AIIFA SUSTAINABLE STEEL MANUFACTURERS ASSOCIATION

(FORMERLY KNOWN AS ALL INDIA INDUCTION FURNACES ASSOCIATION)

(Promoting Sustainability in Steel for Greener Future)

AIIFA News

VOL. No. XXVI
ISSUE No. 6, June 2025

What's Inside

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ELITE CRANES

Fabrication Industries Prefer Special-Quality Mild Steel from Induction Furnaces for Cost-Effective, High-Quality Production

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INTRODUCTION

Mild steel, commonly known as low-carbon steel, remains a cornerstone material in industries such as construction, automotive, and industrial equipment manufacturing due to its favorable mechanical and processing characteristics. With a typical carbon content ranging from 0.05% to 0.25%—occasionally extending up to 0.30% in certain industrial grades—mild steel is predominantly composed of ferrite and pearlite within a body-centered cubic (BCC) crystal structure. This microstructural configuration offers a balanced combination of ductility, strength, and excellent machinability, making it particularly suited for applications requiring formability, weldability, and cost-effective production.

From a manufacturing standpoint, optimizing the machining parameters of mild steel is a critical area of focus aimed at enhancing surface integrity, reducing production time, and extending tool life. Surface roughness, a key indicator of product quality, significantly influences the fatigue strength, corrosion resistance, and wear behavior of machined components. This is especially important in high-performance sectors such as aerospace and automotive, where dimensional precision and surface finish are paramount. Thus, controlling cutting conditions—especially in turning operations—is essential to meet the stringent quality demands of these industries.

Tool wear and machining efficiency are two of the most sensitive indicators influenced by machining variables such as cutting speed, feed rate, depth of cut, and tool geometry. The interplay between these parameters determines not only surface finish but also tool longevity and material removal rates. Selecting optimal machining settings is, therefore, crucial for achieving high productivity, minimizing downtime, and maintaining dimensional accuracy. Advances in sensor-based monitoring and computer-aided process modeling have further facilitated the development of intelligent machining strategies tailored to mild steel's specific properties.

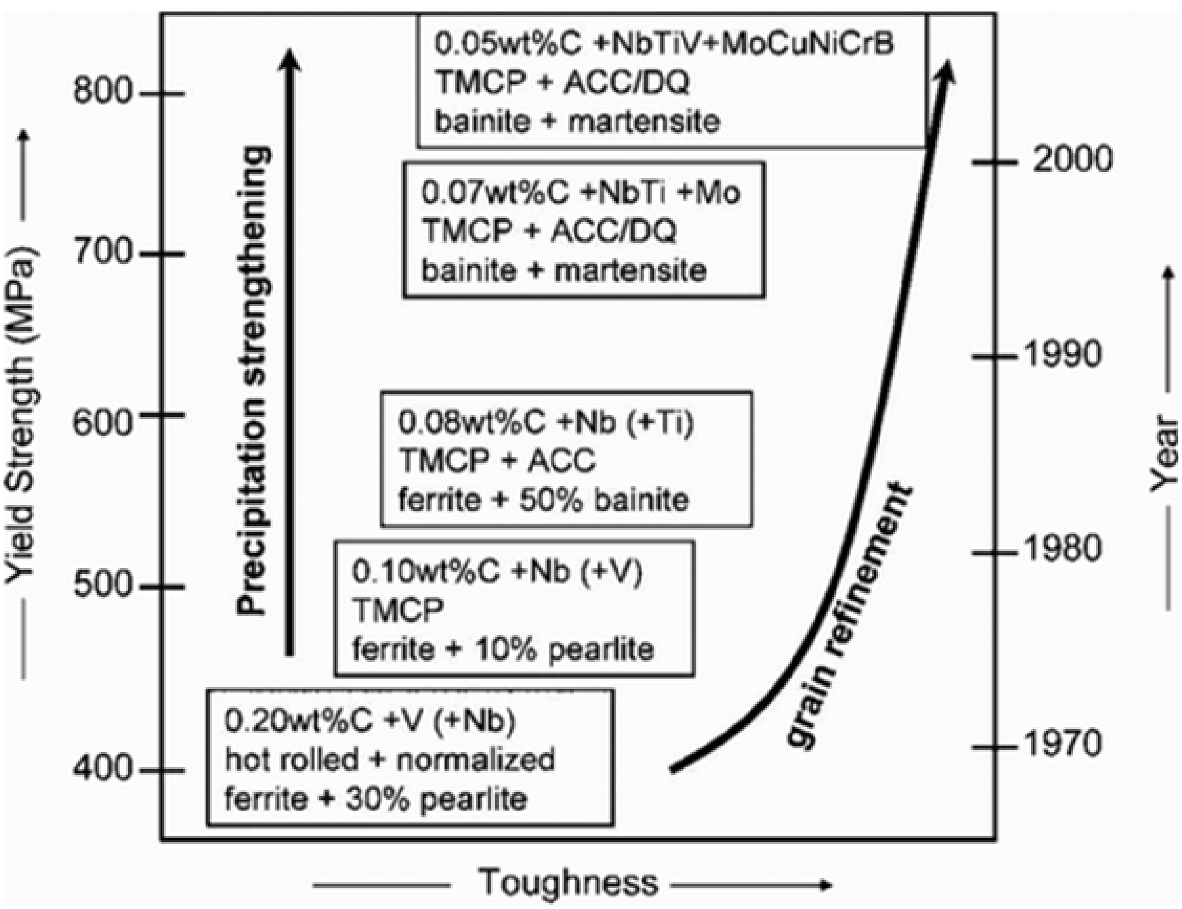
Special quality mild steel represents a refined variant of conventional low-carbon steel, produced under stringent metallurgical control to meet defined standards of purity, strength, and microstructural uniformity. While standard carbon steels primarily contain iron and carbon, special quality grades are processed to limit inclusions and residual elements, improving their formability, weld integrity, and consistency. Unlike alloy steels that derive enhanced properties from alloying elements such as chromium, molybdenum, and nickel, special quality mild steels rely on controlled processing and thermal treatments to achieve desired mechanical performance while retaining the economic and operational advantages of low-carbon steel. This makes them ideal for precision components in demanding industrial environments.

Expectation of Quality and Properties of Raw Material by the Fabrication Industry

The fabrication industry places paramount importance on the quality, consistency, and performance of raw materials, particularly in processes such as design, machining, welding, and assembly. These operations require materials with predictable mechanical and metallurgical properties to produce high-precision components that meet stringent specifications set by Original Equipment Manufacturers (OEMs). Any inconsistency in raw material properties—such as variations in chemical composition, microstructure, or surface quality—can lead to defects affecting dimensional accuracy, weldability, surface finish, and structural integrity. This is especially critical when fabricating components from special or high-performance steels, where the use of advanced machinery and skilled technicians is necessary to manage complex geometries and ensure cost-effective, high-quality production.

Microalloyed mild steel, a variant of low-carbon steel enhanced with trace elements, has emerged as a material of choice across fabrication-intensive sectors including automotive, construction, oil & gas, and heavy engineering. These steels combine high strength, excellent toughness, and improved weldability, enabling the production of lighter, thinner, and more efficient structures without compromising performance or safety. Their enhanced strength-to-weight ratio allows for material savings and increased load-bearing capacity, while their ductility ensures formability during fabrication. As industries move toward higher efficiency and sustainability, microalloyed mild steels support reduced energy consumption and raw material usage.

Special quality mild steels—particularly microalloyed grades—are extensively used in demanding environments, such as marine and mildly corrosive settings. Applications span offshore platforms, cross-sea bridges, subsea tunnels, oil and gas pipelines, port terminals, and railway infrastructure, where materials must resist cyclic loading, abrasion, and corrosion. These steel grades are engineered to maintain consistent mechanical performance and structural reliability under such extreme conditions. The typical chemical composition of microalloyed mild steels includes low carbon (0.05%–0.25%) and manganese (up to 2.0%) for weldability and toughness, along with small additions of alloying elements such as chromium (Cr), nickel (Ni), molybdenum (Mo), copper (Cu), vanadium (V), niobium (Nb), titanium (Ti), zirconium (Zr), and nitrogen (N) to refine microstructure and enhance performance metrics.



Among these alloying elements, **niobium (Nb)** plays a particularly critical role in microstructural refinement and property enhancement. Niobium strengthens steel primarily through precipitation hardening and grain refinement. It forms fine niobium carbide (NbC) precipitates that act as pinning points for dislocation movement, thus increasing the yield strength and impact toughness of the material. Additionally, Nb impedes recrystallization during hot working, resulting in a finer and more uniform ferrite grain structure. These microstructural modifications are especially beneficial in high-stress applications such as automotive frames, suspension components, and high-pressure pipelines. Studies show that as little as 0.034 wt.% Nb can reduce grain size by up to 71% compared to conventional mild steel, significantly improving fatigue performance and fracture resistance.

From a practical standpoint, niobium offers several advantages over other microalloying elements. It has a lower atomic weight, providing efficient strengthening with minimal addition, and is more abundantly available with relatively stable market pricing compared to molybdenum or vanadium—making it both technically and economically viable for large-scale production of advanced mild steel grades.

Moreover, niobium contributes to corrosion resistance in aggressive environments. Research indicates that small Nb additions improve microstructural homogeneity, which suppresses localized anodic dissolution and reduces corrosion rates. In particular, Nb-microalloyed steels with 0.04 to 0.10 wt.% Nb exhibit higher passive resistance and charge transfer resistance when exposed to acidic media like sulfuric acid. This improvement is attributed to the formation of a passive oxide film rich in niobium compounds, which are chemically stable and act as an effective barrier against corrosion.

In other words, the integration of microalloying elements, particularly niobium, into mild steel significantly elevates its performance in terms of strength, toughness, corrosion resistance, and processability. These advancements align well with the stringent and evolving demands of the fabrication industry, supporting the development of complex, high-performance structures across diverse industrial applications. As global industries continue to pursue efficiency, reliability, and sustainability, special quality microalloyed mild steels represent a robust and forward-looking material solution.

Mild Steel Characteristics and Fabrication Considerations

Mild steel, commonly referred to as low-carbon steel, typically contains up to 0.30% carbon. This low carbon content makes it relatively soft, highly ductile, and easy to form, weld, and machine—qualities that render it indispensable in sectors such as construction, automotive, machinery, and general engineering. Its affordability, widespread availability, and ease of fabrication make mild steel a preferred material for structural components, mechanical parts, and fabricated assemblies. The high malleability and weldability of mild steel also allow it to be readily adapted to a wide range of manufacturing processes.

The fabrication of components using mild steel generally involves a sequence of interdependent stages: material selection and procurement, design, cutting and shaping, joining (via welding or bolting), machining, quality control, and final finishing. At each stage, the mechanical and metallurgical properties of the material must align with the end-use requirements to ensure durability, reliability, and structural integrity. When enhanced with microalloying elements such as niobium, mild steel exhibits improved mechanical properties—particularly in strength and toughness—while supporting fabrication efficiency in terms of production speed, material utilization, and cost management.

However, machining—one of the most critical yet resource-intensive stages of fabrication—introduces several challenges. Unlike simpler processes such as cutting or welding, machining operations significantly increase production time and complexity. Precision machining requires advanced equipment like CNC lathes and mills, which involve high capital investment and ongoing maintenance costs. Furthermore, the need for skilled machinists with in-depth knowledge of machining dynamics and material behaviour adds to labour costs and project planning challenges. In regions with limited technical workforce availability, fabricators may face delays or the need to outsource, impacting project timelines and profitability.

From a metallurgical perspective, the microstructure of mild steel predominantly consists of ferrite (α-Fe) and pearlite (a lamellar mixture of ferrite and cementite, Fe_3C). This structure offers a balance of strength and ductility suitable for general applications. When alloyed with niobium, the microstructure undergoes significant refinement. Niobium additions result in the formation of finely dispersed niobium carbide (NbC) precipitates, which pin grain boundaries and inhibit grain growth during thermomechanical processing. This leads to a finer ferrite and pearlite matrix, improving yield strength, impact resistance, and fatigue performance. These precipitates, depending on heat treatment and cooling rates, may be distributed along grain boundaries or within grains, contributing to overall microstructural stability and enhanced mechanical behaviour.

Rationale for Favoring Smaller Quantity Lots of Mild Steel in Fabrication

Fabricators frequently opt for smaller quantity lots of mild steel over bulk procurement, particularly for custom fabrication jobs, due to advantages in flexibility, process control, and risk mitigation. Smaller lots allow for more precise management of production workflows, enabling faster responses to design changes and on-the-fly adjustments to machining or welding processes. This is especially critical in prototype development, short-run manufacturing, and projects with evolving design specifications, where agility is a key factor in ensuring quality and meeting delivery timelines.

From a cost perspective, smaller lots reduce the financial exposure associated with material waste, machining errors, and process rework. In the early stages of product development or during the fabrication of high-precision components, minimizing scrap and optimizing tooling are vital to maintaining project budgets. Small-batch processing also facilitates experimentation with different machining parameters—such as feed rates, tool geometries, and cutting speeds—allowing fabricators to fine-tune operations before scaling up, thereby improving efficiency and ensuring consistency in larger runs.

Additionally, small-lot procurement simplifies material handling, storage, and quality control, offering better traceability of steel grades and certifications. This is particularly important when working with special quality mild steels that are microalloyed for enhanced mechanical properties such as strength, toughness, and corrosion resistance. While conventional mild steel produced via the BF-BOF (Blast Furnace–Basic Oxygen Furnace) route is economical for bulk supply, special quality grades—especially those incorporating microalloying elements like niobium or vanadium—can be cost-effectively produced through the Induction Furnace (IF) route. This offers an efficient and scalable solution for meeting specific property requirements without the overhead of bulk production.

In summary, the preference for smaller quantity lots of mild steel in fabrication stems from the need for process adaptability, cost containment, and quality assurance—making it a strategic choice for both prototyping and specialized production in today's dynamic manufacturing landscape.

Considerations by Fabricators for Micro-Alloyed Mild Steel in Small Lots

For small and medium-sized fabrication businesses, the upfront cost of procuring large volumes of micro-alloyed mild steel can be a substantial constraint. Opting for smaller lot sizes offers a more economical and flexible approach, allowing these enterprises to access advanced material grades without incurring excessive financial risk. This approach aligns well with the dynamic nature of custom fabrication and short-run production, where adaptability and precision are critical.

Smaller batch sizes significantly reduce the likelihood of material waste resulting from machining errors or miscuts. In the event of a process deviation, the financial impact is minimized compared to large-scale operations. Additionally, small lots facilitate enhanced quality control, as each component can be closely inspected to ensure compliance with specified mechanical and dimensional tolerances—an essential factor when working with high-performance micro-alloyed steels.

Traceability and inventory management are also simplified with smaller quantities, allowing for better oversight throughout the production cycle. This is particularly advantageous when dealing with microalloyed mild steels, which are tailored for superior strength, toughness, and weldability through the controlled addition of elements such as niobium, vanadium, or titanium.

While the conventional Blast Furnace–Basic Oxygen Furnace (BF-BOF) route continues to dominate global mild steel production—contributing approximately 70% of the total output—the Induction Furnace (IF) route has emerged as a viable and efficient method for producing special quality mild steel in smaller, customized batches. The IF route is particularly suited for microalloyed grades, offering lower production costs, reduced energy consumption, and the flexibility needed to meet specific application requirements.

In summary, small-lot production of micro-alloyed mild steel provides fabricators with greater agility, cost-efficiency, and quality assurance—making it a strategic choice for specialized projects and custom manufacturing environments.

Ferrous Scrap-Based Production via Induction Furnace: A Sustainable Steelmaking Approach

The Electric Induction Furnace (EIF) route, which primarily utilizes ferrous scrap and Direct Reduced Iron (DRI) as feedstock, is increasingly recognized as a more sustainable alternative to traditional steelmaking processes. Although it currently accounts for approximately **25% of India's total steel production**, its environmental advantages position it as a key contributor to the future of green steelmaking.

The **DRI–EIF route** generates a **significantly lower carbon footprint** compared to the conventional **Blast Furnace–Basic Oxygen Furnace (BF–BOF)** route and even the **Electric Arc Furnace (EAF)** process. This is largely due to its use of recycled steel scrap and energy-efficient operation, making it a compelling solution for decarbonizing the steel sector. Additionally, the EIF route offers **greater flexibility for small-batch, specialized steel production**, including micro-alloyed grades, at a lower capital and operational cost.

Globally, **mild steel accounts for approximately 80% of total carbon steel production**, given its versatility and widespread use across construction, automotive, and general engineering sectors. In India, while granular data on the exact proportion of **low-carbon (mild) steel** within total steel output is limited, industry trends strongly suggest it constitutes a significant majority of the domestic production portfolio. **Micro-alloyed mild steels**, though currently representing **only 5–8% of global mild steel output**, are gaining traction due to their superior mechanical properties and suitability for demanding applications.

India's steel industry is undergoing a strategic transition toward sustainable practices. The **Ministry of Steel's Green Steel Initiative** underscores a national commitment to decarbonizing steel production. In addition to adopting **low-carbon production routes**, the industry is investing in advanced technologies such as **Coke Dry Quenching (CDQ)**, **Sinter Plant Waste Heat Recovery**, and **energy-efficient rolling mills** to reduce emissions across traditional routes.

The **private sector**, which accounts for over **80% of India's crude steel production**, is playing a pivotal role in this transformation. A considerable share of finished steel products comprises **non-alloy grades**, predominantly **low-carbon mild steels**, which align well with India's infrastructure growth and industrial demand.

In summary, the **EIF route—particularly when coupled with DRI and scrap-based input—presents a viable path forward for cleaner, cost-effective, and localized steel production**. With ongoing policy support and technological advancements, it is poised to play an increasingly important role in India's sustainable steel landscape.

Cost, Quality, and Property Comparison: Mild Steel vs. Micro-Alloyed Steel

The selection between mild steel and micro-alloyed steel hinges on the interplay of cost, mechanical performance, and end-use requirements. Mild steel, or low-carbon steel, is widely favored for its affordability, owing to its simple composition—primarily iron with up to 0.25–0.30% carbon and minimal alloying elements. Its malleability, ductility, and ease of welding make it an ideal choice for general-purpose applications in construction, infrastructure, and fabrication where high strength is not a critical requirement. On the other hand, micro-alloyed steels are specifically engineered to achieve enhanced mechanical properties through the addition of small quantities of alloying elements such as niobium (Nb), vanadium (V), and titanium (Ti). These additions enable significant improvements in yield strength, toughness, and fatigue resistance by refining the grain structure and enhancing precipitation hardening—often eliminating the need for additional heat treatment. However, this superior performance comes at a higher cost due to more complex processing and the use of specialty alloying elements.

Micro-alloyed steels are therefore more suitable for demanding applications such as automotive structural components, pressure vessels, bridges, offshore structures, and pipelines, where strength-to-weight ratio, durability, and formability under stress are paramount. Moreover, their enhanced weldability and resistance to environmental degradation make them well-suited for marine and mildly corrosive conditions. In contrast, mild steel continues to dominate in cost-sensitive segments where structural integrity can be maintained without the added benefits of micro-alloying. Ultimately, the decision between the two depends on performance expectations and economic feasibility. While mild steel offers a practical and low-cost solution for standard fabrication needs, micro-alloyed steel provides advanced mechanical advantages necessary for high-performance and safety-critical applications.

Overall Advantages of Microalloyed Mild Steel

Microalloyed mild steel, a subcategory of High-Strength Low-Alloy (HSLA) steel, derives its enhanced properties from the controlled addition of small amounts (typically 0.05% to 0.15%) of alloying elements such as niobium (Nb), vanadium (V), titanium (Ti), molybdenum (Mo), and boron (B). These microalloying elements significantly improve the mechanical performance of mild steel by refining its grain structure and promoting precipitation hardening. As a result, the steel exhibits superior yield strength, enhanced toughness, better fatigue resistance, and improved weldability—key properties that extend its utility across demanding structural and industrial applications.

While microalloyed steel is costlier than conventional mild steel due to the inclusion of these additional elements and slightly more complex processing, it is highly favored in applications where performance is critical. Industries such as automotive manufacturing, oil and gas transmission, construction, shipbuilding, and heavy engineering increasingly rely on microalloyed steels for components that demand a combination of strength, weight reduction, and ease of fabrication. The enhanced strength-to-weight ratio allows for thinner sections and lighter components without compromising structural integrity—an essential advantage in today's efficiency- and sustainability-driven manufacturing landscape.

Different microalloying elements contribute uniquely to property enhancement. Niobium (Nb) is especially effective in achieving grain refinement and precipitation strengthening, offering the highest strengthening effect among common microalloying elements. It delays recrystallization during hot working and promotes a fine-grained ferritic structure, which enhances both toughness and strength while maintaining excellent weldability. Vanadium (V) also contributes to grain refinement and strengthens the steel through vanadium carbide precipitates, improving fatigue and impact performance. Titanium (Ti), while useful primarily for precipitation hardening, shows relatively lower overall strengthening benefits compared to niobium and vanadium. Nonetheless, it plays a crucial role in stabilizing carbon and nitrogen, thereby refining microstructures and controlling grain growth during high-temperature processing.

In practice, microalloying with a combination of Nb, V, and Ti allows for tailored mechanical properties without the need for post-processing heat treatments—a key advantage in mass production settings. These elements influence various metallurgical phenomena such as grain growth during heating, recrystallization behaviour of austenite, phase transformation kinetics during cooling, and precipitation hardening in ferritic phases.

Empirical studies consistently indicate that niobium-alloyed steels achieve the smallest grain sizes and highest strengthening among microalloyed steels, followed by vanadium. Titanium-based strengthening, while less impactful, still contributes significantly to overall performance, especially in combination with other elements. Consequently, microalloyed mild steels present a reliable, high-performance option for fabricators and manufacturers who require elevated mechanical properties without sacrificing productivity or formability.

In conclusion, despite their higher upfront cost compared to conventional mild steel, microalloyed grades are widely embraced across industries that prioritize long-term performance, safety, and reliability over initial material expenses. The benefits—ranging from weight reduction and higher strength to improved fatigue life, corrosion resistance, and ease of forming and welding—outweigh the incremental costs. Industries recognize that the use of microalloyed mild steels leads to improved equipment functionality, extended service life, and higher productivity, making them an essential material choice in modern engineering and fabrication environments.

Sustainable Steel: Regulatory Compliances - 2026 & beyond

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As countries and corporates both move towards a low-carbon future, driven by climate regulations, Net Zero and NDCs (Nationally determined Contributions), Indian steel (and most importantly, MSMEs) must act swiftly to comply with evolving norms and seize emerging business opportunities. With over 1,000 small and micro enterprises forming the backbone of India's sustainable steel manufacturing landscape, the time for collective transformation is now.

A look at the emerging regulations relevant to the industry, in brief can be summarised as follows –

A. **CBAM** (Carbon Border Adjustment Mechanism – EU) : is a carbon tariff on imports into the EU based on embedded emissions. Indian steel exports to Europe have to necessarily disclose verified carbon emissions. From 2026, non-compliant exporters will face financial penalties.

B. **BRSR** (Business Responsibility and Sustainability Reporting – India) is a SEBI-mandated ESG reporting for the top 1,000 listed companies. It calls for detailed emission declarations, and a long-term plan to mitigate them. It indirectly cascades down to MSMEs in their supply chains.

C. **CCTS** (Carbon Credit Trading Scheme – India) is a domestic market-based carbon pricing system to incentivize emission reductions. So, Steel producers, especially high-emission MSMEs, may need to buy credits or invest in low-carbon processes to remain competitive or compliant in the future.

D. **Green Steel Taxonomy** (India – under development) shall Classify steel based on carbon intensity (e.g., "green steel"). This will shape procurement norms (especially government & public sector), green financing access, and brand value.

The rest of this article (first in a series of four) focusses on understanding CBAM, its applicability to the Indian Steel Industry, Financial implications (of Adjustment), impact on Indian Industries (MSMEs) and possible preparations that the industry needs to initiate to absorb the impact.

Understanding CBAM

a. The background & Scope/ Coverage

The Carbon Border Adjustment Mechanism (CBAM) is a pivotal component of the EU's climate strategy, designed to address the risk of "carbon leakage" from outside into EU (European Union).

This mechanism aims to impose a carbon price *(adjustment)* on imports into the EU, thereby levelling the playing field with EU domestic producers who already incur carbon costs under the EU ETS (Emissions Trading System).

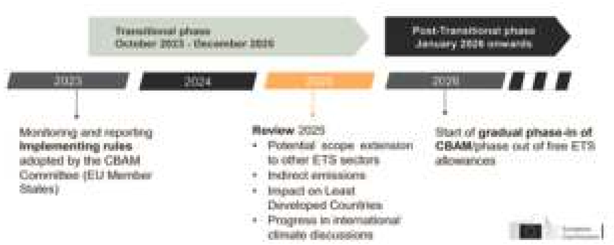
CBAM applies to imports arriving in 27 countries in Europe.

At present, CBAM is limited to carbon-intensive goods including iron & steel, cement, fertilizers, aluminium, hydrogen, and electricity, along with certain precursors. The scope of CBAM is projected to expand significantly by 2030 to encompass all product groups covered by the EU ETS (Emission Trading System) or those at risk of carbon leakage.

b. Timelines for Implementation

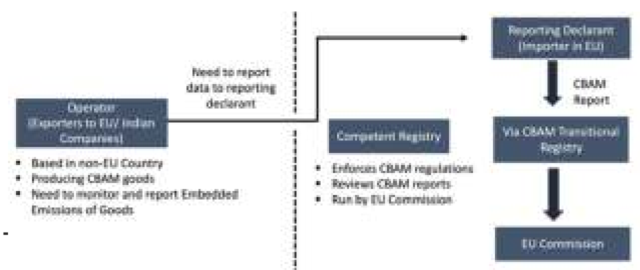
The implementation of CBAM is structured in two key phases - The Transitional Phase, which commenced on October 1, 2023, and ends on December 31, 2025.

The Definitive Phase begins from January 1, 2026. Annual reporting with declarations of the total quantity of goods and their embedded emissions will become mandatory in this phase. The reports provided are verifiable by an EU-accredited verifier.



In this phase, the EU importers will be required to submit quarterly reports detailing the total quantity of each type of goods imported, their total embedded emissions (both direct and indirect), and any carbon price paid in the country of origin. As a consequence, the Indian exporters in turn will have to submit the same to their customers, i.e. EU Importers.

c. Participants / Stakeholders



stakeholders and the compliance happens on a digital platform. Briefly, the stakeholders comprise of

I. **European Union Institutions** like European Commission, EU Customs Authorities (Monitor and verify the CBAM certificates during import), CBAM Transitional Registry (Digital platform for reporting and certificate trading).

ii. **Importers into the EU** (EU-Based) including Authorised Declarants (EU-based companies or individuals legally responsible for importing CBAM-covered goods (steel). They will need to submit verified emissions reports and purchase CBAM certificates to cover embedded emissions in imported goods.

iii. **Non-EU Exporters** (e.g., Indian Steel Manufacturers). These Exporters/ Producers must disclose product-specific embedded emissions and facilitate verification through accredited bodies. They will need to work with importers to provide accurate carbon data & failure to do so may increase declared emissions.

iv. **Independent Verifiers and Accreditation Bodies** who will Validate the emissions data submitted by non-EU producers.

v. **National Governments (Non-EU)** e.g., Government of India who will negotiate mutual recognition agreements, provide MRV support, or subsidize decarbonization efforts for exporters.

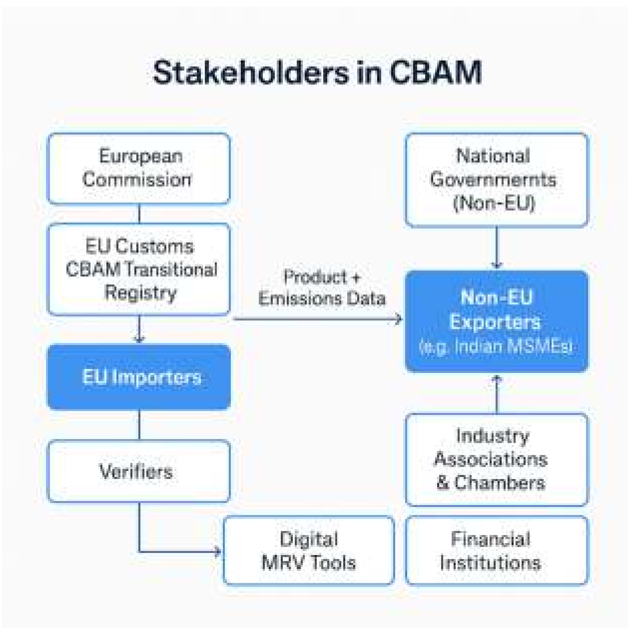
vi. **Industry Associations & Chambers like AIIFA** could act as aggregators for information, training, carbon accounting tools, and policy advocacy.

vii. **Digital Platform Providers / MRV Tool Vendors** who can offer carbon accounting software to help exporters track and report emissions efficiently and affordably.

viii. **Financial Institutions who can Provide**

green finance, loans for low-carbon upgrades, and support for carbon-related compliance costs.

The CBAM registry is a digital platform and all submissions will have to be made online, starting from 2026. So having systems & processes in place will be a basic requirement for all exporters. Further, all declarations by exporters are auditable by accredited verifiers, in case if reporting have gaps or inconsistencies.



The high carbon intensity of India's steel production, estimated at 2.7+ tons of CO_2 per ton of crude steel is considerably higher than the global average of 1.91 tons of CO_2 per ton of crude steel, in EU. This higher carbon footprint will directly lead to increased tax liabilities under CBAM, unless appropriate steps are taken timely.

In numbers -

- The EU intakes 38% ($3.7 billion) of India's steel exports, which annually amount to 3-5 million tons of finished steel.
- Projections indicate that CBAM could impact 15% to 40% of India's annual steel exports to Europe.
- Estimates suggest that CBAM could impose an additional 25% in costs on Indian iron and steel exports to the EU, significantly raising their price and diminishing competitiveness.
- This translates to potential additional tax charges of $102 to $190 per ton of Indian steel imports over the next decade, in absence of relevant corrections.
- Consequently, profits from Indian steel exports to the EU may decline by US$65-160 per metric ton between 2026 and 2036.

Importers will be required to purchase CBAM certificates, with their price linked to the weekly average auction price of EU ETS allowances (expressed in €/tonne of CO_2 emitted), which are currently approx at €68-70 per ton of CO_2, and likely to go up to approx €85 per ton of CO_2 in the definitive phase from 2026. In summary, with time, the penalties will only go up and hurt more.

e. CBAM: The Bigger Picture

CBAM appear punitive. It does have a direct impact on business, revenues and profitability. It may appear to cause immediately –

- Loss of export market/customer access, esp. EU
- Supply chain exclusion from larger exporters (and domestic buyers too)
- Reduced competitiveness in global tenders (due to penalties& taxes)
- Difficulty in securing green finance from Banks, esp. for MSMEs.

But it also presents an opportunity to modernize Indian steel MSMEs and align with future-ready business standards. Compliance with CBAM can unlock multiple benefits:

- Access to green finance/ favourable rates of interest from Banks, esp. for MSMEs.
- Improved operational efficiency as in the long term, focus on Energy efficiency becomes better
- Stronger market positioning in global supply

chains as ESG-sensitive supplier

- Enhanced resilience to future regulatory risks.

f. Conclusion

CBAM is not a distant European policy - it is an immediate business reality. With far-reaching implications for the Indian steel industry, more for MSMEs.

Govt. Of India, Min. Of Steel, MSME ministry and your association – AIIFA Sustainable Steel Manufacturers Association, all have a critical role to play and are available to extend all possible support to the industry.

Timely action now will help Indian steel secure global sustainability leader position in a fast-emerging sustainability and carbon-conscious world.

A number of Indian regulations are also evolving and under implementation – Green Steel Taxonomy, CCTS, Emission reporting etc. A compliance burden today will open opportunities for those who act in time - market access, investor confidence, and global competitiveness.

Stay tuned in for the next article on 'Green Steel Taxonomy' in the next publication of your monthly magazine. Pls. feel free to reach out to the authors for any queries, feedback, help/support if required.

The Growing Importance of Coated Steel in Industrial Applications

Prabhakar Mishra, Sr. Executive Director, AIIFA

ABSTRACT

Coated steel is rapidly becoming a foundational material across diverse industrial sectors such as construction, automotive, appliances, and infrastructure. In a global environment that demands performance, durability, sustainability, and aesthetic appeal, coated steel is emerging as the material of choice. The rising importance of coated steel lies in its ability to provide corrosion resistance, extended service life, and economic efficiency, while aligning with modern sustainability goals. This article explores the various types of coated steel, their applications and advantages, and why this material is fast becoming indispensable for industries navigating 21st-century challenges.

Introduction

In today's evolving industrial landscape, materials must do far more than provide basic structural support. The demand is now for materials that offer multifunctional performance—durability, corrosion resistance, environmental sustainability, and economic feasibility. Coated steel, which refers to steel that has been given a protective or decorative surface treatment, is at the forefront of meeting these expectations. From galvanized and aluminized varieties to polymer and color-coated innovations, coated steel is now central to industrial design and development.

This shift is not merely a result of advancements in material sciences but a direct response to evolving industry demands, including the need for climate-resilient infrastructure, stringent regulatory requirements, and growing public and institutional awareness of sustainability. As industries seek to build smarter, longer-lasting, and environmentally responsible products, coated steel has moved from being an option to a necessity.

Types of Coated Steel and Their Properties

There are several major types of coated steel, each designed to serve specific purposes depending on the industry and application.

Galvanized Steel is the most widely used, featuring a zinc coating applied through hot-dip or electro-galvanization. This zinc layer acts sacrificially, corroding before the steel itself is affected, thereby significantly extending the material's lifespan. It is extensively used in automotive components, construction materials like roofing and structural frames, and agricultural fencing due to its strong resistance to corrosion in outdoor environments.

Aluminized Steel consists of a steel base coated with an aluminum-silicon alloy. It offers excellent resistance to both high temperatures and oxidation. This makes it highly suitable for applications such as exhaust systems, industrial ovens, and heat shields where exposure to intense heat is routine. Its reflective surface also adds value in energy-efficient designs.

Colour-Coated Steel, also known as Pre-Painted Galvanized Iron (PPGI), incorporates organic coatings such as polyester or PVDF over a galvanized or aluminized base. This product is known for its aesthetic versatility and is used in construction (building facades, roofing), home appliances, and even in branding efforts. The wide range of colors, finishes, and textures allows architects and designers to incorporate steel without compromising on visual appeal.

Polymer-Coated Steel involves applying plastic or advanced polymer layers for specialized functions. These coatings are designed for environments requiring hygiene or chemical resistance, such as food processing plants, hospitals, and clean rooms. These materials not only ensure durability but also simplify cleaning and sterilization.

Key Advantages Driving the Adoption of Coated Steel

Corrosion Resistance is arguably the most critical advantage. Traditional steel is prone to rust and environmental degradation, which can severely compromise safety and integrity. Coated steel, however, stands up to extreme conditions—whether in coastal areas, urban pollution zones, or tropical climates—making it a top choice for long-term infrastructure investments. For example, in bridge construction or coastal defence structures, duplex-coated or galvanized steel can offer decades of maintenance-free operation.

Enhanced Aesthetics and Customization are another driver of adoption. The colour-coated variants offer architects and engineers greater design flexibility with a wide array of colours, gloss levels, and textures, enabling modern, eye-catching architecture. From commercial spaces to transport hubs like metro stations and airports, coated steel meets both structural and aesthetic needs.

Sustainability and Environmental Compliance are integral in today's policy-driven industrial environment. Coated steel is recyclable and frequently manufactured through eco-friendly processes. It supports long service life, reducing the frequency of material replacement, which in turn lessens the lifecycle carbon footprint. Regulations like LEED certification and India's Energy Conservation Building Code (ECBC) increasingly favour such environmentally responsible materials.

Cost Efficiency over the lifecycle of a product or structure also sets coated steel apart. While initial investment may be slightly higher than uncoated alternatives, the savings on maintenance, downtime, and replacements are considerable. Industries such as automotive and consumer appliances prioritize coated steel to avoid costly warranty claims and to enhance long-term product performance and customer satisfaction.

Compatibility with Advanced Manufacturing Systems has made coated steel a perfect match for Industry 4.0 environments. It is available in highly uniform, ready-to-use formats that integrate seamlessly into automated production lines. Coil coating lines are now equipped with AI-powered inspection systems that enhance quality control while reducing waste and costs.

Industrial Applications: Sector-Wise Insights

Construction and Infrastructure

In the construction sector, coated steel is used for roofing, cladding, structural framing, and even for smart city elements like prefab structures and urban furniture. It stands up to harsh environmental conditions such as acid rain, UV exposure, and wind loading, making it ideal for long-term infrastructure projects.

Automotive Industry

In vehicle manufacturing, coated steel is found in underbody components, fuel tanks, and body panels. It offers excellent formability and weldability while resisting corrosion and reducing the need for secondary treatments. Lightweight coated steel variants are also supporting the design of more efficient electric vehicles (EVs).

Consumer Durables

Refrigerators, washing machines, and air conditioners all use coated steel for outer panels and internal components due to its clean finish, resistance to moisture, and ease of cleaning. This has helped manufacturers create more attractive and durable products while also improving production efficiency.

Energy and Power Sector

Coated steel plays a critical role in renewable energy infrastructure such as solar panel frames, wind turbine structures, and power transmission towers. It ensures high durability under variable climatic conditions, particularly in remote or high-salinity regions where maintenance access is limited.

Innovation and the Future of Coated Steel

Rapid innovation in coatings technology continues to push boundaries. Emerging solutions include self-healing coatings that automatically repair minor surface scratches, smart coatings that change color based on stress or temperature, and nano-ceramic coatings that offer ultra-thin, high-performance protection layers. These innovations are enabling new applications and improving material longevity.

India is making significant strides in this space. Domestic steel manufacturers are investing heavily in R&D to develop coatings tailored for specific regional challenges, such as high heat and humidity. Public and private collaboration in technology parks and innovation hubs is further accelerating the development of indigenous coated steel solutions.

Challenges and Opportunities

Despite its rising adoption, coated steel faces a few challenges. Price volatility of key inputs like zinc and aluminium can impact cost planning. Supply chain disruptions, particularly in coating chemicals and equipment, can delay projects. Additionally, skilled labour is required to handle, install, and fabricate coated materials correctly to avoid damage or reduced effectiveness.

However, numerous opportunities are on the horizon. Government initiatives such as the Production Linked Incentive (PLI) scheme for Specialty Steel are expected to catalyse domestic production. The national infrastructure push under programs like PM Gati Shakti will also expand the use of coated steel in large-scale projects. Export demand, particularly from emerging economies in Africa and Southeast Asia, further strengthens the growth outlook.

Conclusion

The rising prominence of coated steel is not just a trend but a strategic necessity for industries that seek long-lasting performance, regulatory compliance, and visual distinction. As economic and environmental challenges intensify, the demand for materials that can deliver on all fronts is more critical than ever. Coated steel fits that bill—offering unmatched corrosion resistance, durability, sustainability, and aesthetic adaptability.

The road ahead calls for deeper collaboration among policymakers, manufacturers, and end-users to expand adoption, reduce costs, and drive research into next-generation coating technologies. In an era defined by sustainability, resilience, and innovation, coated steel is not merely an alternative—it is the essential choice.

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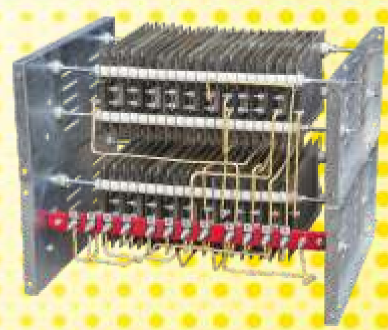

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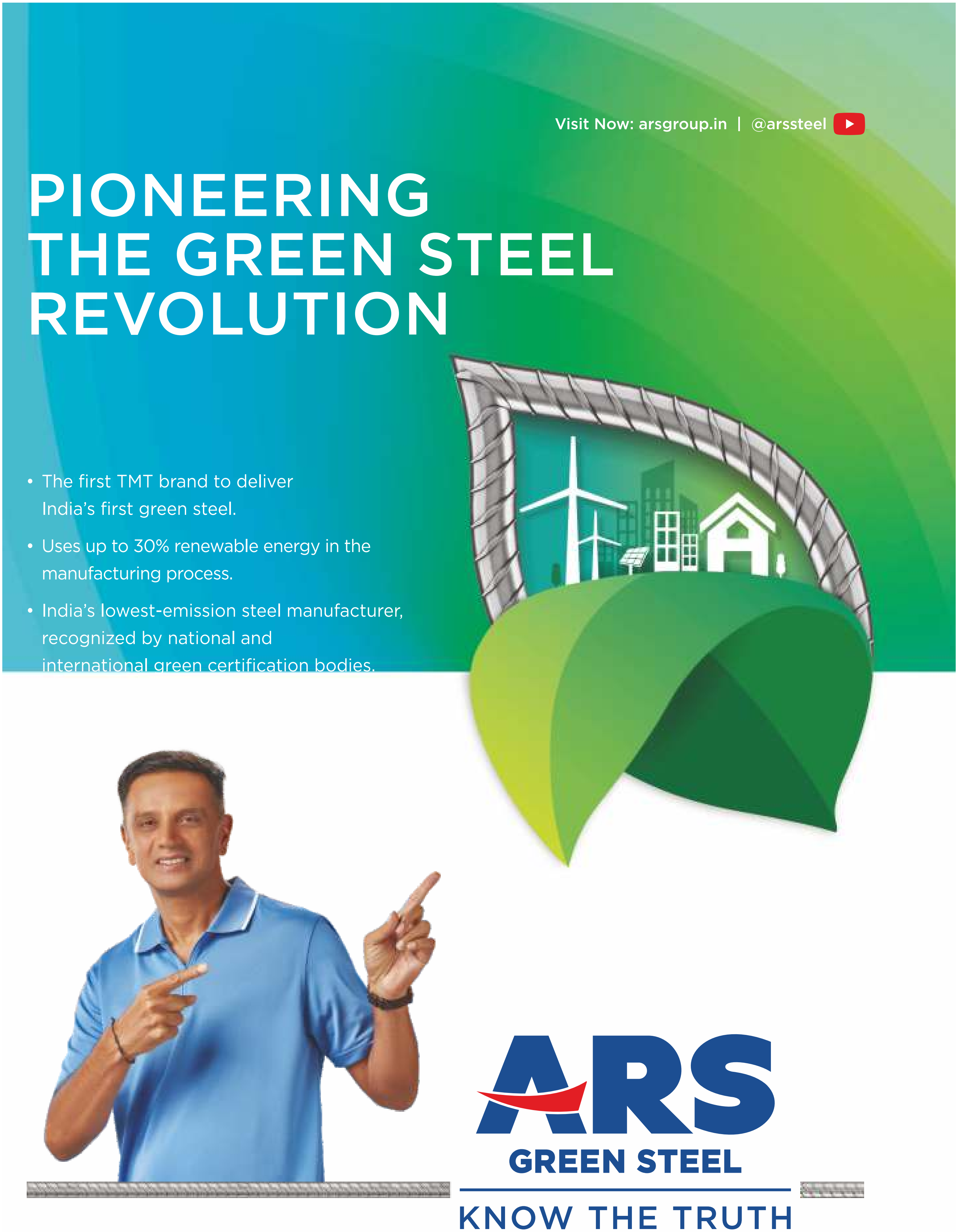
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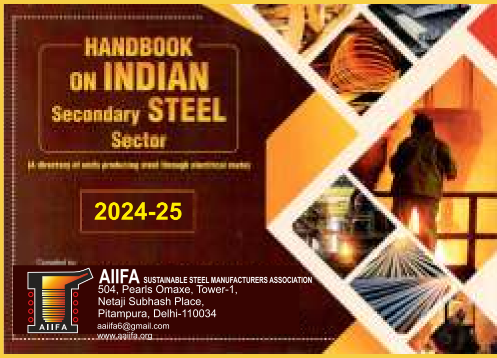

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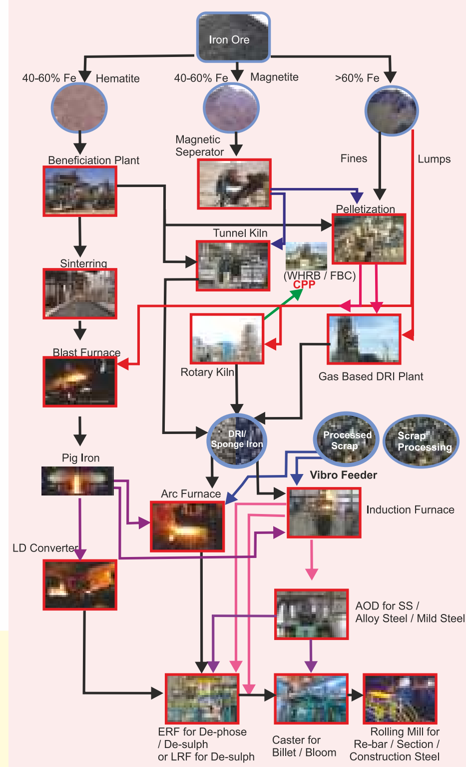

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