available at various mines should be fully utilized. Blast Furnaces based plants should introduce a minimum of 20 percent pellets in the burden. Coal-based DRI plants should use a minimum of 50 percent pellets and balance calibrated ore gas-based DRI plants should have minimum 70 percent pellet in the charge-mix.

India's sinter production capacity is estimated at 100 Mt and that of pellets at 80 Mt. Together they will consume lot of iron ore fines which constitute over 60 percent of India total production of iron ore, pellet production has already reached 50 Mtpy. India exported 1.5 Mt of pellets in 2013-14. Hence, there will be no surplus of fines for exports.

According to D.G., INSTAG, inspite of huge capacity of pellet production in the country, the use of pellets by the indigenous Blast Furnaces is limited. On an average, only 30 percent of BF burden is pellets and balance 70 percent is sinter. In case of COREX and Gas-based DRI plants around 70-80 is provided by pellets. These plants use low grade ore, fines and iron ore tailing dam slimes through beneficiation. Pellets are energy saving and environment friendly and BFs must have facilities to utilize higher mix of pellets for productivity improvement and cost reduction.

Illegal Mining Episode

To prevent illegal mining of iron ore, mining was banned in Karnataka in 2011. It was followed by a ban or mining of iron ore in Goa in 2012. These bans were lifted in 2013. The situation after lifting of the ban in Karnataka and Goa is presentation brief below :

Karnataka : The Supreme Court (S.C.) on April 18, 2013 has allowed reopening of all mines in Karnataka subject to statutory approves that include clearance from India Bureau of Mines (IBM), Union Environment Ministry, State Pollution Control Board, Central Empowered Committee (CEC) appointed by the Apex Court.

After assessing the illegalities conducted by all 166 mining leases, the Survey Team appointed by CEC has classified the mines into there categories. A, B and C depending on the extent of illegalities. The Apex Court has ordered cancellation of all leases under C-Category. Category a comprises 45 mines and Category B has 70 mines.

CEC has capped production of 30 Mt for the state. However, only 23 mines were operational and their total production was only 10 Mt in 2013-14. NMDC's two mines produced 9 Mt, taking total production to 19 Mt in 2013-14. The state had produced 49 Mt in 2008-09. The minimum demand of iron ore in Karnataka region is 36 Mtpy.

The e-auction and e-permits were introduced in Karnataka to prevent illegal mining which has been successful. During 2013-14, against e-permits of 17 Mt, about 15 Mt has already been transported. e-auction started in September, 2011 and upto March, 2014; 69 Mt of ore has been sold. Currently, the S.C. is hearing the matter regarding Karnataka Government's affidavit for allowing continuous of the e-auction process.

Goa : The Supreme Court (S.C.) order directing resumption of mining in Goa has limited iron ore extraction at 20 Mtpy. The S.C. order has come up with several issues that now need to be tackled by the Union and State Governments along with stake holders including the exporters. The lobby of exporters and mine owners are worse hit with the several conditions laid down by the S.C. that might not go well for their profit making. The S.C. order says that the expert committee will decide the utilization of dumps within six months, which means till that time, there will be complete uncertainty as to whether the dumps can be counted as exportable surplus.

The S.C. order also says that mining leases within one km area of wildlife sanctuaries or National Park will not be operational anymore. The State Government has recommended that mining in the buffer zone of the km as outer limit and should be allowed to phase out operation in next 5-10 years, as sudden phasing will wipe out employment of thousands of people. There are 24 mining leases located in the buffer zone of which 12 were operational.

Mining Problems in Odisha

Justice M. B. Shah Commission instituted by the Central Government in November, 2010 has made the following major observations on the iron ore mining scenario in Odisha :

- Most iron ore leases are not renewed in time and are continuing as deemed extension under Rule 24A(6) of MCR, 1960 which is the root cause for irregularities.
- Increase in production by revising mining plans led to the misuse of Rule 10 of MCDR.
- Mining leases have been issued Transit Permit by authorized officials on collection of royalty and other taxes. Now, demanding cost of iron ore for additional quantity mined over permitted quantity do not justify.

The commission has estimated the value of unlawful extraction as about Rs. 592 crore.

With a view to curbing illegal mining, the State Government has taken certain remedial measures as follows :

- Constitution of District and State Level Committees and Enforcement Squads to frequently raid various mines to check various activities.
- Periodic Review of the level of Chief Secretary.
- Use of high resolution satellite data for delineating encroachments and illegal mining.

Renewal of mining concessions are governed by Rule 24A(6) of MCR 1960. Experts suggest that all steps should be taken to dispose of all applications before expiry of lease to avoid deemed extension clause. This measure will prevent illegal mining. The State Government has granted several Temporary Working Permission (TWP) to some leases to continue mining operation having necessary statutory clearances and have applied for renewal in time.

Odisha have 35 percent of India's total iron ore resources. The authorities should take proactive steps to continue iron ore mining operations after complying will all statutory approvals. The illegal operators may be punished but the iron ore mines should continue operation.

Coal, Coking Coal, Non-coking Coal

Coal is made up principally of the remains of animal and vegetable matters which has been partially decomposed. Coal is a combustible, organic rock (composed primarily of Carbon, Hydrogen and Oxygen) formed from vegetable and animal matters which has been consolidated between other rock state to form coal seams and altered by combined effects of microbial action, pressure and heat over a considerable period of time.

According to Geological Survey of India, India had a coal reserve of 285.87 billion tonnes as on 01.04.2011 of which coking coal was 33.47 million tonnes and non-coking 252.40 billion tonnes.

Coking Coal

Coking coal is usually sub-divided into Primary, Medium and Semi-coking coal. As on 01.04.2011 primary coking coal had a share of 15.87% India's total coking coal reserves. The reserves of various grades of coking coal as on 01.04.2011 shown in Table –2.

Table – 2 : Reserve of Various Grades of Coking Coal as on 01.04.2011 (MT)

Grades of Coal	Proved	Indicated	Inferred	Total
Primary Coking Coal	4614	699	==	5313
Medium Coking Coal	12573	12001	1880	26454
Semi-coking Coal	482	1003	222	1707
Total	**17669**	**13703**	**2102**	**33474**

Source : G.S.I.

Coking coal required for use in Blast Furnaces should have an ash-content of 17 percent (max), volatile matter 20 to 26 percent, very low sulphur and phosphorous, good rheological properties, wide range of fluidity and low inert content.

Indian coking coal has high ash-content of 22 percent (min) and has to be blended with imported coking coal. Due to shortage of supply and quality constraints, Indian steel producers are compelled to import huge quantities of coking coal. India imported 31.80 Mt in 2011-12.

Because of very high ash content in Indian coking coal and its poor washability characteristics, clean coal yield varies between 30 to 50 percent. In 2011-12, supply of domestic washed coking coal was 6.54 Mt.

The Indian steel industry should make serious efforts to reduce coke rate in blast furnaces and higher usage of domestic coking coal. Experts have given many suggestions in this regard some of which mentioned below :

- To build bigger blast furnaces with latest technology and operate with high blast temperature, high top pressure, minimum 80 percent agglomerates in the burden, coal dust injection, oxygen enrichment of blast etc.
- Exploration efforts should be gearded us on Prime Coking Coal resources at a much greater depth to bring them to 'Proved' category.
- Emphasis should be given for research and investment in beneficiation of low grade coking coal.
- All future coke plants should have stamp charging technology. This technology allows usage of higher proportion of low grade coal without affecting the coke quality.
- Where it is not possible to adopt stamp charging technology. Other pre-carbonisation technologies like pre-heating of coal, selective crushing of coal, partial briquetting of coal etc. should be used.

Non-Coking Coal

It is a coal with poor coking properties. It does not soften and does not form cake during carbonization in coke ovens. India has a vast reserves of non-coking coal but they are of high ash content, poor washability and poor grindability.

Ash content, poor washability and poor grindability.

Non-coking coal is being used in the following processes in India :

- Conarc Process
- Corex Process

Some upcoming projects based on non-coking coal are :

- Hi-Smelt Process
- ITMK3 Process
- FINEX Process

Non-Coking Coal for Sponge Iron Projects

Non-coking coal for use in coal-based Sponge Iron Plants with certain parameters like reactivity, ash softening temperature, coking and swelling indices and sulphur content. The reactivity of coal is essential for good performance of sponge iron units.

Supply of non-coking coal for sponge iron production in India is not adequate. Some sponge iron producers are importing non-coking coal to meet their requirement. During the period from 2006-07 to 2010-11, average supply of non-coking coal to sponge iron industry was 22 Mt against their demand of about 35 Mt. Presently, a number of coal-based units have closed down due to non-availability of quality raw materials and also for environmental reasons.

Thermal Coal

Non-coking coal having higher ash-content is used in the Thermal Power Plants to produce steam. India has a share of about 11 percent in the global reserves of thermal coal.

Metallurgical Coal (Met-Coal)

These are coking coals which can be used to produce metallurgical coke, having high strength at elevated temperature. Metallurgical coal when heated to a high temperative between 900-1045 degree centigrade in absence of air, its complex organic molecules break down to yield gases together with liquid and solid organic compounds of lower molecular weight and relatively non volatile carbonaceous residue which is metallurgical coke. It takes about 1.5 tonnes of Met Coal to produce one tonne of Met Coke. Met Coke is an essential input for Blast Furnaces.

Ferrous Scrap

Ferrous scrap is an important input for EAF/EOF and Induction Furnace (IF) iron and steelmaking. Previously, some furnaces were using even 100 percent scrap in the charge-mix. But now direct reduced iron (DRI) has emerged as an important substitute for scrap. Some EAFs/IFs are using 70 to 80 percent DRI with satisfactory results. In India there shortage of quality scrap.

Currently, scrap usage in electric steel in India varies between 20 to 30 percent. Scrap is also used in BOF steelmaking to the extent of 10 percent in the change mix scraps acts as a covalent in the process.

India does not produce enough scrap imports

have come down from 8 Mt in 2012-13 to 4.66 Mt in 2013-14. There is no proper recycling of scrap in India. There is a body called "Metal Recycling Association of India." But scrap recycling is highly disorganized. Experts opine that it is necessary to formulate a national recycling policy so that recycling is done properly in an organized manner.

Ferro Alloys

Ferro Alloys are vital addictives that are added in steelmaking for de-oxidation, grain size control, imparting specific properties to the finished steel and improvement of mechanical properties. Ferro Alloys consist of less than one percent of the total raw materials required for steelmaking but though being a low constituent, they play a vital role in steelmaking.

Major raw materials required for the Ferro Alloy industry are Manganese Ore and Chromium Ore. Manganese alloy is introduced in the form of ferro-manganese, silico-manganese and manganese metal. Stainless steel accounts for about 6 percent of total production of ferro-manganese and silico manganese in India. The average consumption of manganese alloy by the Indian stainless steel industry is about 105 Kg/tonne.

Chromium Ore

The use of chromium is steelmaking depends on the end-use pattern. Low chromium steels with less than 5 per chromium and small quantities of nickel is used in the manufacture of rails, automobiles, armoured vessels etc. Intermedical chromium steels containing up to 12 percent chromium along with small quantities of tungsten, molybdenum or silicon are used in high speed valves for engines and equipment which require resistance to abrasion corrosion and oxidation. High chromium steels are stainless steels and super stainless steels used for the manufacture of cutlery, cooking utensils in airports and high speed trains.

Ferro alloys are grouped into two categories : Bulk Ferro Alloys and Nobe Ferro Alloys. According to Indian Ferro Alloy Producers Association (IFAPA), the present capacity of the Ferro Alloys industry can easily cater to the production of 120 Mt of steel. The capacity is expected to group substantially in the next few years.

Fluxing Materials

Limestone and Dolomite are used in iron and steelmaking to remove impurities present in iron and coal inform of slag. Both limestone and dolomite are carbonates of calcium and magnesium while limestone essentially contains calcium carbonate, dolomite contains calcium carbonate and magnesium carbonate in the ratio of 3:2. Dunite can be used place of dolomite. Dunite contains 36 to 42 percent Mgo and 36 to 39 percent $SiO2$. The material can also perform the function of diluting $Al2O3$ in the blast furnace slag. India has enough reserves of these materials.

However, limestone quality available in the steel belt is not suitable for steelmaking. Either it has to be transported from North. East and Rajasthan or imported. India produces about 6 Mtpy of dolomite. About 5 Mt of limestone is imported mainly from the Middle East.

Conclusion

Raw materials play a vital role in iron and steelmaking and accounts for about 33 percent of the total cost of steel production.

India has a vast reserve of iron ore. However, iron ore produced in the country contains 60-65 percent of fines. These fines can be successfully used in iron and steelmaking by beneficiation and pelletisation.

Presently, Indian steel producers are giving major thrust on beneficiation and pelletisation. This needs to be further geared up. Reserves of prime coking coal are not only insignificant but also suffers from poor coking qualities and high ash-content, India, therefore, imports huge quantities of coking coal.

Indian steel producers are making serious efforts to acquire overseas coking coal assets and have met with partial success. Modern technology for improving coke rate should be adopted on a broader scale.

Raw materials security is essential for steel industry's efficient operation, and increased production to meet the country's future needs.

Acknowledgements

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