# DRI UPDATE

SIMA

Sponge Iron Manufacturers Association

Indian voice for the ore based metallic & steel industry


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# Editorial

Dear Readers,

I hope you all are doing very well. Q4 of the FY 2022-23 was very encouraging in terms of physical and financial performances. We have record production of DRI/HBI of 43.557 MT showing an increase of 11.1%. Coal based DRI route continued to be the main driver with more than 80% contribution in the total DRI production. We are also happy to state that Indian DRI contribution to the global production is gradually increasing. It was 38% in the last F.Y. It may be recalled that National Steel Policy-2017 envisaged DRI demand/production of 80 million tonnes by 2030. As per our information lot of coal based DRI capacity is being set up. Even if we take a modest growth rate of 7%, we will reach to very near to the target.

Now a days there is a lot of discussions on decarbonization of Indian steel sector. Ministry of steel has constituted 13 Task Force on the various related issues of decarbonization. In my opinion two Task Forces are very important – Taxonomy of Green Steel and Monitoring of $CO_2$ Emissions. These Task Force should clearly define the definition of green steel and methodology of calculating the $CO_2$ emissions of various process routes/products. We all know that European Union have announced that iron ore and steel producers have to declare $CO_2$ emissions of the exported products. Issues relating to defining green steel and calculating & monitoring $CO_2$ emissions should be globally acceptable.

It is felt that India should initially target low hanging fruits like substituting thermal energy by renewable energy, maximizing the use of steel melting scrap and adopting energy saving innovative ideas.

This issue brings out two articles and annual statistics of FY 2022-23. I hope readers would find this issue useful. I also take this opportunity to request all stakeholder to contribute articles to our magazine.

Wish you all very best.

***Deependra Kashiva***
***Director General***

# *Dilemma of Indian DRI Industry*

**Deependra Kashiva, Director General**

**Sponge Iron Manufacturers Association of India**

## 1. Current Indian DRI Scenario

Indian Direct Reduced Iron (DRI) Industry, within a span of 42 years since its inception, has been world largest DRI producer for last consecutive 20 years. It has been playing important role in augmenting steel production in the country. Besides, it saves foreign exchange , provides huge employment ,contribute in Government exchequer and regional developments. Major growth in coal-based sector was from 2003-04 to 2008-09 mostly in small and medium sectors. Domestic DRI capacity increased by about 280% in nine years during 2005-14. No greenfield natural gas based DRI plant came up after 1994 (29 years) due to non-availability of natural gas. India is only country in the world making DRI from coal gasification. Due to the non-availability of natural gas at affordable prices, more than 80 per cent production is through coal-based route.

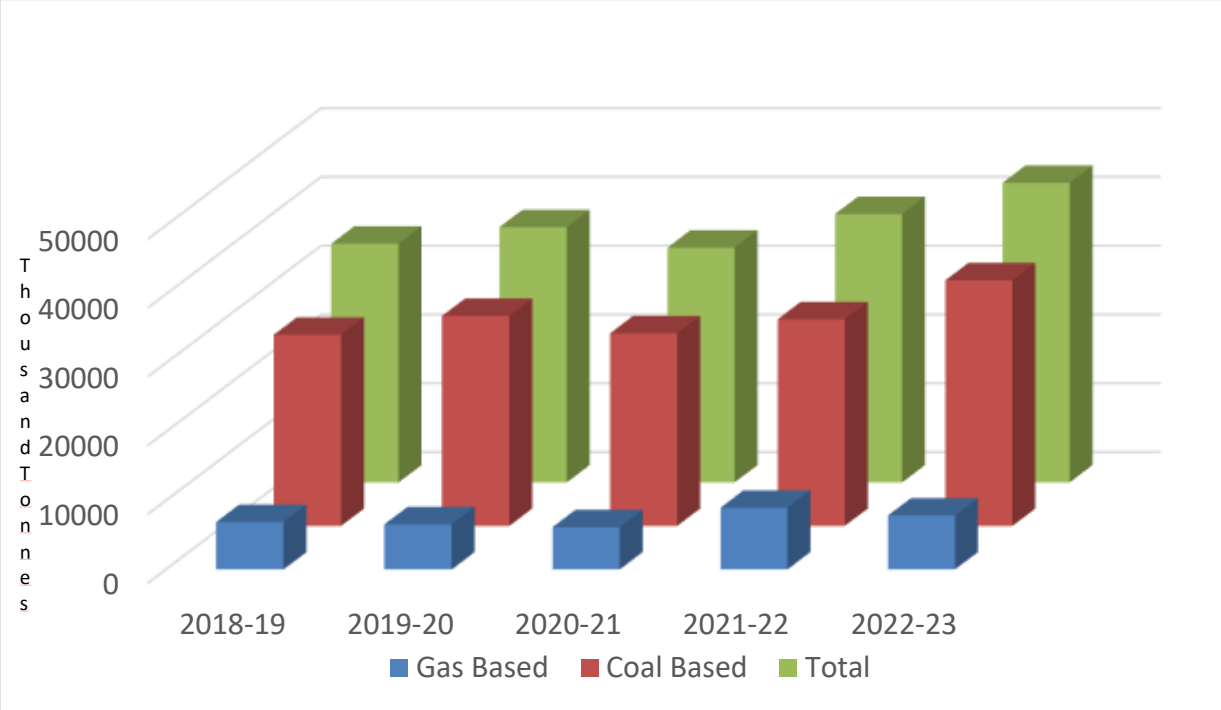
### 1.1 Structure of the industry

| Parameters | No. of Units | Capacity (MTPA) |
|---|---|---|
| Total operational DRI Plants | 285 | 49.27 |
| Coal Based Plants | 280 | 37.07 |
| Gas Based Plants | 5 | 12.20 |
| | | |
| Small (≤ 0.05 MTPA ) | 57 | 1.75 |
| Medium (>0.05 MTPA and ≤0.15 MTPA) | 173 | 14.13 |
| Large (> 0.15 MTPA) | 55 | 33.39 |
| | | |
| Standalone | 143 | 10.87 |
| Composite | 142 | 38.40 |

## 1.2 Production

**(Figures in thousand tonnes)**

| Year | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022 -23 |
|---|---|---|---|---|---|
| Gas Based | 6899 | 6564 | 6148 | 8978 | 7841 |
| Coal Based | 27806 | 30539 | 28007 | 30053 | 35716 |
| Total | 34705 | 37102 | 34155 | 39031 | 43557 |




# 2. Contribution of DRI Industry in Steel Production

DRI is a substitute of steel melting scrap and substantially contribute in metallics requirement of steel industry. Due to limited domestic availability, about 5-7 million tonnes of scrap is imported annually resulting precious foreign exchange outgo. Availability from the global sources is likely to shrink in coming years as entire world is moving towards DRI + electric steel making route basically to reduce carbon footprints and to meet their national targets. The current focus of the major global steel producers is to produce low carbon steel / green steel for which efforts are being made to produce green DRI with the help of green hydrogen and renewable energy. Gas based production route is highly desirable due to the low tramp metals and highly eco-friendly in nature.

This route also desirable for transition to green DRI once availability of green hydrogen is made available at affordable prices.

### 2.1 Growth Prospects

National Steel Policy -2017 realized the importance of DRI and projected 80 million tonnes requirement by 2030. In the year 2021-22, DRI production grew by 13.5%. As per the JPC 43.557 million tonnes DRI/HBI was produced in the current financial year with growth rate of 11.1% compared to 39 million tonnes of last year. Assuming a modest growth rate of about 7%, we expect that DRI production in the country would be around 70 million tonnes *by 2030* against the target of 80 million tonnes as envisaged in the National Steel Policy -2017.

In the light of above, Indian DRI industry plays and has a potential to play important role in augmenting steel production in the country subject to the hand holding by the central, state governments and other stakeholders.

## 3. Challenges of Indian DRI

### i. Coal Based Route

Coal based DRI capacity is about 40 MTPA and contributes more than 80% in the total DRI production. Due to the current technological limitation this route leads to higher energy consumption and $CO_2$ emissions.

### ii. Natural Gas Based Route

There is a limited availability of natural gas from domestic sources and more than 50% of the total domestic requirement is supplemented through Imports. Import prices are very high and are also volatile. Current Ukraine – Russian war has further aggravated the situation.

**iii. Syn Gas Based Route**

Commercially proven technology for Syn gas (coal gas) is not currently available. Secondly it also generates CO2 until unless CCUS system is incorporated.

**iv. Green Hydrogen Based Route**

Currently, there is uncertainty about its availability, infrastructure and price of green hydrogen. In addition, it is highly inflammable and offers challenges for storing it.

It may be mentioned that about 680 projects with a capex of US$ 240 billion for green hydrogen have been announced globally. Indian nodal Ministries like Power and New Renewable Energy have also announced massive production of green hydrogen at an affordable price. It is felt that clear picture in India would be available around 2030.

# 4. Emissions Related Issues

Despite low per capita emissions (1.8 tonnes CO2 per capita), India is third largest global emitter. Contribution of Indian steel industry is 12% of the total domestic CO2 emissions.

### 4.1 Targets of reduction in CO2 Emissions

- As per the Paris declaration (COP 21), India is committed to reduce 35% CO2 emission by 2030. In addition, in the recent COP 26 meeting, India has committed to be Carbon Neutral by 2070.
- As per the draft VISION 2047, CO2 emissions intensity is proposed to be reduced by 20% by 2030 and 50% from 2.55 to 1.3 tonne CO2/per tonne of crude steel by 2047 and 100% by 2070.

# 5. Way Forward

### 5.1 Possible Short -Term Solutions to Reduce Emission Intensity

#### 5.1.1 Maximize the use of steel scrap

Availability from domestic and international sources is limited and likely to persists. As per the available information domestic scrap generation and utilization was about 25 million tonnes in

2022-23. It may be mentioned that the steel scrap generation in China was 255 million tonnes in 2021. To support the metallic requirement India has imported 3 times of steel scrap amounting to 9.8 million tonnes 2022-23. High price of good quality scrap is also a limitation to increase its consumption for which collection dismantling centers and logistic facilities need to be increase gradually with suitable policy support. Further Vehicle Scraping Policy should be vigorously implemented and setting up of more scraping yards should be encouraged.

**5.1.2 Increase use of gases in coal- based route DRI production**

There is a need to substitute part of coal by bio gas/ syn gas/ natural gas/green hydrogen in the existing coal based DRI route to save about 40 MTPA installed capacity which has been set up with huge investment, provide large number of direct and indirect employment and plays very significant role to the regional development.

Above suggestion requires to be techno economically established through R&D efforts. It may be mentioned here that due to SIMA's persistent efforts, one such project is being pursued in IIT Roorkee. There is need to take up such more R&D projects.

**5.1.3** It is desirable to explore the possibility of using CCUS in the rotary kilns.

**5.1.4** Need to encourage existing producers to adopt measures like waste heat recovery plant, pre heating of iron ore/coal, automation, use of energy efficient devices etc.

**5.2 Long Term Solutions**

**5.2.1 To set up more natural gas (NG) based DRI plants.** Due to the uncertainty in the availability and its prices, no NG based DRI plant has come up in the country since last 29 years.

GAIL has set up a 2655 Kms gas pipe line from Jagdishpur to Haldia with investment of about Rs. 13000 Cr . This passes through major public and private sector steel plants, DRI plants and pellets plants in Jharkhand, Orissa and WB. So far, no major iron and steel producer have shown any serious interest. Ministry may organize a meeting with the all stakeholders like Ministry of

Petroleum and Natural Gas, GAIL, major iron and steel producers to sort out the present situation.

**5.2.2 To set up syn gas based DRI plants.** Though it highly desirable in view of the vast coal reserves in the country however lack of commercially proven technology and high capex are the stumbling blocks.

Merchant syn gas plants based on commercially proven technology should come up either in the four cluster of DRI or near the iron ore belts with proper infrastructure facilities.

**5.2.3 To set up green hydrogen based DRI plants.** To reduce CO2 emissions, use of green hydrogen in BF and DRI making is highly desirable. However, presently there is limitation in the use of green hydrogen in the Blast Furnace route (10-15%) Major global steel producers are contemplating to switch over to Green Hydrogen + Electric Arc Furnace route.

Green DRI is going to play a major role in India to fulfil our commitment and to be Carbon Neutral by 2070. However, availability of green hydrogen at an affordable price, required infrastructure and storage facilities will decide the expansion of this route.

Presently lot of R&D work is going on in various countries to produce green steel/low carbon steel through green DRI. There is a need to take up a National Demonstration Project in India under the R&D mission to produce steel through green hydrogen based on indigenous resources.

# 6. Conclusion

Indian DRI industry has been contributing significantly to meet the metallics requirement of the steel industry. It is expected this industry will continue to contribute not only to augment steel production in the country but also to the reduction of carbon footprints.

*(Views expressed in this article are personal)*

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## Make for India-Need for Aligning BIS Standards for TMT with Indian Conditions

Yogesh Kumar Dalmia, MD, Suraj Products Limited

*This article gives a new dimension to the BIS standard on TMT Bars and subsequently quality steel making in conventional induction furnace route. It is suggested that BIS should look into its contents (Editor)*

# Origin of Indian TMT standards (BIS)

| Formulation of TMT standard= |
|---|
| Weightage to international standard and practices |
| + |
| relating it to the practices in India |

- These international standards are mostly adapted from the pioneers of steel making- **The Western Countries or "The Colder Countries".**

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# Current TMT Standards

- The standard was first published in 1961 and subsequently revised in 1966, 1979 and 1985.
- The chemical constituent of different grades are

| Chemical (wt%) | FE500 | FE500D | FE550 | FE550D |
|---|---|---|---|---|
| C Max | 0.30 | 0.25 | 0.30 | 0.25 |
| S | 0.055 | 0.040 | 0.055 | 0.040 |
| P | 0.055 | 0.040 | 0.050 | 0.040 |
| S+P Max | 0.105 | 0.075 | 0.100 | 0.075 |
| Mn | 0.50 | 0.50 | 0.50 | 0.50 |
| Si Max | 0.40 | 0.40 | 0.40 | 0.40 |

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# PresentScenario

From 1985 to 2023, the scenario has undergone a sea change.

- **Low Phosphorous iron ore** that was readily available in the past, **is scarce now**.
- Corrosion due to **environmental degradation** is severe on reinforcement which is a critical problem now in most of the construction.
- The sponge Iron route was introduced in late 1990s.



# Why Standards have low Phosphorous?

- Cold shortness is caused by Phosphorus (P). It increases the critical temperature of Ductile to Brittleness transformation (DBT).
- The Critical Temperature of DBT for steel varies with change in percentage of Phosphorus and Carbon.
- Again there is effect of Sulphur, Manganese and silicon.

| Phosphorus | Carbon | Critical Temperature of DBT |
|---|---|---|
| 0% | 0% | -50°C |
| 0.1% | 0% | -30°C |
| 0.1% | 0.2% | -5°C |

## Is Low Phosphorous required in India

- With optimization:
  **The critical temperature of -5°C to 0°C can be maintained at 0.1% Phosphorus.**
- In cold countries, 0.1% P may pose a problem.
- **India where Atmospheric temperature is >0°C in winter at most of the places, 0.1% P will not pose any problem.**



## Phosphorous improves strength

- Phosphorus (P) is one of the most potent solid solution **strengthener of ferrite**.
- Even if we add 0.17% P, both yield and tensile strength increases and back hardening and deep draw-ability improves.
- **Hence, Phosphorus is used for cold forming application.**

# Corrosion resistant steel and Phosphorus

- "Phosphorous" is the crucial element in weather steel owing to superior corrosion resistance.
- India and corrosion:
  - India has a **coast line of 7516km**.
  - Acid rain has been increasing in recent decade.
- The effect of Phosphorous is more pronounced in **decreasing corrosion rate** of steel, especially during long term exposure.



# Corrosion Resistant steel and Phosphorus

- Example of corrosion resistance steel (Patented Technologies):
  1. SAILCOR STEEL developed by Bokaro steel plant(SAIL)
  2. Patented by CORTEN STEEL, USA.

Chemical constituents are compared

| Chemical (Wt%) | SAILCOR | CORTEN |
|---|---|---|
| C | 0.12 | 0.12-0.16 |
| Mn | 0.2-0.5 | 0.2-1.2 |
| Si | 0.25-0.75 | 0.25-0.75 |
| P | 0.145 Max | <0.15 |

# Phosphorous with low carbon steel

- In High Carbon Steel, Phosphorous increases strength and hardness but at the expense of ductility and impact to toughness.
- However, in **Low and Medium Carbon Steel,** Phosphorus increases strength and resistance to corrosion while keeping the ductility and toughness intact.



# Case Study Significance of Phosphorus

- 12 mm TMT bars of reputed steel manufacturer designated as X and a mini steel plant following induction route via Sponge iron route designated as Y are collected for comparisons. Sulphur and Phosphorus are compared.

| Chemical ( Wt%) | TMT X | TMT Y |
|---|---|---|
| Phosphorus | 0.026 | 0.092 |
| Sulphur | 0.022 | 0.042 |

# Case Study – Microstructural

- **Microstructural study:**

  Microstructural studies are done on both the TMT bars under reflected light in an universal optical microscope.

  Microstructural studies reveals that both the TMT bars have similar structure at core and periphery (**Perlite** structure in the core and retained **Austenite** in the periphery).



# Case Study – Corrosion Resistance

- **Corrosion study**:

  To study the corrosion behavior both the TMT bars are dipped partially in:

  Mild acid solution composed of Sulphuric acid, Nitric acid, Hydrochloric acid, carbonic acid considering the **constituent of acid rain for six months**.

  Periodic observation of Chemical constituents are compared.

# Case Study – Corrosion Resistance improves with phosphorus content

- **Corrosion study**: Periodic observation is

| Observation | TMT X | TMT Y |
|---|---|---|
| After 1 month | Turned red | Turned mild red |
| After 3 months | Mild corrosionin the ribs | No corrosion in the ribs |
| After 6 months | 1% loss in solution | 0.4% loss in solution |

**The study indicates corrosion resistance improves with the phosphorous content.**



# Case Study – Impact of 0.1% Phosphorous

- Literature review indicates for 0.1% Phosphorous content, **DBT temperature is -5°C**.
- Microstructural studies reveals that both the TMT bars have **similar** structure in the core and periphery.
- Experiment and literature review indicates that with 0.1% Phosphorous content, **corrosion resistance improves to a greaterextent**.

## Greener and Cheaper steel making

- India has high Phosphorous iron ore which necessities further treatment of hot metal in order to achieve BIS standards. This requires **energy, adds to pollution and increases cost**.
- By using higher Phosphorus steel we will reduce pollution and energy requirement, contributing to de-carbonization process.
- **Cheaper steel** meant for Indian environment conditions can potentially be a growth engine for Indian economy.

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## 0.1% P is suitable to Indian conditions

- In India, most of the places, except Himalayan region, have **temperature above 0°C in winter**.
- **Coastal region**, covering significant portion of the country, have high moisture, resulting in early corrosion.

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# Facts prove that higher content of Phosphorus is desirable

**A suggested specification is**

| Chemical | C | S Max | P Max | S+P | Mn | Si |
|---|---|---|---|---|---|---|
| Wt. % | 0.15-0.20 | 0.050 | 0.100 | 0.140 | 0.60 | 0.40 |



# Make in India – Make in India

The BIS standards should be reworked for:

- Indian Climatic Conditions,
- Domestic Ore Availability,
- Indian Consumer Requirements and
- Reduce the Carbon Footprint and energy requirement

**We have been producing steel based on norms set according to the requirements of western world, which are very different from India.**

**With our Honorable Prime Minister's initiative to Indianize products to benefit the Indian consumers, the relevant BIS standards need to be reviewed.**




# References

1. Effect of Phosphorous on formation of retained Austenite and mechanical properties in Si containing low carbon steel, H C Chen, H Era & M Shimzu Metallurgical Transaction A 444, Volume 20A, March 1989
2. Corrosion behavior of high Phosphorous containing weather resistant steel, G Sahoo et.al RDCIS, Ranchi, J. Met. Mater. Miner 24(2), 2014
3. Structure of protective rust layers formed on weathering steels by long term exposure to Industrial atmosphere of Japan and North America, Yamashita et.al ISIJ int 38(3) 285-290, 1998
4. The long term growth of protective rust layer formed on weathering steel by atmospheric corrosion during a quarter of Century, Yamashita et.al Crros. Sci 36(2) 283-299, 1994
5. Is low Phosphorous content in steel a product requirement? H. K. D.H Bhadeshia et.al Iron Making and Steel making Vol 42 No 4 259 2015

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**As a part of National Green Steel Mission, Ministry of Steel have constituted following Task Forces;**

i. Developing Taxonomy for Green Steel

ii. Monitoring of carbon emission of steel plants

iii. Creation of Demand

iv. Energy Efficiency

v. Renewable Energy Transition

vi. Material Efficiency

vii. Green Hydrogen,

viii. Carbon Capture, Utilization and Storage,

ix. Process Transition,

x. Research & Development,

xi. Finance,

xii. International Focus and

xiii. Skill Development.

*NOTE:*
*SIMA has been contributing in many of above Task Forces.*

# Statistics

| Item | Performance of Indian Steel Industry | | |
|---|---|---|---|
| | April-March 2022-23*(mt) | April-March 2021-22 (mt) | % Changes* |
| **Crude Steel Production** | 126.258 | 120.293 | 5.0 |
| **Hot Metal Production** | 81.099 | 78.223 | 3.7 |
| **Pig Iron Production** | 5.882 | 6.262 | -6.1 |
| **Sponge Iron Production** | 43.557 | 39.200 | 11.1 |
| **Total Finished Steel (alloy/stainless + non-alloy)** | | | |
| **Production** | 122.276 | 113.597 | 7.6 |
| **Import** | 6.022 | 4.669 | 29.0 |
| **Export** | 6.716 | 13.494 | -50.2 |
| **Consumption** | 119.864 | 105.752 | 13.3 |
| Source: JPC; *provisional; mt=million tones | | | |

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