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इस्पात मंत्रालय
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INTERNATIONAL CONFERENCE & EXHIBITION ON IRON & STEEL INDUSTRY "ENHANCING EFFICIENCY & SUSTAINABILITY"

(ISIEES - 2025)



SOUVENIR

11th & 12th November, 2025
Ranchi, Jharkhand

Organised by

The Institution of Engineers (India)
Jharkhand State Centre
Under the aegis of
METALLURGICAL & MATERIALS ENGINEERING DIVISION BOARD

In Association With

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Customer may suggest their needs other than above, we will meet their requirements & feel happy to serve your organization.

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  - Chimney
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- **SUGGESTED PRODUCTS:**
  - PROGCAST-TAB94 : 94% Alumina Castable.
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  - EIL Type Insulating Castables.
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    High Purity & Moderate Grade
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SANTOSH KUMAR GANGWAR
GOVERNOR OF JHARKHAND

सत्यमेव जयते

RAJ BHAWAN, RANCHI-834001
JHARKHAND
Phone: 0651-2283465



Message

1 am delighted to learn that The Institution of Engineers (India), Jharkhand State Centre, under the aegis of the Metallurgical & Materials Engineering Division in association with MECON Limited and supported by the Ministry of Steel is organizing an International Conference on the Iron & Steel Industry on the theme "Enhancing Efficiency & Sustainability" on 11 and 12th November, 2025 at Ranchi.

The timing and theme of the conference are indeed very relevant in the present scenario, as the steel industry in our country is poised for rapid growth, driven by the increasing demand for steel in construction, infrastructure, automotive manufacturing, and white goods.

India's steel sector stands as a cornerstone of our nation's economic growth and industrial development. As the world's second-largest producer of crude steel, the industry not only contributes significantly to our GDP but also supports livelihoods for millions across the country.

At the same time, the Indian steel sector faces challenges such as the availability of quality raw materials, environmental concerns, higher operational costs, export-related constraints, and rising imports at competitive prices. Addressing these challenges is essential for aligning this vital sector with India's global climate commitments and sustainable development goals.

I am confident that this International Conference will deliberate upon effective strategies for transforming the steel industry into a more efficient, sustainable, and low-carbon sector. I am sure it will offer constructive insights that will help in achieving India's climate objectives while ensuring that the steel industry continues to remain a strong pillar of nation's progress.

I convey my greetings to the organizers and participants and wish the International Conference a grand success.

(Santosh Kumar Gangwar)

एच. डी. कुमारस्वामी
H. D. Kumaraswamy

सत्यमेव जयते

मंत्री
भारी उद्योग एवं इस्पात मंत्रालय
भारत सरकार, नई दिल्ली
Minister of
Heavy Industries and Steel
Government of India, New Delhi

MESSAGE

I am pleased to learn that an International Conference on Enhancing Efficiency and Sustainability of the Iron & Steel Industry is being organised at Ranchi by The Institution of Engineers (India) in association with MECON Limited, with the support of the Ministry of Steel.

The iron and steel industry holds strategic importance for the economic development of every nation. In India, the sector contributes substantially to the national GDP and plays a vital role in advancing industrialisation, infrastructure creation, and overall economic progress. In keeping with these objectives, India has set an ambitious target to achieve self-sufficiency in select categories of specialty steel by 2030–31.

Recognising that steelmaking is an energy-intensive and environmentally sensitive process, the country is taking concerted measures to lower the sector's carbon footprint. As steelmaking and related mining activities are closely associated with occupational safety and health issues, India remains firmly committed to achieving global standards in industrial safety and sustainability.

Against this backdrop, I am glad to note that the Conference in Ranchi will deliberate on enhancing efficiency and sustainability across the steelmaking value chain, while fostering greater collaboration between major producers and downstream small-scale industries — a goal that is both timely and relevant.

I extend my best wishes to all the participants and organisers of the Conference and look forward to its meaningful deliberations and fruitful outcomes.

(H. D. Kumaraswamy

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Ministry of Heavy Industries : Room No. 176, 'E' Wing, 1st Floor, Udyog Bhawan, New Delhi-110011, Tel. : +91-11-23061782, Fax : +91-11-23062552

भूपतिराजु श्रीनिवास वर्मा (बी.जे.पी. वर्मा)
భూపతిరాజు శ్రీనివాసవర్మ (బి.జె.పి. వర్మ)
BHUPATHIRAJU SRINIVASA VARMA (B.J.P. VARMA)

सत्यमेव जयते

इस्पात एवं
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भारत सरकार
उद्योग भवन, नई दिल्ली–110011
MINISTER OF STATE FOR STEEL
AND HEAVY INDUSTRIES
GOVERNMENT OF INDIA
UDYOG BHAWAN, NEW DELHI-110011



MESSAGE

I am delighted to convey my heartfelt greetings and best wishes to the organizers, participants and distinguished delegates attending the **International Conference on Enhancing the Efficiency & Sustainability of Iron and Steel Industry to be held on 11th-12th November, 2025 at MECON, Ranchi**.

The timing of this conference is significant, as we are currently navigating geopolitical shocks, a shifting global order, the redrawing of global trade maps, rising protectionism, trade barriers and tariffs, concerns related to climate change & sustainability and evolving customer needs, among other challenges. These uncertainties are impacting the Indian Iron and Steel sector, as well as the global Steel industry.

I am pleased to note that the conference provides an opportunity for the Indian Steel industry to reassess and review its goals, including building capacity & increasing capacity utilization, achieving self-sufficiency in high-value products, reducing import dependence on coking coal, ensuring best-in-class industrial safety and health practices, enhancing environmental sustainability and approaching global benchmarks in efficiency. I am confident that the conference's deliberations will yield actionable outcomes, valuable policy insights and address the key concerns of the industry.

I wish the conference grand success.

(Bhupathiraju Srinivasa Varma)

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Camp Office : Narasayya Agraharam Bhimavaram, Andhra Pradesh- 534201 • Tel. : +91-97010 53445

Hemant Soren
Chief Minister



MESSAGE

It is a pleasure to announce that The Institution of Engineers (India), Jharkhand State Centre, with support from MECON Limited and the Ministry of Steel, is organizing an International Conference on Iron & Steel Industry: "Enhancing Efficiency & Sustainability," on 11th & 12th November 2025 at Ranchi.

Jharkhand plays a crucial role in India's steel sector, contributing from raw material production to finished products. The steel industry is a backbone of national industrial strength, driving economic development and global trade. As the world's third-largest steel consumer, India's demand is propelled by infrastructure, construction, and manufacturing.

While challenges exist, numerous opportunities are present. Innovation and collaboration are key for India's steel sector to become a major global force, with efficient, sustainable practices aligned to long-term climate goals.

The conference's timing and themes are especially relevant today. I wish the event great success and convey my best wishes to all participants and organizers.

(Hemant Soren)



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अध्यक्ष एवं प्रबंध निदेशक

SANJAY KUMAR VERMA
Chairman and Managing Director

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स्वच्छ भारत
एक कदम स्वच्छता की ओर

MESSAGE



We are privileged to organise an International Conference on " Enhancing Efficiency and Sustainability in the Iron and Steel Industry" along with The Institution of Engineers (Jharkhand State Centre) and with support of the Ministry of Steel.

This Conference comes at a momentous time-againstthe backdrop of global uncertainties, tariff-battles, raging wars in supply-chain routes, rising steel production costs, affordability pressures of consumers, environmental concerns associated with steelmaking, and so on. These challenges also offer opportunities for steel manufacturers to improve efficiencies, ramp-up productivities, leverage the benefits of digitalisation , and so on.

MECON Limited has played its role all along the journey of growth and maturity of the Indian steel-sector- as consultants, as repositories of knowledge and excellence in engineering, project-management consultants, as EPC contractors, and as partners in operation & maintenance activities. Looking forward, the organisation is committed to remain a key-contributor as India progresses towards its objectives for 2030-31 and beyond towards' Atmanirbhar' (Self-Reliance) in key-resources, and towards ' Vision-2047' of a 'Viksit Bharat ' (Developed India).

I am sure that this Conference will provide an excellent opportunity for large producers and MSMEs alike to collaborate, exchange knowledge, and drive the transformation towards a future that balances growth with environmental responsibility, improving operational efficiency and embracing sustainable practices aligning with national goals.

With Warm Regards,

Your Sincerely

06/11/2025

SANJAY KUMAR VERMA

The Institution of Engineers (India)

AN ISO 9001 : 2015 CERTIFIED ORGANISATION
(ESTABLISHED 1920, INCORPORATED BY ROYAL CHARTER 1935)

Er.V B Singh , FIE
President



Headquarters : 8 Gokhale Road, Kolkata 700020
Contact : 91- 33-40106202 / 40106204
E-mail : president@ieindia.org

A Century of Service to the Nation

MESSAGE

I am pleased to learn that the Jharkhand State Centre of the Institution of Engineers (India) is organizing All India Seminar on Iron & Steel Industry – —Enhancing Efficiency & Sustainability during 11-12 November 2025 in association with MECON Limited and with the support of Ministry of Steel, Govt of India under the aegis of Metallurgical & Materials Engineering Division Board.

The iron and steel industry is the backbone of modern development, used in every walk of life – from our day-to-day appliances to advanced structural applications in modern society. India is the second largest crude steel producer in the world. However, this vital industry is also a significant contributor to global emissions. Recognizing this duality, we have embarked on a crucial journey towards sustainability. Today, as global challenges evolve, our focus must go beyond production and profit. It's about creating value responsibly.

Balancing the need for continued growth in the steel sector, by enhancing efficiency and sustainability, we strive to produce more with less — reducing energy consumption, minimizing waste, and lowering carbon emissions through innovation and smart technology. Every improvement in process and practice brings us closer to a future where growth and environmental stewardship coexist in harmony.

I am confident this seminar will offer rich insights from seasoned engineers and academicians, fostering meaningful dialogue and knowledge exchange. My warm greetings to the organizers and participants, with best wishes for its resounding success.

(V B Singh)

4/125, Vishal Khand, Gomti Nagar, Lucknow 226 010, **Mobile**: 8004288301, **E-mail:** vbsingh51@gmail.com

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MUKESH KUMAR
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MESSAGE



I am happy that MECON is hosting an International Conference on 'Enhancing Efficiency and Sustainability in the Iron and Steel Industry ' along with The Institution of Engineers (India), Jharkhand State Chapter.

A look at the global steel scenario over the past decade or so will show that while production and consumption of steel have grown robustly in India- on the back of ready availabi lity of most of the raw materials (notably, except coke), cheap labour availability, and various reforms and incent i ves of the Government, as facilitator- other top producing countries have seen a dip in production.

From the National perspective, steel is one of the countrie's core industries and plays in overall industrial growth. It ranks just behind petroleum refining and electricity in the Government of India's index of Eight Core Industries, making it an important contributor to the Nation's industrial production. The steel sector also supports significant economic activity and provides large scale employment, with an estimated 20 lakhs people engage directly and indirectly across the country.

India also aspires to attain strategic self-sufficiency in steel, especially in high-end value-added steel, to reduce import-dependence on coking-coal, to match-up with global benchmarks in industrial safety and health, to reduce carbon footprint of the industry, and to considerably step-up research & development in the sector by the financial year 2030-31.

I convey my best wishes for the Conference and wish it to be another stepping-stone in India's path to achieving its goals in the iron & steel sector.

(Mukesh Kumar)

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Amit Raj
Director (Technical)

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वेबसाइट / Website : http://www.meconlimited.co.in

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MESSAGE



It gives me great pleasure that The Institution of Engineers (India), Jharkhand State Centre, under the aegis of the Metallurgical & Materials Engineering Division, in association with MECON Limited and supported by the Ministry of Steel, is organising the International Conference on Iron & Steel Industry - "Enhancing Efficiency & Sustainability" on 11th & 12th November, 2025 at Ranchi.

The Indian steel industry holds a unique position - with nearly 50% of production contributed by small and medium enterprises enabling them to cater effectively to diverse domestic consumers. To sustain this momentum, the focus must be on enhancing efficiency in existing plants, alongside capacity expansion.

While efficiency and quality continue to be top priorities, environmental sustainability and carbon reduction have now become central to the industry's long-term vision. Ensuring the availability of high-quality iron ore, addressing rising imports, and improving technological competitiveness are essential for maintaining growth and ensuring future sustainability

This two-day international conference has been conceived to deliberate on tools, technologies, and strategies that will help the sector achieve greater efficiency and sustainability - covering the entire value chain from mining to finished products.

I am confident that the deliberations and outcomes of this conference will pave the way for a more efficient, sustainable, and self-reliant Indian steel industry, further strengthening India's leadership in global steel making.

Amit Raj

AMIT RAJ

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एक कदम स्वच्छता की ओर

जयन्त कुमार झा
निदेशक (वाणिज्यिक)
J. K. Jha
Director (Commercial)

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MESSAGE



I am happy and excited with the International Conference on *'Enhancing Efficiency and Sustainability in the Iron and Steel Industry'*, being held at MECON.

To set the perspective for the · conference: substantial increases in global steelmaking capacity are foreseen over the next few years -the bulk · of it from Asian economies. On the other hand, global demand is expected to be sluggish- with almost certain decline in China and the developed countries offset by growth in the ASEAN and MENA areas. Meanwhile, global steel prices are volatile and currently low. This will result in a decline in plant capacity utilisations, affect margins of steel manufacturers and constrain their appetites to invest in new technologies, such as in decarbonising efforts. Moreover, the excess capacity problem will most likely exacerbate dumping-related issues and retaliatory steel-tariffs by countries obligated to protect their respective steel-industries. However, there may be a generation of demand because of rebuilding of infrastructure in the war affected zones.

On the Indian front, India's crude-steel production capacity, which was 179.5 million tonne (MT) in 2023-24 (provisionally about 200MT in the last financial year), is targeted to grow to 300MT by 2030-31- which will require a compounded annual growth rate of nearly 7o/o. We also direly require to reduce emissions and the carbon footprint of our plants, through improved energy efficiency, switching to non fossil fuels, development and deployment of new 'greener' technologies, and expansion of our carbon capture, utilisation and storage effmis.

I hope the Conference will address these and other urgent issues in the steel sector.

I wish the Conference every success.

(Jayant Kumar Jha)

The Institution of Engineers (India)
Jharkhand State Centre

MESSAGE



All India Seminar on **"Iron & Steel Industry - Enhancing Efficiency Sustainability"** is being organized by the Institution of Engineers (India), Jharkhand State Centre, under the aegis of Metallurgical & Materials Engineering Division Board in association with MECON Limited and supported by Ministry of Steel, GOI on 11th & 12th Novermber 2025.

The two days All India Seminar aims to cover a wide area of the challenges and issues pertaining to steel sector. As we are aware that increase in steel production needs enhancement of efficiency of existing units, quality operations in addition to capacity augmentations.

I am sure that the seminar will be helpful in creating a tangible understanding about the various aspects of Iron & Steel Industry. I also hope that the deliberations on the theme and thereafter recommendation will show a beacon light to the industry.

I with the seminar a grand success.

"Jai Hind"

(Sandeep Kumar Bhagat)
Chairman



प्रद्युम्न कुमार दीक्षित
अध्यक्ष संगठन समिति

PRADUMN KUMAR DIXIT
Chairman Org. Committee

MESSAGE

it is with great pleasure and a sense of shared purpose that we welcome you to the Interpational Conference on Iron & Steel Industry - "Enhancing Efficiency & Sustainability."

The timing of this conference is critical. India's steel sector is experiencing a historic surge, having reached 200 Mt production capacity in FY 2024-25 and sustaining impressive growth led by robust demand in construction, infrastructure, and automotive sectors. This momentum makes the National Steel Policy's vision of 300 Mt capacity by 2030-31 not just an aspiration, but a realistic goal fuelled by the **'Make in India'** initiative.

To realise this ambitious target, we must focus intensely on two strategic pillars that define this conference: Enhancing Efficiency and Achieving Sustainability.

We must dramatically increase production, not only through capacity additions, but also by boosting efficiency in existing plants. Concurrently, environmental concerns, particularly carbon reduction, have taken centre-stage, posing a genuine threat to long-term sustainability. This event is designed to tackle these issues head-on, with focused sessions on:

Enhancing Efficiency: Exploring advanced tools like AI and automation and new steel plant technology advancements to optimise the entire process chain, from mining to the finished product.

Achieving **Sustainability:** Driving the transition through strategies for decarbonisation in existing plants, implementing new technologies for Carbon Reduction, and seriously exploring Hydrogen Usage in the steel sector.

A vital part of our programme is the unique session, "Synergy for Atmanirbharta." Recognising that approximately 50% of the country's production comes from small and medium players, it is crucial to address the rising import of steel products. This session is designed to forge a powerful domestic alliance, bringing together major players and SSIs to establish a supportive ecosystem. This synergy is essential to ensure quality input materials for SSIs and a widened domestic market for primary producers, directly strengthening the nation's self-reliance.

We are confident that the next two days of focused discussions will generate actionable insights and collaborative pathways. We are also pleased to offer extended advisory services to SSTs on expansion projects and government schemes, underscoring our commitment to the growth of the entire ecosystem.

Thank you for being part of this essential dialogue. Your expertise and commitment are key to shaping a more efficient, sustainable, and Atmanirbhar future for the Indian Iron and Steel Industry.

प्रद्युम्न दीक्षित

(PRADUMN KUMAR DIXIT)



NISHEETH KUMAR
Senior General Manager (RM), MECON Ltd. &
OrganisingCo-Chairman

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FOREWORD

It is proud privilege to organizeinternational conference on enhancing efficiency and sustainability of the Iron & Steel industry at Ranchi by The Institution of Engineers (India) in association with MECON Limited, and supported by the Ministry of Steelon 11th – 12th November2025 at Ranchi.

The iron & steel industry is of strategic importance to any industrial nation. In India, the industry contributes significantly to the GDP, and is central to the country's goals of industrialization, infrastructural development and economic growth. Consequently, India has set itself the ambition to become self-sufficient in some strategically important specialty steels by 2030- 31. Steelmaking is also environmentally sensitive, and hence, the country has embarked on a serious effort to reduce the carbon footprint of the steel industry. Moreover, steelmaking, along with the mining of its raw-materials, is traditionally fraught with safety and health issues – and India is committed to attaining global industrial safety and health standards.

The topic of this Conference has been chosen against this backdrop, The Conference will focus on enhancing efficiency and sustainability across the steelmaking value-chain, and facilitate a better understanding between major players and downstream small-scale industries, which are the need of the hour.

I hope that outcome of the deliberation in this seminar may guide all of us to address these abiding concerns of the Industrythis will foster better understanding amongst different stakeholders.

(NISHEETH KUMAR)



KARMVEER PRATAP SINGH
Assistant General Manager (MW), MECON Ltd. &
Organising Secretary

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FOREWORD

The Steel industry is going through a transition phase across the globe,keeping in with the emerging technologies and the regulations and policies on the carbon footprint besides the uncertainties in supply chain, trade and macroeconomic factors. Despite the constraints and challenges, Indian steel sector is bolstered by the sustainable domestic demand for foreseeable future. At the same time challenges of raw material security, need of technology breakthrough for coal based DRI and decision to be taken for adopting gas based DRI-EAF route are few risk factors to be assessed for investment decisions.

Government of India is putting up every effort to support and sustain the Steel industry.Schemes such as Production Linked Incentive Scheme (PLI) are a testament to this. This conference also has its roots from continued efforts from Ministry of Steel in promoting decarbonization, adoption of AI, and efficiency in steel production besides focus on self-reliance. I am sure participants will find the theme of conference in similar lines.

Further, there is need to create synergy between the large, medium and small steel players to counter variety of threats from assured supply of input steel to deterrence from global turmoil. I hope the discussions going to be held at the international conference and exhibition ISIEES-2025 will help to pave the way and shall be taken forward in a collaborative way bythe industry.

Karmveer.

(KARMVEER PRATAP SINGH)

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Adoption of Artificial Intelligence in Iron & Steel Industry

Sl.	Topic	Author
1.	From Data to Benefit - Preconditions and Boundaries for the Application of AI in Steel Production	Anup Kumar Kedia
2.	AI Ethics and Governance in Public Sector	P. K. Dubey & Manish Kumar
3.	AI Enabled Cloud Data Centres - Driving Intelligent Operations in the Iron & Steel Industry	(Ms.) S. Selvi
4.	Transforming Blast Furnace Stock-house Operations through AI-based Predictive Material Modelling	Abhinav Bisen

Advance Automation in Beneficiation, Agglomeration, Iron & Steel Sector

Sl.	Topic	Author
5.	Fully Automated Iron-ore Sampling System	Abhinav Bisen
6.	Automation in Mining	Deendayal
7.	Accelerating Iron & Steel Production Efficiency Quality Assurance & Sustainability with Thermo Fisher Analytical Solution	Abhijit Sen

Enhancing Efficiency though Technological Advancements in Raw Material to Ironmaking

Sl.	Topic	Author
8.	Loesche Mills for Pulverised Coal Injection, LD Slag / Steel Slag Processing and Dry Iron-ore Grinding	Rajesh Khanna
9.	Innovative Approaches for Enhancing Productivity and Sustainability of Pelletising Process at JSW BPSL	Shyam Sundar Yadav, Arbind Akela, Sanjay Kumar, Prakash G., Prakash Sappa Umesh Rai

10.	Enhancing Material Quality through Sustainable Utilisation of Solid Wastes in Steel & Mining Industries	Manish Madhav, Praveen Kumar, Praksh Sudhir, Mahadeo Roy
11.	Driving Sustainable Beneficiation: Unlocking coal & Iron-ore to Power the Future of Iron & Steel Industry	Tim Sheehan Subhasis Das, M. Gupta, Subhrangshu Mukherjee, M. Tuchscherer P. Mesquita

Enhancing Efficiency though Technological Advancements in Steelmaking to Shaping andFinishing of Steel

Sl.	Topic	Author
12.	Driving Yield, Efficiency and Profitability through Advanced AGC, Real-time Reporting, and AI-driven Insights	Nivit Gill
13.	DanieliQuall-HSM: The Next Gen. HSM Process	Antonio Comelli, Giacomo Franzil, Marco Petronio, Santanu Rudra
14.	Achieving Sustainability through State-of-art Technologies in Tundish	Rajesh B. Mukhekar Soumya Bhattacharjee Murali Sabhapathy, Akash Sharma Andrea Gianni
15.	Exploring the Future of EAF Melting and Casting	Hirannyad Dutta

Sustainability through Reduction in Carbon Emission and Carbon Capture, Utilisation & Storage

Sl.	Topic	Author
16.	Dry Gas Cleaning Technology in Oxygen Steelmaking process: A Green future	Sanjit Biswas
17.	From Carbon Capture to Carbon Credit	Harsh Choudhry

Exploring Options through Hydrogen and Other Possibilities

Sl.	Topic	Author
18.	Sustainability through Synergistic Integration of Steel Sub-Structures and FRP Super-structures	Prof.Bankim ChandraRay
19.	Circulating Fluidised Bed (CFB) Gasification: Paving the Way for Green Steel	Varun Jindal
20.	Waste to Wealth – A Better Resilient World	Anil Passary
21.	Biochar in coke making: A sustainable approach to minimize CO2 emissions by partially replacing fossil coal with a carbon-neutral alternative.	Sachchit Majhi, Pratik Swarup Dash

Sustainability through Quality

Sl.	Topic	Author
22.	Improving Reliability of Inclined Conveyor Systems: Improvements on Conveyor BC-245 at Rourkela Steel Plant	Ujjal Kumar Mondal
23.	High Volume Production of Quality Rebar using Induction Furnace Ecosystem	Nikunj Kabra
24.	Waste to Wealth Mission to Strengthening the Steel Industry	Uttam Chand Mehta, Tusar Tushar U. Mehta, Dr. Anil Kumar Chaturvedi
25.	APC solutions for steel plants	Amit Chandra

Other Papers

Sl.	Topic	Author
26.	Over-engineered but Under-utilised: The Paradox of Automation in Indian Steel Plants	Ishan Gupta, B.M SenGupta
27.	Potential of Dry & Wet Technologies to Enhance Efficiency & Sustainability for Iron & Steel Industry Value-chain	Subhrangshu Mukherjee, Subhasis Das, Tim Sheehan
28.	Danieli's QSP-DUE: Unlimited freedom for green HRC production	Alessandro Pigani, Er. Riccardo Conte, Shantanu Rudra
29.	Commerce & Steel Industry: The Foundation of a Self-reliant India	Debasish Bose

ABOUT THE INSTITUTION OF ENGINEERS (INDIA)

The Institution of Engineers (India) or IEI is the largest multidisciplinary professional body that encompasses 15 engineering disciplines and gives engineers a global platform for sharing professional interest. IEI has membership strength of above 0.2 million. Established in 1920, with its headquarter at 8 Gokhale Road, Kolkata-700020, IEI has served the engineering fraternity close to a century. During this period of time, IEI has been inextricably linked with the history of modern-day engineering.

In 1935, IEI was incorporated by Royal Charter and remains the only professional body in India which has been accorded this honour. Today, its quest for professional excellence has given it a place of pride in almost every prestigious and relevant organization across the globe. It provides a vast array of technical, professional and supporting services to the Government, Industries, Academia and the Engineering fraternity, operating through its 124 Centres located across the country and 6 overseas chapters. Besides, IEI has bilateral agreements with about 31 international bodies and membership of another 8 international bodies of the developed nations across the globe.

Being recognized as a Scientific and Research Organisation (SIRO) by the Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India, IEI promotes the cause of research and development by providing Grant-in-Aid support to undergraduate, post graduate students and PhD Research Scholars of Engineering Institutions and Universities.

IEI holds the International Professional Engineers (IntPE) Register for India under the global International Professional Engineers Alliance (IntPEA). The institution also awards the Professional Engineers (PE) Certification.

IEI in collaboration with Springer regularly publishes peer-reviewed international journal in five series, namely, Series A, Series B, Series C, Series D and Series E covering fifteen engineering disciplines.

ABOUT IEI JHARKHAND STATE CENTER

The Ranchi Sub-Centre of the Institution of Engineers (India) was founded on 23rd July 1961 and over the years, the sub-centre was upgraded to Local Centre on 5th August 1983 and elevated to State Centre on 30th March 2001 after the creation of Jharkhand State. This centre was always striven to increase its various activities so as to cater fully the needs of the engineering fraternity at Ranchi. This centre has been actively engaged in articulating various technical matters, and on the engineer's role in society and as managers. In addition to various technical activities, this centre has been actively associated in organizing cultural programmes by the wives of the members (EWA) to inculcate bond among members and their families. All Statutory Days such as Engineers Day, World Water Day, World Telecommunication and Information Society Day, World Environment Day, etc. are celebrated every year with family members.

From a little hut to a campus with a three storied building, two conference halls, each capable of seating 100 people, office, library, guest house, auditorium for 300 people, 3 classrooms for continuous education has been an impressive journey.All the classrooms are equipped with large display TVs for digital classes. There are battery bank for solar panel, roof top solar panel, gents & ladies toilet & Bio-mas collection pit also.This has been possible only due to the dedicated contributions of esteemed members, State Government, Public Sector Undertakings and Private Sector Organisations.

Jharkhand State Centre has been designated as 'A' category centre by The Institution of Engineers (India) with around 6000 corporate members and 7500 student members. This centre has been adjudged as 'Best Centre' for All Round Performance in the years 2007-08,2008-09, 2010-11, 2015-16,2016-17 and 2017-18 by The Institution of Engineers (India). Jharkhand State Centre has received All India Best Technician Chapter Award for last four year in a row i.e. 2016-17,2017-18,2018-19 and2019-20.

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THE INSTITUTION OF ENGINEERS (INDIA)

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MECON LIMITED, a Public Sector Undertaking, under Ministry of Steel, Government of India, is India's frontline Design, Engineering, Consultancy & Contracting Organisation.

MECON, having Pan India presence, is an ISO 9001:2015 accredited, multi-disciplinary organisation offering full range of services required for setting up of Greenfield and Brownfield Projects from Concept to Commissioning including Turnkey Execution.

MECON is known for its deep domain knowledge of Iron & Steel Industry and has evolved & restructured itself, over the years, into 3 verticals - Metals, Energy (Power and Oil &Gas) and Infrastructure - to effectively deliver customized services to Clients. In its over six decades of operation, MECON with a workforce of 1000+ graduate engineers and professionals has done over 3500 Consultancy and EPC/Turnkey Projects for clients in India & Abroad.

Scope of Services of MECON includes providing Design & Engineering, Consultancy & Project Management Services, Erection-Procurement-Commissioning (EPC) Execution, EPCM / EPMC Services, O&M Services, Transaction Advisory Services and other Value Added Services, in the areas of Metals, Mining, Energy, Infrastructure and other Strategic Sectors.

MECON has played a pivotal role in development and expansion of Indian Iron & Steel industry and has also successfully done EPC execution of projects in the areas of Coke Oven Batteries & By–product Plants, Blast Furnaces, Steel Melting Shops, Rolling Mills, Ports & Material Handling facilities and Special Projects. In Power and Oil & Gas Industry, MECON is contributing in a big way towards providing services from Concept to Commissioning of Captive/Utility Power Plants and also towards making available Clean & Green Energy through CGD & LDPL Projects. In Oil & Gas sector, MECON has emerged strongly as an Engineering & Project Management Consultant in the Mid-stream and Down-stream segments. MECON is also contributing significantly in Infrastructure Projects.

Internationally, MECON has made its presence felt by providing quality Design, Engineering & Consultancy Services for many Projects / Clients in different countries such as Australia, Bangladesh, Canada, Europe, Indonesia, Iran, Japan, Middle East, Mauritius, Nepal, Nigeria, Oman, Romania, Singapore, South Africa, Thailand, UAE, USA and Vietnam.

MECON's multi-skilled expertise in about 35 technical disciplines creates the synergy vital for realizing projects in Time, targeting Cost effectiveness and adhering to Quality consideration.

International Conference on Iron & Steel Industry "Enhancing Efficiency and Sustainability"(ISIEES-2025) November 11-12, 2025, at Ranchi

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Program Details

Day -1 (Focus-Efficiency)		Day -2 (Focus-Sustainability)	
Time	**Session**	**Time**	**Session**
9:00 am – 10:00 am	Inauguration	9:00 am – 10:00 am	Session 6: Sustainability through reduction in carbon emission & CCUS
10:00 am - 10:30 am	Exhibition visit	10:00 am – 10:30 am	Sustainability Round table/ Panel discussion
10:30 am – 11:00 am	High Tea	10:30 am – 11:00 am	Tea Break
11:00 am – 12:00 pm	Session 1 : Adoption of Artificial Intelligence in Iron & Steel	11:00 am – 12:00 pm	Session 7 : Exploring options through hydrogen and other possibilities
12:00 am – 1:00 pm	Session 2 : Advance automation in beneficiation, agglomeration and Iron & Steel making	11:00 am – 1:00 pm	Session 8 : Sustainability through Quality
1:00 pm – 2:00 pm	Lunch Break	1:00 pm – 2:00 pm	Valedictory
2:00 pm - 3:15 pm	Session 3 : Enhancing Efficiency though technological advancements in raw material to Ironmaking	2:00 pm – 3:30 pm	Lunch
3:15 pm – 4:15 pm	Session 4 : : Enhancing Efficiency though technological advancements in Steelmaking to Finishing of steel products	Advisory services for Secondary Steel Industry	
4:15 pm – 4:30 pm	Tea Break	3:30 pm – 4:30 pm	Presentation on Scheme of Ministry of Steel for Secondary Steel Industry
4:30 pm – 5:30 pm	Session 5 : Creating Synergy through Atmanirbharta – SSI perspective	4:30 pm – 5:30 pm	Open session for Interaction with experts from MECON for advisory on greenfield/ brownfield expansion projects
7:00 pm onwards	Dinner & Cultural Program		

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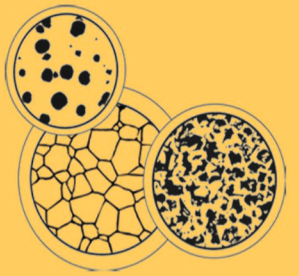

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(Lower Sileru, APGENCO)



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SESSION

"ADOPTION OF ARTIFICIAL INTELLIGENCE IN IRON & STEEL INDUSTRY"

FROM DATA TO BENEFIT - PRECONDITIONS AND BOUNDARIES FOR THE APPLICATION OF AI IN THE STEEL PRODUCTION

Author
Anup Kumar Kedia

In the ongoing digital transformation of the steel industry, Artificial Intelligence is increasingly integrated into the automation of the production processes. However, the true potential of AI technologies can only be realized if preconditions to data quality are given, and domain expertise is effectively digitized.

This paper explores the application of AI technologies – such as machine learning, deep learning, and expert systems – in areas like predictive maintenance, process control, and defect detection.

A special focus is placed on the unique characteristics of steel production data, including its complexity, heterogeneity, and real-time processing requirements. Additionally, we discuss the importance of capturing and structuring expert knowledge in digital form to enhance AI- driven decision-making and ensure long-term knowledge retention.

By combining high-quality data with digitized know-how, steel manufacturers can achieve tangible benefits such as reduced downtime, improved product quality, enhanced sustainability, and continuous improvement of the production processes along the entire production chain. This paper will highlight best practices for transforming raw data and human expertise into actionable insights, demonstrating how AI can drive measurable benefits in steel production automation.

AI ETHICS AND GOVERNANCE IN PUBLIC SECTOR

Authors

P. K. Dubey(GM IT), Manish Kumar(AM IT)
MECON Limited, Ranchi

Synopsis

This document contains key insights on the ethical governance of Artificial Intelligence (AI). While AI presents transformative opportunities for governance and public service, its deployment consists of significant ethical risks like systemic bias, misinformation, and lack of accountability. Consequently, robust governance frameworks are essential for building public trust and ensuring AI serves citizens unbiasedly.

*The core ethical challenges identified are the propagation of **misinformation and deception** through AI-generated content like hallucinations and deepfakes. The perpetuation of societal inequalities through **algorithmic bias** in high-stakes domains such as hiring, lending, and law enforcement is also a risk. Real-world failures, such as chatbots providing illegal advice and recruitment tools discriminating against women, depict the tangible harms of deploying AI without rigorous safeguards.*

*To mitigate these risks, a multi-layered governance approach is necessary, founded on the principles of **human-centric accountability, transparency, and fairness.** Key strategies include implementing **Explainable AI (XAI)** to make algorithmic decisions interpretable, conducting **fairness audits** to detect and correct bias, and mandating human-in-the-loop supervision for all high-impact decisions. The responsibility for AI outcomes must always rest with human institutions, not the algorithms themselves.*

*The national strategy for AI by NITI Ayog - **"#AIforAll,"** aims to leverage AI for inclusive economic growth and social development. This strategy prioritizes intervention in five key sectors: **Healthcare, Agriculture, Education, Smart Cities, and Smart Mobility.** To build a vibrant domestic AI ecosystem, the strategy outlines critical initiatives focused on bolstering research through **Centres of Research Excellence (COREs) and International Centers for Transformational AI (ICTAIs).** These initiatives enhance workforce skills, and accelerate adoption through proposed platforms like the **National AI Marketplace (NAIM) and the National AI Resource Platform (NAIRP).** Ultimately, the successful deployment of AI in governance depends on ethical leadership that embeds human judgment, empathy, and democratic values at every stage of the technology's lifecycle.*

1. Ethical AI in Governance

Artificial Intelligence is reshaping governance, public service delivery, and citizen interaction. As AI systems become embedded in critical decision-making processes, they bring profound opportunities alongside significant ethical risks. AI Ethics, defined as the principles and practices guiding the development and deployment of AI in ways that uphold human values and constitutional safeguards, is therefore not a secondary concern but a core component of good governance. In a public sector context,

where AI impacts individual rights and public trust, principles of fairness, inclusivity, transparency, and accountability are non-negotiable.

1.1. Core Ethical Risks and Failures in AI Systems

There are numerous real-world incidents where AI systems crossed ethical boundaries, leading to public backlash, legal consequences, and an erosion of trust. These failures are categorized as governance breakdowns, not mere technical glitches.

Misinformation and Deception: AI systems, particularly generative models, can create and spread incorrect, misleading, or fabricated content.This includes factual errors, "hallucinated" citations, harmful suggestions, and malicious deepfakes (AI-generated synthetic media that mimics real people).

Bias and Algorithmic Discrimination: AI bias occurs when an algorithm systematically produces prejudiced results due to flawed data, skewed training, or embedded social inequalities. This is a governance failure that reinforces discrimination.

Lack of Consent and Authorship: AI's ability to replicate human creativity and identity raises critical issues of consent, intellectual property, and legacy.

Opaque and Unaccountable Systems: Failures stemming from an inability to understand, question, or assign responsibility for an AI's decision.

2. Foundational Principles and Strategies for Responsible AI

To counter the identified risks, a set of core principles and actionable strategies must be embedded into AI governance frameworks. These measures aim to build trust, ensure fairness, and maintain human control over technology.

Principle/Strategy	Description	Key Actions
Human-Centric Accountability	The principle that humans and institutions-not algorithms-are ultimately responsible for the outcomes of AI systems.	Establish clear AI governance frameworks with human accountability protocols. Mandate human-in-the-loop (HITL) oversight for all high stakes decisions (e.g. health, welfare, process automation, etc).
Transparency & Explainability	AI systems must be designed to be understandable. Explainable AI (XAI) makes algorithmic decisions interpretable to humans.	Implement XAI to justify outputs, especially in public services. Clearly label all AI-generated content (text, images, audio) to avoid misleading users. Maintain audit trails of AI decision-making.
Fairness & Bias Mitigation	Proactively designing and auditing AI to prevent systematic bias and ensure equal treatment across all demographic groups.	Conduct fairness audits using tools like fairness dashboards to detect and correct biases before deployment. Use high-quality, inclusive, and verified data for training.
Safety, Reliability & Risk Assessment	Ensuring AI systems are robust, secure, and thoroughly tested in real-world contexts before public deployment.	Implement continuous monitoring and regular audits of AI outputs. Evaluate and mitigate risks, especially in sensitive domains. Restrict generative AI in critical areas like legal or health advice unless fully regulated.

Privacy & Informed Consent	Protecting personal data and ensuring individuals grant clear, voluntary agreement for the use of their data, likeness, or voice.	Enforce strong data protection safeguards. Ensure creators or their estates provide informed consent before their style or likeness is replicated.
Ethical Use & Guardrails	Actively preventing the deceptive, manipulative, or malicious use of AI.	Avoid using AI for surveillance or creating deceptive deepfakes. Embed ethical guardrails into prompt design to discourage fabrication or harmful suggestions.

3. India's National Strategy for Artificial Intelligence: #AIforAll

The Government of India, through NITI Aayog, has crafted a national strategy on the vision of #AIforAll, positioning India to leverage AI for inclusive growth, social development, and as a "Garage" for developing scalable solutions for other emerging economies. The strategy acknowledges that a purely commercial approach will not address societal needs and requires government leadership to optimize for social good.

3.1. Priority Sectors for Intervention

NITI Aayog has identified five key sectors for targeted AI intervention to address pressing societal challenges:

1. Healthcare: To increase access and affordability of quality healthcare. AI applications include AI-driven diagnostics (e.g., for diabetic retinopathy), personalized treatment, early identification of pandemics, and analysis of pathology images to support oncologists.
2. Agriculture: To enhance farmers' income, increase farm productivity, and reduce waste. AI can provide real-time advisories on sowing and pest control, predict crop prices, and improve soil health monitoring.
3. Education: To improve access to and quality of education. AI can enable adaptive learning tools for customized instruction, automate administrative tasks, and predict student dropout risks to allow for preemptive intervention.
4. Smart Cities and Infrastructure: To manage rapid urbanization and improve quality of life. AI use cases include intelligent traffic management to reduce congestion, smart utility distribution, AI-driven public service delivery, and enhanced crowd management and public safety.
5. Smart Mobility and Transportation: To create smarter, safer modes of transport. Applications include intelligent transportation systems, travel route optimization, autonomous trucking, and remote condition monitoring for railways to prevent accidents.

3.2. Building a National AI Ecosystem: Key Challenges and Recommendations

The national strategy identifies several barriers to AI adoption in India, including a lack of research expertise, absence of enabling data ecosystems, high resource costs, and unclear regulations. To address these, a multi-pronged approach is recommended.

Bolstering Research

- **Two-Tiered Structure:**
  - Centres of Research Excellence (COREs): To focus on fundamental core research in AI and push technology frontiers.
  - International Centers of Transformational AI (ICTAIs): Industry-led institutions focused on developing and deploying application-based research in priority sectors.
- **Grand Challenges:** Pursue "moonshot research projects" and establish a "CERN for AI," a supranational agency to solve audacious problems.
- **Infrastructure:** Develop a common computing platform, termed AIRAWAT (AI Research, Analytics and knoWledge Assimilation plaTform), to provide pooled cloud and supercomputing infrastructure. Skilling for the AI Age
- **Workforce Reskilling:** Recognize the disruption to the job market and promote the creation of new roles (e.g., data annotation). Incentivize companies to reskill employees and standardize training certifications.
- **Updating Education:** Re-align school and higher education curricula to promote applied skills in STEM. Introduce bridge courses in AI for non-computer science post-graduates to encourage cross-disciplinary innovation.

Accelerating Adoption and Data Availability

- **National AI Resource Platform (NAIRP):** A proposed open data, knowledge, and innovation platform to act as a central repository for publicly shareable data, tools, literature, and best practices. It aims to replicate the success of the National Digital Library of India.
- **National AI Marketplace (NAIM):** A proposed three-pronged formal marketplace focusing on (1) data collection and aggregation, (2) data annotation, and (3) deployable models. This aims to reduce information asymmetry, unlock new data sources, and create a level playing field for startups.
- **Data Quality and Availability:** A core recommendation is to make high-quality, annotated datasets available. This involves standardizing data formats for interoperability, defining clear data management and privacy practices, and ensuring data is unbiased. Government-held data should be opened for public use, and crowdsourcing for annotation should be explored.

4. Ethics, Privacy, and Security Frameworks

A responsible AI strategy requires robust frameworks to address ethical dilemmas, protect privacy, and ensure security.

4.1. Ethical Considerations

- **Fairness and Bias :** The strategy emphasizes that algorithms are not inherently neutral and can reinforce existing societal biases present in data. It calls for proactive identification and reduction of bias.
- **Transparency and "Opening the Black Box":** AI systems must offer "explainability." This is not about technical code disclosure but about providing human-understandable justifications for decisions, a concept advanced by research into Explainable AI (XAI).
- **Accountability:** A consortium of Ethics Councils at each Centre of Excellence is proposed to establish and enforce standard ethical practices. The legal framework should focus on a negligence

test for damages caused by AI, rather than strict liability, encouraging responsible design and monitoring.

4.2. Privacy and Data Protection

- **Legal Framework :** The report highlights the need for a legal data protection framework, referencing the work of the Justice Srikrishna Committee. Key principles include informed consent, data minimization, and controller accountability.
- **Sectoral Regulation:** In addition to a central law, sector-specific regulatory frameworks are recommended for areas like self-driving cars.
- **Privacy-Preserving AI:** Investment in and collaboration on research in technologies like Differential Privacy is encouraged to enable data sharing while protecting individual identities.

4.3. Top Ethical Practices from Government Frameworks

Guidelines from bodies like MeitY, UNICEF, and NITI Aayog converge on the following top practices for ethical AI deployment:

1. **Human-Centric AI:** Ensure AI enhances human dignity and rights.
2. **Safety & Reliability:** Deploy only thoroughly tested and robust systems.
3. **Fairness:** Design AI to prevent bias and ensure equal treatment.
4. **Transparency:** Make AI decisions understandable and explainable.
5. **Privacy:** Protect personal data with strong consent and security.
6. **Accountability:** Establish clear responsibility and redress mechanisms.
7. **Inclusivity:** Make AI accessible and representative of all communities.
8. **Risk Assessment:** Evaluate and mitigate risks before deployment.
9. **Ethical Use:** Avoid deceptive or manipulative use of AI.
10. **Open Collaboration:** Promote cooperation and capacity building for ethical AI.

4. Conclusion

This paper concludes that AI is there for assisting and automating tasks and has immense potential to transform India's public sector by enhancing efficiency, transparency, and decision-making. However, its deployment demands a strong ethical foundation that safeguards human values, privacy, and fairness.

For India's steel and engineering sector, the path forward lies in developing domain-specific, explainable, and human-supervised AI systems that complement human expertise rather than replace it. In adherence to the latter, MECON has developed a domain specific LLM to handle project specific queries using AI Chatbot - MECGPT.

In conclusion, using ethical AI governance and with robust safeguards, transparency, and continuous human accountability, AI can become a trusted partner in advancing both industrial excellence and public good.

"AI-ENABLED CLOUD DATA CENTRE'S: DRIVING INTELLIGENT OPERATIONS IN THE IRON AND STEEL INDUSTRY"



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The convergence of Artificial Intelligence (AI), Machine Learning (ML), and Cloud Computing is revolutionizing industrial operations by enabling real-time intelligence, predictive analytics, and autonomous decision-making. In modern iron and steel industries, massive volumes of data are continuously generated from sensors, process control systems, and industrial equipment. Cloud data centres empowered with AI/ML capabilities serve as the core platform for collecting, processing, and analyzing this data at scale, transforming raw information into actionable insights.

Through AI-based analytics hosted in the cloud, steel plants can perform predictive maintenance of critical assets such as blast furnaces, rolling mills, and conveyors, significantly reducing unplanned downtime. ML algorithms enable process optimization by dynamically adjusting parameters like temperature, pressure, and chemical composition to enhance yield and product quality. Cloud-based AI systems support energy management by analyzing power consumption patterns, identifying wastage, and optimizing load distribution to reduce energy costs and emissions. Additionally, AI-driven digital twins and simulation models hosted on the cloud allow engineers to visualize and fine-tune plant operations remotely, ensuring safer and more efficient production.

The study demonstrates that AI/ML-powered cloud data centers are not just IT enablers but strategic industrial assets that directly enhance efficiency, reliability, and sustainability in the iron and steel sector. By combining scalable cloud infrastructure with intelligent analytics, organizations can achieve end-to-end digital transformation and unlock the full potential of Industry 4.0 in steel manufacturing.

INSMART SYSTEMS INDIA PRIVATE LIMITED

Author
Abhinav Bisen

Transforming Blast Furnace Stock House Operations through AI-Based Predictive Material Modelling

Consistent control of raw material quality is critical for achieving stable and efficient blast furnace and Corex operations. The stock house typically contains multiple silos for iron ore pellets, sinter, limestone, coke, and coal, each periodically replenished to maintain operational continuity. The extracted materials are weighed, blended, and transferred through skip hoists to form the base mix fed into the furnace. Conventional quality control approaches-relying on manual sampling, laboratory testing, and delayed feedback-are inherently reactive and slow, limiting the ability to manage variations in raw material chemistry and size distribution in real time.

This work introduces an AI-driven, physics-informed modelling framework designed to create a continuously evolving three-dimensional (3D) representation of each silo's internal composition. The model integrates real-time analytical inputs with physical characteristics such as particle friction, bulk density, and angle of repose to simulate how successive feed layers settle and interact. Advanced artificial intelligence algorithms then infer the chemical and granulometric distribution throughout the silo, effectively building a digital twin that predicts the composition of material being discharged at any moment.

These AI-based predictions provide actionable insights for dynamic furnace control—enabling proactive adjustments to burden distribution, oxygen enrichment, and fuel rates in response to feed variability. The system continuously refines itself using feedback from robotic laboratory analyses and cross-belt samplers, evolving into a self-learning, adaptive control environment.

By integrating physics-based simulation, AI inference, and automated material characterization, this approach transforms traditional stock house operations into an intelligent, predictive system. The result is tighter process control, improved energy efficiency, and enhanced product quality-representing a significant step toward the fully digitalized, self-optimizing ironmaking plant of the future.

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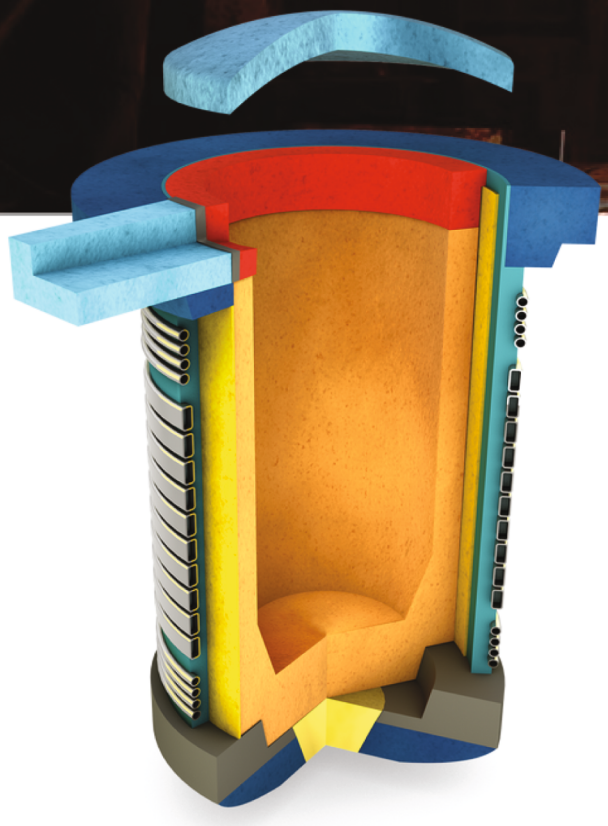

Market Segments

Iron and Steel | Foundry | Cement | Aluminium

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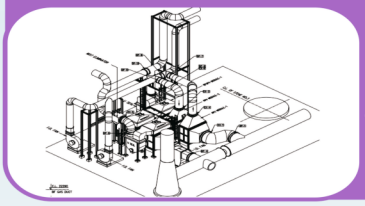
MECON – MOVING TOWARDS DE-CARBONISATION AND GREENER PRODUCTION OF IRON

WASTE HEAT RECOVERY IN STOVES

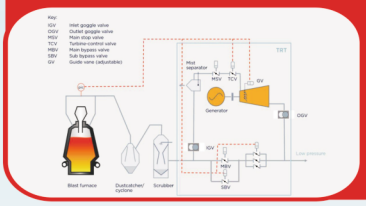


BF Gas & Combustion Air Temp can reach up-to 220°C

Indirect Saving of Carbon in BF Process

- Uses thermal energy of waste heat from stoves.
- Heats up BF gas & Combustion air.
- Increases the Stoves efficiency by achieving high flame temperature.

TOP RECOVERY TURBINE



Typical 4000 m3 Blast Furnace can produce approx. 16-18 MW Power

Indirect Saving of Carbon in BF Process

- Uses Blast Furnace Top Pressure to generate power.
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HOT BLAST STOVES WITH MUSHROOM DOME



INCREASE IN HBT BY 50°C

LOWERS COKE RATE BY 5KG/THM

- Higher dome surface area – Results in reaching high Dome Temperature.
- Upto - 1250 deg C Hot Blast Temperature.

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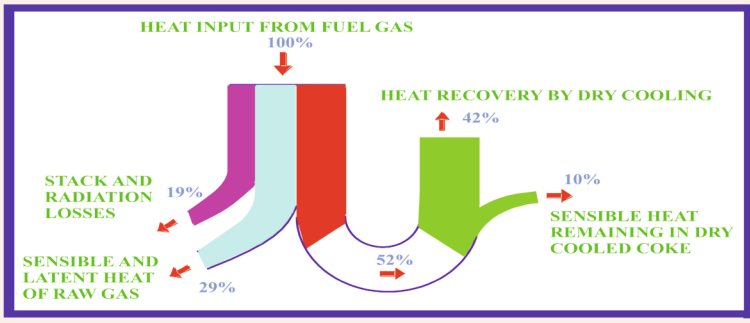

COST ANALYSIS

PAY BACK PERIOD:
3.5 YEARS
LOW MAINTENANCE COST:
(1.5% OF CAPITAL COST)

- POLLUTION CONTROL i.e NO WET QUENCHING EMISSION
- IMPROVED COKE QUALITY i.e M10 BY 2 POINTS
- STEAM GENERATION - 0.48 t/t OF COKE
- POWER GENERATION - 4-5 MW

WASTE HEAT RECOVERY SYSTEM FOR SINTER COOLER

- Sinter from sinter machine to cooler has temperature of about 7000 deg C, cools down to 1000°C in sinter cooler. Sensible Heat of Hot Sinter is normally lost to the environment.
- Installation of Waste Heat Recovery System could recover 45% of Sensible Heat from off-gas of Sinter Cooler & utilize for generation of Steam and Power without burning any fuel.
- 8 to 10 MW Electrical Power can be generated from 312 m2 Sinter Plant and 4 to 7 MW from 204 m2 Sinter Plant.

OTHER DEVELOPMENT FOR DECARBONISING IN SINTER PLANT

- EOS facilitates to re-circulate partial hot waste gas through sinter machine bed which results in decreased solid fuel consumption (10-20%) by utilization of CO in recirculated sinter waste gas.
- Gaseous fuel injection in Sinter Bed at JFE Steel resulting decrease in coke consumption by 4% with improvement in shatter index , RI & RDI. Injection of COG in sinter bed in under experimental stage in JSW , Vijaynagar.
- Mix pre-heating in balling drum by steam injection of COG burner installation reduced coke consumption.

Indirect Saving of Carbon due to energy efficient process

SESSION

"ADVANCE AUTOMATION IN BENEFICIATION, AGGLOMERATION, IRON & STEEL SECTOR"

INSMART SYSTEMS INDIA PRIVATE LIMITED

Author
Abhinav Bisen

1) FULLY AUTOMATED IRON ORE SAMPLING SYSTEM

Insmart Systems offers a state-of-the-art, fully automated iron ore sampling and laboratory preparation system designed for mining, beneficiation, and dispatch plants. The solution eliminates manual handling, ensures sample integrity, and delivers precise, traceable, and contamination-free analytical results in full compliance with international sampling standards.

The system automatically collects a 100 kg ore sample for every 200 tons of material dispatched. For bulk storage racks, a 1,200 kg composite sample is generated for every 4,400 tons of ore. Sampling is carried out through an end-of-belt automated sampler, where multiple increments are extracted from the moving conveyor and combined into a sealed composite sample box, labeled with a unique sample ID.

All sample boxes are transported to a centralized laboratory where they are received, tracked, and authenticated via barcode or RFID. A robotic handling system then manages the complete sample workflow: drying, primary crushing, automated rotary sample division, and pulverizing. From the divided material, a 500-gram representative sample is retained, out of which three 100-gram portions are prepared—one for internal analysis, one for the customer, and one archived as a reference sample.

The system is fully automated from sampling to reporting, offering real-time traceability, digital process logging, and seamless data transfer to SAP/ERP platforms. In the lab, the final pulverized sample is used for LOI, elemental composition, and moisture analysis, ensuring dependable ore quality assessment with minimal human intervention.

This advanced solution significantly enhances sampling accuracy, throughput, and operational efficiency while reducing manpower dependency and eliminating tampering risks. It enables steel and mining organizations to achieve higher quality assurance standards and consistent furnace-grade ore supply.

Project Success in Progress :

Automated sampling and quality control systems are currently under implementation at NMDC's Kirandul and Bacheli projects in Chhattisgarh and the Donimalai plant in Karnataka

2) AUTOMATION IN COAL SAMPLING PROCESS

Accurate and traceable characterization of incoming coal is vital for power plants, steel plants, and industrial boilers, as it directly impacts combustion efficiency, contract settlement, and environmental compliance. Traditional manual sampling introduces variability, safety risks, and non-representative results. To overcome these limitations, Insmart Systems has developed an integrated, fully automated coal sampling, preparation, and analysis solution designed for high-volume coal receipt operations.

The system supports coal delivered by road or rail and is capable of handling up to 150 trucks or wagons per day. Automated auger or belt-type samplers extract primary increments, which are accumulated and grouped into composite sample buckets. Up to 60 composite samples can be processed in parallel, each sealed with tamper-proof locking and digitally registered to maintain a complete chain-

of-custody from source to test result.

Once registered, samples enter a fully automated preparation line that performs drying, crushing, sample division, and sub-sampling without human intervention. The final prepared sample is transferred to automated analysers forSurface &Total Moisture,Gross &Net Calorific Value,Thermogravimetric Analysis(TGA),Ash,VM,FC.

All analytical results are time-stamped, digitally logged, and visualized through an operator HMI showing numerical values along with thermal and mass-loss profiles, enabling real-time decision-making and quality validation.

Key Benefits

Zero manual handling → eliminates safety exposure & operator bias

Guaranteed representativeness → standard-compliant coal sampling

End-to-end traceability → sealed samples, barcode/RFID tracking, digital audit trail

Rapid sample-to-result turnaround → supports faster contract and furnace decisions

Regulatory & commercial compliance → defensible results for buyers & suppliers.

This system transforms coal quality control from a labour-intensive process into a fully automated, data-driven workflow, significantly improving reliability, throughput, and analytical confidence for large supply chains.

This automated coal sampling and analysis solution has already been successfully commissioned and is in live operation at MB Power, Madhya Pradesh.

3) AUTOMATION IN FERRO ALLOY SAMPLING ANDPREPARATION

Ferro alloys such as FeSi, FeMn, SiMn, FeCr, and FeMo are critical additives in steelmaking, directly influencing final chemistry and furnace efficiency. Traditionally sampling and preparation of ferro alloys are manual, labour-intensive, and prone to operator bias, poor representativeness, and safety risks. To overcome these challenges, Insmart Systems offers a fully automated ferro alloy sampling and preparation solution designed for high-throughput steel plant operations.

Ferro alloys are received in 1-ton jumbo bags, typically 30 tons per truck. The system selects three bags per truck for analysis, ensuring statistical representation. Each bag is processed through an automated sampling unit that extracts:

- 150 kg for size fraction (granulometry) evaluation
- 10 kg for chemical analysis

Across three bags, this yields 450 kg for size distribution and 30 kg for chemical testing, providing a true representation of the full 30-ton consignment.

The 30 kg chemical sample undergoes automated primary crushing and size reduction, followed by rotary sample division to produce a 150-gram laboratory-ready representative sample. The final sample is automatically bottled, sealed, and barcode-labeled to maintain traceability and eliminate handling errors. Three identical preserved sets are generated:Plant laboratory analysis,Refree sample,Supplier reference sample.

System Advantages

- Zero manual handling → improves operator safety and compliance
- Repeatable & bias-free sampling → supports ISO & BIS quality standards.

- Single-operator control → reduced manpower requirement and faster turnaround
- Full traceability → automatic ID assignment, data logging & batch history
- Higher throughput → enables faster truck clearance and furnace charging decisions
- Quick ROI → reduced rejection losses, improved procurement transparency

This solution enables steel plants to achieve consistent, defensible, and data-driven ferro alloy quality certification, eliminating the variability and delays of manual sampling.

The automated ferro alloy sampling and preparation system is successfully commissioned and running at Rourkela Steel Plant (SAIL)

4) QUALITY CONTROL SYSTEMS IN CEMENT PLANTS

Modern cement manufacturing demands precise, real-time quality control to maintain clinker chemistry, reduce variability, and ensure product consistency. Manual sampling and testing introduce delays, human error, safety risks, and non-traceable variations. To overcome these challenges, Insmart Systems provides a fully automated, robot-assisted quality control solution that eliminates manual intervention across the entire sampling–preparation–analysis workflow.

The integrated system operates in two major zones:

1. Automated Sample Transportation – pneumatic tube conveyor or bucket-based system transfers samples directly from the production line (raw mill, kiln feed, clinker, cement silos) to the central laboratory without human contact.
2. Automated Sample Preparation & Analysis – industrial robots handle sample receipt, drying, crushing, dosing, pelletizing, and instrument feeding, ensuring standardized and repeatable preparation for XRF, XRD, and other laboratory instruments.

By removing operator dependency, the system delivers up to 99.99% sampling and preparation accuracy with 100% equipment availability, enabling true process transparency and auditability. Automated closed-loop control allows real-time lime correction and process adjustments, reducing standard deviation and stabilizing plant performance.

All analytical data is collected in a unified software platform that offers :

- Centralized monitoring and traceability
- Live dashboards for kiln, mill, and product chemistry
- Automatic alarm triggers and statistical process control
- Instant corrective feedback to plant DCS/PLC

Key Advantages

- Zero human handling → zero contamination, zero bias
- Guaranteed repeatability and traceable sample history
- Reduced QC response time → faster corrective action in clinker & cement production
- Enhanced safety → eliminates exposure to dust, heat, and rotating machinery
- Higher plant uptime and fuel efficiency through stable chemistry control

This robotic automation transforms cement quality control into a high-efficiency, high-accuracy,

Industry 4.0-ready process, driving productivity, cost savings, and safety excellence.

Systems Installed & Operating at:

- Dalmia Cement, Umrangshu (Assam)
- JK Cement, Panna (Madhya Pradesh)
- UltraTech Cement, Tadipatri (Andhra Pradesh)

5) SMART CONTAINERISED LAB FOR FULLY AUTOMATED METAL SAMPLE PREPARATION & ANALYSIS

The Smart Containerised Lab is a fully automated system designed for rapid, precise, and contamination-free preparation and analysis of metal samples, eliminating the need for manual intervention. The process begins with the operator placing the lollipop sample into a semi-automated tail-cutting machine located outside the container. After pin removal, the sample is transferred to the sample entry station, where a robotic system takes over all further operations.

The robot picks the sample and loads it into a high-precision milling machine to prepare a clean and uniform surface. Following milling, the sample is moved to an integrated vision system that performs surface inspection through image analysis to identify the optimal spark location. Based on the verified surface, the robot aligns the sample at the spark stand of an Optical Emission Spectrometer (OES) with exact positioning relative to the electrode.

Once the OES analysis is completed, the chemical results are automatically validated. If the composition is within the defined acceptable range, the analysis is marked as complete. All analytical results are then transmitted in real time to a predefined database, control room, or user interface for further processing, reporting, or decision-making.

The fully automated workflow ensures high accuracy, repeatability, safety, and zero human influence, making it ideal for high-speed production environments such as steel plants, foundries, and alloy manufacturers.

This automated system has already been successfully commissioned and is currently in operation at Rourkela Steel Plant (SAIL) and Bokaro Steel Plant(SAIL).

IRON ORE BENEFICIATION AND AUTOMATION: AN OVERVIEW

Mr. Andreas Hees, Processing engineer, DMT Consulting Private Limited



The evolving demands of the steel industry and the growing emphasis on resource efficiency have heightened the need for effective beneficiation and process optimization of iron ore. This presentation provides an overview of contemporary iron ore beneficiation practices and highlights the increasing role of automation in enhancing productivity, product quality, and operational sustainability.

Iron ore deposits vary significantly in mineralogy—from high-grade hematitic ores to itabirite and magnetite-bearing formations—and require systematic characterization to define appropriate

beneficiation routes. Core physical and chemical upgrading processes, including crushing, grinding, gravity separation, magnetic separation, flotation, hydrometallurgical extraction, and pyro-metallurgical treatment, are discussed in relation to ore type, gangue composition, and downstream steelmaking requirements. Emphasis is placed on achieving optimal Fe recovery, reduction of SiO_2 and Al_2O_3, and control of deleterious elements such as P and S, which impact both metallurgical performance and final product quality.

The integration of automation and digital process control has emerged as a critical enabler for improved plant performance. Automated systems enhance feed consistency, stabilize operating parameters, enable predictive maintenance, improve safety, and support energy-efficient operation. These advancements collectively contribute to higher recovery rates, improved product consistency, reduced downtime, and overall cost competitiveness.

Through international project experience and global operational footprints, the discussion underscores the relevance of integrated plant design, mineralogical understanding, and automation-driven operational excellence in meeting the current and future requirements of the iron and steel value chain.

Accelerating Iron and Steel Production Efficiency, Quality Assurance and Sustainability with Thermo Fisher Analytical Solutions

ABHIJIT SEN

Enhancing efficiency and sustainability in iron and steel production is imperative to meet growing global demand while reducing energy consumption, emissions, and environmental impact. Thermo Fisher Scientific's advanced XRF, XRD, Spark-OES, and automation solutions engineered for high-precision elemental and phase characterization throughout the iron and steel production chain. From rapid melt chemistry via Spark-OES to quantitative phase analysis and bulk composition control, these technologies deliver consistent accuracy and reproducibility. Integrated automation systems enable seamless sample preparation, handling, and data correlation, driving real-time process control, improved yield, and sustainable optimization across raw materials, steel refining, and finished product verification.

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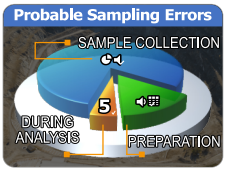

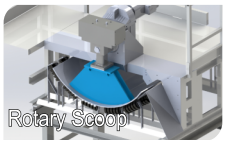



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This system is uniquely designed to overcome complex material handling challenges, moving directly from bulk jumbo bags to fully analyzed, XRF-ready samples.

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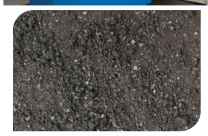
- High-Volume Precision: Achieve 1 Ton/cycle throughput with automatic pulverization to a highly precise 100# fineness.





Pilot Coke Oven
for simulation of carbonisation process with oven wall pressure determination







RI / RDI determination apparatus



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Determination Apparatus for Iron Ore Pellets
As per ISO:4700





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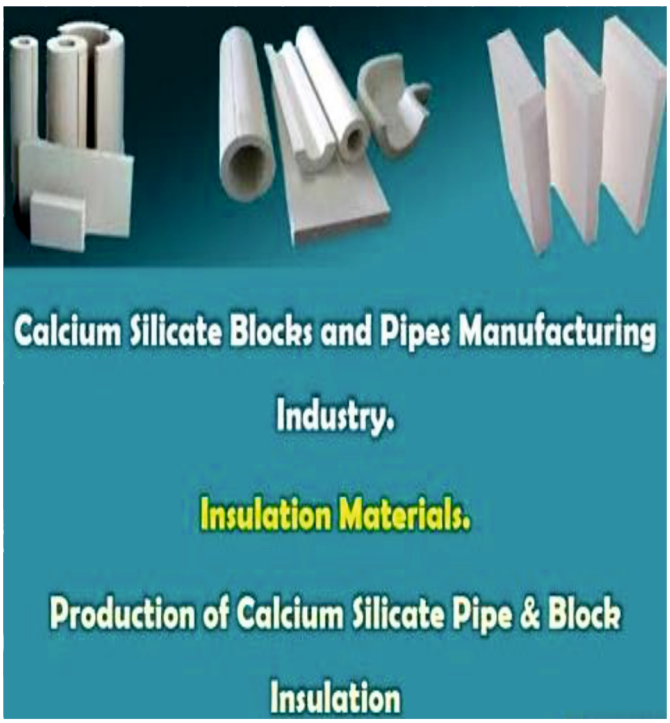



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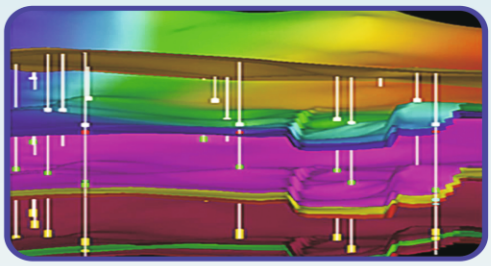

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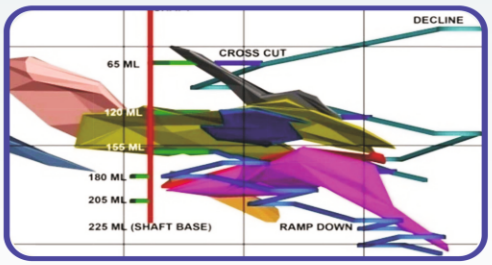

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EXPLORATION

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SESSION

"ENHANCING EFFICIENCY THROUGH TECHNOLOGICAL ADVANCEMENTS IN RAW MATERIAL TO IRON MAKING"

LOESCHE MILLS FOR PULVERIZED COAL INJECTION, LD SLAG / STEEL SLAG PROCESSING AND DRY IRON ORE GRINDING

Presenters: Mr. Rajesh Khanna, Director

LOESCHE INNOVATIVE ENGINEERING

Conference: ISIEES 2025, Mecon

This abstract reviews and synthesises the capabilities and applications of Vertical Roller Mill (VRM) technology developed by Loesche GmbH across three key domains of the iron & steel and mineral processing industry:

(i) Pulverised Coal Injection (PCI) Into Blast Furnaces,

(ii) Dry Processing of LD-Slag / Steel-Slag,

(iii) Dry Grinding of Iron Ore.

The aim is to highlight how one mill-platform concept, suitably adapted, can deliver benefits of flexibility, energy efficiency, process integration and circular-economy compatibility across these domains.

1. Background & Technology Platform

Loesche, a German MNC, established in the year of 1906 in Dusseldorf, Germany is known for its VERTICAL ROLLER MILL (VRM) design — characterised by a rotating grinding table and two or more grinding rollers, integrated high-velocity gas drying or inertising systems, and an internal dynamic classifier — was originally developed for clinker and granulated blast-furnace slag in the cement industry. Over time, this technology has been adapted for the power, steel-industry and mining/ore-industry markets, enabling dry-grinding of a wide range of materials including solid fuels (coal), slags (steel, LD, EAF), and mineral ores. With a proven global footprint, Loesche has successfully commissioned over 2,000 mills across diverse industrial sectors — a testament to its engineering excellence and operational reliability.

Application 1: Pulverised Coal Injection (PCI)

In the blast-furnace of Steel Industry, injecting pulverised coal (PCI) is a well-established method for reducing coke consumption and improving cost/energy efficiency of the furnace. VRM technology from Loesche has been used for this application across various steel plants worldwide.

Typical benefits of the Loesche mill in the PCI role include:

- High reliability and availability, suited to the demanding metallurgical-plant environment.
- Precise fineness and throughput control
- Lower power consumptions
- Lesser vibrations with the help of Sturdy and proven design
- Integrated drying/inertising gas systems which allow grinding of hard coals with moisture and
- Volatile content, maintaining safety in the blast-furnace feeding system.
- Compact footprint compared with traditional ball-mill or tube-mill solutions, and reduced energy consumption per tonne of coal ground.

By applying the same VRM platform, blast-furnace operators can upgrade or retrofit their injection systems with improved process flexibility (e.g., ability to handle a wider range of coals or blend coals) and higher throughput.

Application 2: LD Slag / Steel Slag Processing

Steel-making operations (e.g., LD /converter slag, EAF slag) generate large volumes of by-product material which present both a challenge (waste disposal) and an opportunity (value recovery). Loesche has adapted its milling technology for dry-processing of steel slags — enabling metal recovery and high-value mineral product manufacture. For instance, a dry processing plant with a Loesche mill in Belgium achieved metal recovery down to ≈ 63 µm and produced a mineral fine-product suitable for building-materials reuse.

Key advantages of this Technology:

- Avoidance of water-based grinding/slurry systems, thereby removing the need for effluent treatment and reducing energy/maintenance burdens associated with de-watering.
- Efficient and cost-effective metal recovery in the coarse range
- Production of a high-quality mineral filler product with precisely definable grain size distribution
- Virtually 100% metal recovery down to the finest fractions range by means of optimised dry grinding, classification and sorting technology
- Enhanced separation of metal particles (via downstream magnetic, density and sensor sorting) when the slag matrix is finely ground and dried.
- Production of a high-quality mineral fraction with controlled size distribution, suitable for use in concretes, precast elements or as filler, supporting circular-economy goals.
- A compact, modular processing line built around the VRM which can be integrated into or adjacent to existing steel-works.

Thus, the Loesche mill offers steel-makers a viable path to converting an industrial by-product into a resource.

Application 3: Dry Iron Ore Grinding

In the minerals and mining sector, cost pressures and sustainability drivers are driving interest in dry grinding of ores, including iron ore, using VRM technology. Loesche's “Mills for minerals and ores” brochure outlines how their mills are used for dry ore grinding, offering savings in energy and water compared to traditional wet grinding circuits.

Primary benefits in the iron-ore context include:

- Elimination or reduction of water consumption in grinding circuits, important in water-scarce regions.
- Simplified downstream dewatering or elimination of tailings-slurry systems.
- Feasibility of integrating grinding and drying in the same machine, potentially reducing overall footprint and energy demand.
- Adaptation to a wide range of feed materials, including lower-grade ores needing more comminution.
- Reduced power consumption

- Lesser operational cost as there is lesser power consumption and wear & tear compared to conventional technology prevalent in the industry

  For steel-and-iron-ore value chains, this opens up new possibilities for mine-to-steel integration, lower-cost commination and coupling with downstream beneficiation.

2. Comparative Discussion & Outlook

While the three applications differ in feed material, final product and downstream destinations, they share a common technology platform. This offers advantages in terms of vendor economies, maintenance commonality, system modularity and operational familiarity.

Key observations:

- **Energy efficiency:** The VRM platform, with its grinding-bed mechanism and hot-gas infrastructure, has demonstrated lower specific energy consumption compared with some conventional mills.
- **Flexibility:** The same mill can be adapted (by roller configuration, classifier settings, gas-flow design) to vastly different materials - from hard coals to slags to ores.
- **Sustainability/circular economy:** Particularly with slag processing and dry ore grinding, the platform supports resource-recovery, water-savings and waste-minimisation.
- **Integration potential:** For steel plants looking to enhance PCI capability, or mines seeking dry-grind solutions, the Loesche technology offers a single-supplier, integrated solution.

However, it is important to recognise that realising these benefits requires careful application engineering -matching mill sizing to throughput, drying/inertisation gas design to material moisture/volatility, classifier design to target fineness, and downstream separation or beneficiation integration (especially for slag processing). Looking ahead, the convergence of decarbonisation pressure (e.g., reduced coke use via PCI), circular-economy mandates (steel-slag reuse) and increasingly stringent water-use constraints in mining make the case for VRM-based solutions even stronger. The next wave of installation will likely address higher throughputs, hybrid fuel/coal blending in PCI, further refinement of dry-slag processing for metal recovery, and broader adoption of dry-grinding in mining.

3. Conclusion

This abstract demonstrates that the Loesche VRM offers a highly versatile, energy-efficient and sustainable solution for key material-processing challenges in blast-furnace iron-making, steel-slag recycling, and dry- iron-ore grinding. By leveraging one adaptable technology across multiple applications, operators in steel, mining and minerals can achieve improved process performance, reduced resource consumption and enhanced circular-economy outcomes. In the context of ISIEES 2025, the convergence of iron-&-steel, energy and sustainability themes makes this cross-application perspective particularly timely. Attendees will gain insight into the technical principles, industry-case examples and future potential of VRM applications in metallurgical and mineral value chains.

INNOVATIVE APPROACHES FOR ENHANCING PRODUCTIVITY AND SUSTAINABILITY OF PELLETIZING PROCESS AT JSW BPSL

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Pellets constitute a major share of the iron-bearing feed for Direct Reduction Iron (DRI) and Blast Furnace operations at JSW BPSL. To enhance productivity and sustainability, a series of novel process and equipment improvements were implemented in the pelletizing plant. The initiatives targeted bottlenecks in filtration, beneficiation, and solid waste utilization. Installation of new Vacuum Pressure (VPA) filters reduced filter cake moisture from 11.3% to 10.7% and shortened cycle time from 22 to 17 minutes, thereby increasing productivity. Feed blend optimization using purchased concentrate with favorable silica and alumina ratios minimized filter cycle time and improved throughput. Incorporation of LONGI magnetic separators in the beneficiation circuit lowered tailing Fe from 50% to 47%, enhancing Fe recovery along with yield percent improvement. Utilization of SMS and iron oxide dust (~12.5 kg/t) reduced filter cake consumption from 1150 kg/t to 1138 kg/t, improving material efficiency.

Comprehensive corrective actions were taken for filter press and thickener operations, including replacement of damaged filter plates, improvement of cloth washing pressure (2.0–2.5 bar), water quality enhancement, and control of slurry and air leakages. Additionally, optimization of gland seal water and proper thickener feed management reduced slurry dilution and torque issues.

As a result of these integrated initiatives, plant production increased from 9000 TPD to 11800 TPD, demonstrating significant gains in efficiency, resource conservation, and environmental performance in line with JSW BPSL's sustainability objectives.

Keywords: Pelletizing plant, Process optimization, Iron ore beneficiation, Sustainability, Productivity improvement.

ENHANCING MATERIAL QUALITY THROUGH SUSTAINABLE UTILIZATION OF SOLID WASTES IN STEEL AND MINING INDUSTRIES

Manish Madhav, Praveen Kumar, Shripraksh Sudhir & Mahadeo Roy
RDCIS, SAIL, Ranchi
Mail ID: madhavmanish@sail.in

Abstract:

The generation of solid wastes in the mining and steel industries presents both an environmental challenge and an opportunity for resource recovery. This paper explores the sustainable utilization of solid wastes such as Blast Furnace (BF) slag, Basic Oxygen Furnace (BOF) slag, Electric Arc Furnace (EAF) slag, mill scale, iron ore slime, and fly ash. By examining structure–property correlations and focusing on recycling technologies, this study emphasizes 'quality through sustainability.' A case study from RDCIS, SAIL, illustrates successful pilot-scale implementation for converting waste into value-added construction materials such as bricks, paver blocks, and hollow blocks.

1. INTRODUCTION

The iron and steel industry generates a considerable amount of solid waste during mining, beneficiation, and metallurgical processes. For every tonne of steel produced, approximately 600–1000 kg of solid waste is generated. Traditionally, these by-products have been disposed of through landfilling, leading to soil contamination, air pollution, and land degradation. To achieve sustainable development goals (SDGs), the steel sector must adopt circular economy practices—reusing, recycling, and reprocessing industrial wastes to minimize environmental impact while maintaining product quality [1].

Waste Generation and Characteristics

Waste Type	Source	Quantity (kg/tonne steel)	Composition	Potential Use
Blast Furnace Slag	Iron making	300–400	CaO, SiO_2, Al_2O_3	Cement, concrete, roads
BOF Slag	Steel refining	20–150	CaO, FeO, MgO	Paver blocks, fertilizer
EAF Slag	Scrap melting	80–150	FeO, SiO_2	Asphalt, aggregates
Mill Scale	Rolling	30–50	Fe_3O_4	Recycled to steel plant
Iron Ore Slime	Beneficiation	300–600	Fe_2O_3, SiO_2	Bricks, ceramics
Fly Ash	Power plant	100–150	SiO_2, Al_2O_3	Cement, construction

Table 1. Types and utilization potential of solid wastes generated in integrated steel plants.

Environmental Impact

Improper disposal of industrial waste results in soil contamination due to heavy metals, resource depletion from mining and elevated CO_2 emissions contributing to climate change. Landfilling disrupts ecosystems and occupies vast land areas. Therefore, sustainable utilization of these wastes is not only an environmental necessity but also an economic opportunity [2].

Sustainable Solutions and Quality Enhancement

Integrating sustainability into steel manufacturing processes requires waste-derived materials to meet strength, durability, and safety standards while reducing lifecycle impacts. Sustainable solutions include resource conservation, energy efficiency, and adopting a circular economy model [3].

RDCIS, SAIL Initiatives: A Case Study

The Research & Development Centre for Iron & Steel (RDCIS), SAIL, initiated laboratory and pilot-scale work to convert waste into valuable construction materials. After successful trial of many compositions for making paver block, bricks and hollow blocks, RDCIS, SAIL has installed a pilot plant for making these products. This includes BOF slag-based paver blocks, bricks, and hollow blocks, successfully implemented in RDCIS campus infrastructure.

Table 1. Composition of solid wastes generated per ton of steel.

Raw Material	Fe (total)	FeO	SiO2	CaO
LD Sludge	52-56	5-5.5	7-8	10-12
BF Sludge	32-35	3-4	8-9	2-3
LD Slag (as received)	6-7	NA	8-10	40-45
LD Slag (+5-20 mm)	19-22	NA	8-10	38-40
LD Slag (-5mm)	15-17	NA	10-12	42-45
BFG slag	0.7-0.8	NA	90-93	2-3
Fly Ash)	5-6	NA	50-54	2-3



Raw material preparation Plant



Brick Making Plant



Vibrating table for paver block



Hollow block machine

Figure1. Pilot Plant Facility



Figure 2. Products made by Steel plant solid waste.

Quality through Sustainability

The principle of "Quality through Sustainability" underscores the interdependence between environmental stewardship and material innovation. It demonstrates that adopting sustainable practices does not merely reduce environmental impact—it can actively enhance the functional and mechanical performance of materials. In the context of the iron and steel industry, sustainability-driven initiatives lead to superior material outcomes when waste resources are re-engineered into valuable products.

The RDCIS initiatives of the Steel Authority of India Limited (SAIL) serve as an exemplary model of this concept. Through meticulous research and pilot-scale implementation, various industrial by-products—such as Basic Oxygen Furnace (BOF) slag, Blast Furnace (BF) slag, and fly ash—were successfully transformed into eco-efficient construction materials. These sustainable materials exhibited performance characteristics equal to or better than conventional alternatives, confirming that waste valorization and product quality can coexist.

Comprehensive laboratory trials revealed that slag-based paver blocks achieved compressive strengths comparable to, and in many cases exceeding, those of traditional concrete blocks. Proper stabilization of free lime, combined with controlled aging and the optimization of particle size distribution, contributed to improved volumetric stability, reduced cracking tendencies, and enhanced surface finish. Additionally, the blending of BOF slag with fly ash facilitated the cementitious reaction, resulting in denser microstructures and improved load-bearing capacity.

From an environmental standpoint, such innovations reduce dependency on virgin raw materials, lower carbon emissions associated with cement production, and minimize land filling of metallurgical wastes. The reduction of free lime reactivity and incorporation of industrial residues into durable products embody the shift from a linear production model to a circular economy framework. Economically, these sustainable materials offer cost competitiveness through reduced raw material input and waste disposal expenditure.

Moreover, the integration of quality assurance protocols, such as compressive strength, water absorption, and durability testing, ensures that sustainability-driven materials meet national construction standards and building codes. The RDCIS work highlights how continuous process optimization, guided by sustainability principles, can lead to consistent product quality and operational resilience within the steel sector [4].

Table 2. Performance properties of BOF slag-based construction products tested at RDCIS.

Product Type	Key Material	Compressive Strength (MPa)	Water Absorption (%)	Suitability
Paver Block	BOF Slag	25–30	6–8	Pavements, landscaping
Paver Block	BOF Slag	25–30	6–8	Pavements, landscaping
Hollow Block	BOF Slag + Lime	10–12	10–12	Partition walls

Conclusion

Sustainable utilization of solid wastes in mining and steel plants embodies the principle of 'quality through sustainability.' The transformation of slag, sludge, and tailings into construction materials exemplifies industrial symbiosis and circular economy in action.

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DRIVING SUSTAINABLE BENEFICIATION: UNLOCKING COAL & IRON ORE TO POWER THE FUTURE OF IRON &STEEL INDUSTRY

T.Sheehan[1], S. Das[2], M. Gupta[3], S. Mukherjee[4],M.Tuchscherer[2], P.Mesquita[3]

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As the global steel production demand is rising, India plans to increase the production by more than two-fold from 140 MT in 2023to 300 MT by 2030. In other to achieve this goal, it has become critical to secure the supply of raw materialsi.e. coal and iron ore. However, the beneficiation process for both is limited by the loss of fines and ultra-fine recovery. Flotation is widely regarded as the best fine particles separation technology and practically all metals we use are produced using flotation. Flotation technology selection has emerged as a key to optimize the supply of raw materials for steelmaking process in a sustainable fashion. However, the conventional flotation cells efficiency is particle-size constrained, and the process is not efficient for fine (<20 µm) particles separation due to poor cell hydrodynamics.

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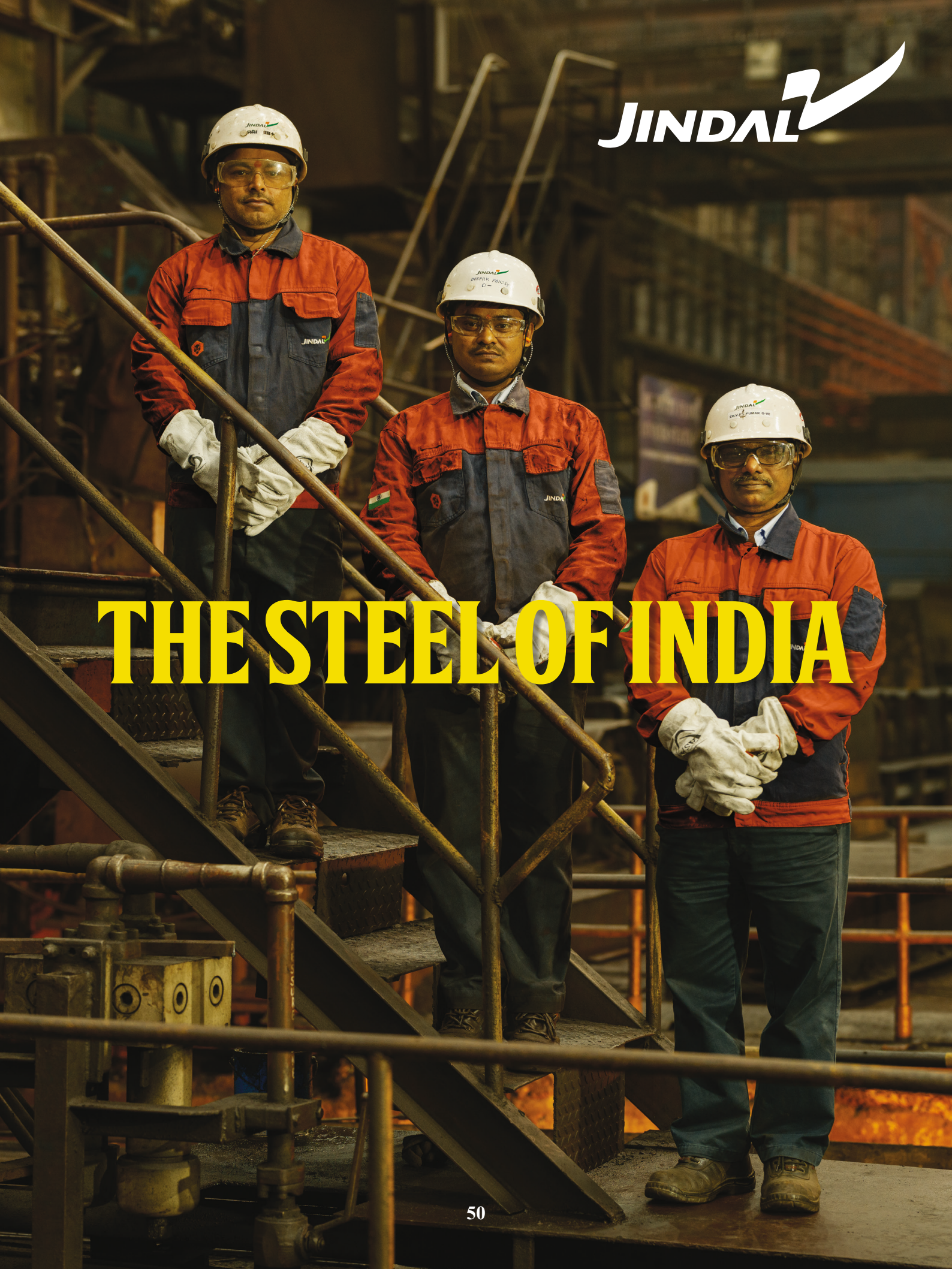
Keywords: CavTube™;Iron ore beneficiation;coal beneficiation; column flotation; Fine particle flotation.

Paper Presenter: Dr. Mohit Gupta

Brief Profile: Mohit Gupta is a Ph.D. in Chemical Engineering from Virginia Tech (VT), USA, and over 13 years of experience across Freeport-McMoRan, Reliance Industries, and Centre for Applied Separation Technologies (CAST), VT, Dr. Gupta brings a strong mix of research and real-world expertise in flotation, mineral recovery, and process design. His expertise spans: High-performance flotation systems, Critical mineral value chains, Waste valorization and energy-optimized flowsheets, internationally recognized research, and technical leadership.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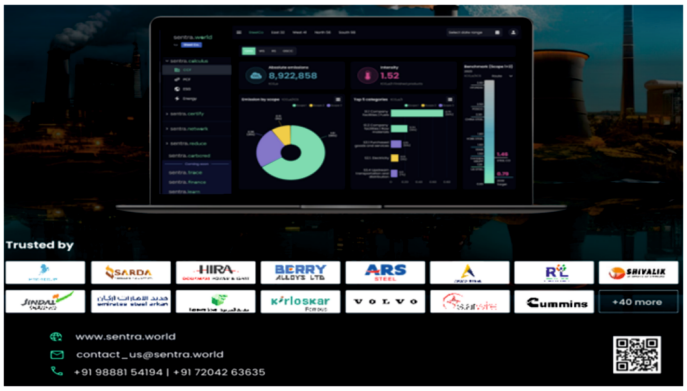

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ACHIEVING SUSTAINABILITY THROUGH STATE OF ART TECHNOLOGIES IN TUNDISH

Rajesh B. Mukhekar1[1] • Soumya Bhattacharjee[1]
• Murali Sabhapathy[1] • Akash Sharma[1] • Andrea Gianni[1]

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Abstract:

Global steel output has expanded dramatically during the past ten years. However, there is a growing demand for clean steel both domestically and internationally. This is the reason that a lot of study is being done in this area right now. However, conventional steel manufacturing techniques have a severe negative impact on the environment and significantly increase greenhouse gas emissions. Right now, the steel industry is undergoing a radical change as it adopts cutting-edge strategies to produce what is known as "green steel." The main objective of this paradigm shift is to rethink the way steel is produced while significantly reducing its environmental effect. It centers on sustainable practices and cutting-edge technology.

In this article, we will dive deep into the innovative technologies developed by Vesuvius that may be helpful for the manufacturing of clean and green steel inside the last metallurgical reactor tundish.

Tundish Working lining is extremely critical refractory component for efficient & safe tundish operations. Spray based working lining requires long dry out and preheating cycle for the overall preparation and to arrive at the ready to cast condition. This practice poses a huge challenge high CO_2 emission during tundish preparation and increased turnaround time for tundish. Vesuvius has developed Basilite QuickStart family of products which minimizes these dry-out and firing cycles and in turn significantly reduces the CO_2 emission and create a faster tundish turnaround cycle.

Keywords: Continuous Casting, Sustainability, Tundish lining, Preheating

DANIELI QUALI-HSM®: THE NEXT GEN HSM PROCESS*

Antonio Comelli[1] • Giacomo Franzil[2] • Marco Petronio[3] • Santanu Rudra[4]

Abstract:

An enhanced strip production concept with Danieli Inductive Heating technology ensuring conventional Hot Strip Mill answers market demand for ultra-thin gauge, high quality, and premium grades.

Thick-slab rolling using conventional Hot Strip Mill holds the leading position when it comes to high production capacity, wide and flexible product mix, and premium grades such as automotive exposed and electrical steel.

The modern HSM production faces a triple challenge in the current dynamic market: achieving sustainability, enhancing quality with tight tolerances and uniform properties, and answer market demand for thin-gauge, hot-rolled coil.

The competing in-line casting and rolling technology is a step ahead in many aspects. The Danieli Quali-HSM® breakthrough process innovation is the answer to those challenges, merging the advantages of both conventional rolling and inline casting and rolling process routes.

The result is the production of HRC at high and uniform temperatures, at a constant speed and down to ultra-thin gauge of 1.0 mm.

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1. INTRODUCTION

The Quali-HSM technology is engineered to produce ultra-thin, high-strength steel grades with exceptional surface quality and uniform properties. The core of this innovation lies in the integration of inductive heating (IH) modules within the finishing mill, enabling high finishing temperatures, stable rolling conditions, and a uniform process.

The typical 7-stand finishing mill is divided into a 2+5 arrangement, optimizing the footprint and enhancing energy efficiency.

This configuration creates the opportunity to include the following equipment insidethe Finishing Mill:

- Induction Heating: a heat-on-demand tool used when rolling thin gauge, placed 5 stands from the end-of-rolling, finding a sweet-spot between process advantages and expenses, both operating and capital ones,
- Additional Descaler Box: an additional descaling point reduces tertiary scale on the final surface,
- Crop shear: installed further downstream compared to a traditional HSM, to reduce the risk for cobbles by improving the shape of the head-end threading the last stands,

Keywords: Green energy, Flexibility, Thin and Hard Grades, Silicon Steel, Digitalization.

- Additional thickness and profile gauge: installed after H2 for additional open- and close-loop automation controls.

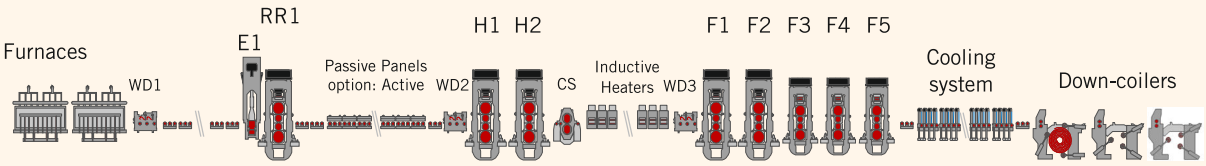

Figure 1 : Quali-HSM Technological Layout

This patentedi configuration makes it possible to thread the last 5 finishing stands with a bar uniformly reheated to the desired temperature and rolling it at the most convenient constant speed, with no need for detrimental speed ramps as typically done in the previous generation HSMs. In those plants, the reliance on speed-up and the crop shear positioned 7 stands from end-of-rolling, constitute major causes for cobbles when rolling thin gauges. These problems are overcome in the Quali-HSM.

The optimal control over the thermo-mechanical process is thus achieved, yielding profile and flatness almost identical to in-line-casting-and-rolling plants.

2. BENEFITS

2.1 Temperature Efficiency

In the traditional HSM, the loss of temperature in the production of thin gauges can only be compensated by the speed-up. This established practice however isdetrimental when producing advanced grades, since the thermo-mechanical conditions of each portion of the strip are different, and the control of thickness and flatness actuators is challenging. The result is high variances in the mechanical properties and the profile, plus an increased risk of cobbles.

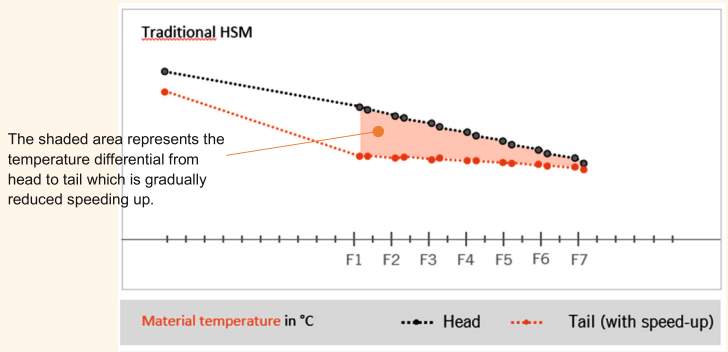

Figure 2 : Traditional HSM Temperature chartii

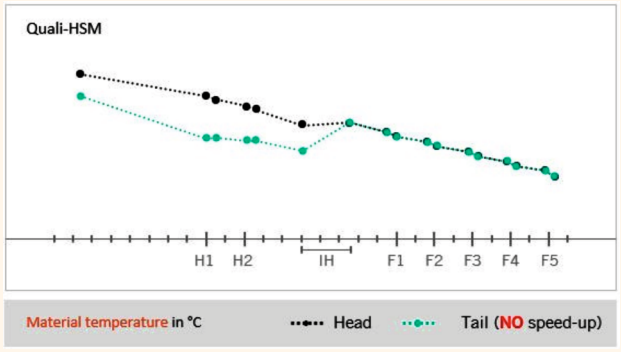

Figure 3 : Quali-HSM Temperature chart

In Figure 3 the Quali-HSM solves this problem by presenting constant thermo- mechanical conditions in the last 5 finishing stands: a 30% increased uniformity of product properties is achievediii.

Positioned strategically within the finishing mill, IH ensures high finishing temperatures and stable rolling conditions. This technology allows for precise control of the strip temperature, which is crucial for producing high-quality steel with uniform properties.

An additional benefit is the option to utilize lower drop out temperatures from the furnaces. The process minimizes the risk of oxidation and scale formation, leading to better surface quality, which is essential for producing high-quality steel.

2.2 Environmental Impact

The Quali-HSM technology not only improves production efficiency but also contributes to environmental sustainability, making it a greener alternative to traditional HSM.

- Reduced Energy Consumption: Quali-HSM consumes 20% less energy, resulting in lower operational costs. The use of induction heating and optimized rolling schedules contribute to the overall energy efficiency of the process.
- Lower CO2 Emissions: The technology's efficiency translates to a 20% reduced carbon footprint, aligning with global sustainability goals. By reducing CO2 emissions, the Quali-HSM technology helps steel producers meet regulatory requirements and improve their environmental performance.

The following charts indicate the required energy (rolling mill only) and CO2 emitted to produce a 1.5mm x 1,600mm NGO 3% Si Steel.

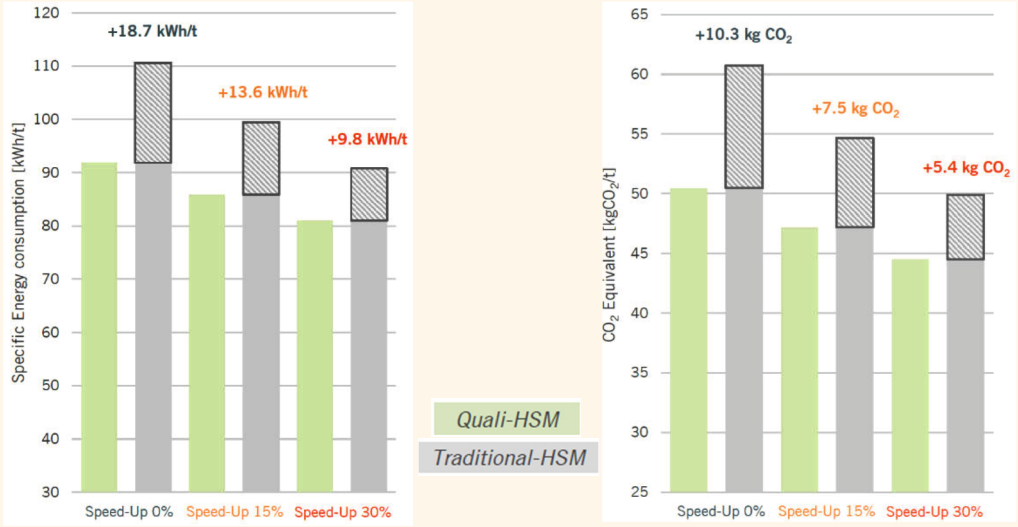

Figure 4 : Energy Consumption Comparison

Figure 5 : CO_2 Emissions Comparison

2.3 Control Efficiency

Advanced control systems ensure tight tolerances and precise crown control, resulting in superior product quality. The ability to maintain tight tolerances is particularly important for applications that require high precision, such as automotive and electrical steel.

The production control starts with the pre-setup, which is calculated when the product enters the production queue. It's based on planned target data, including strip geometry and rolling strategy.

The second step is the setup calculation when the slab is discharged from the furnace, using latest available information and adaptations from previous products. An example block diagram of the setup calculation is reported in Figure 6.

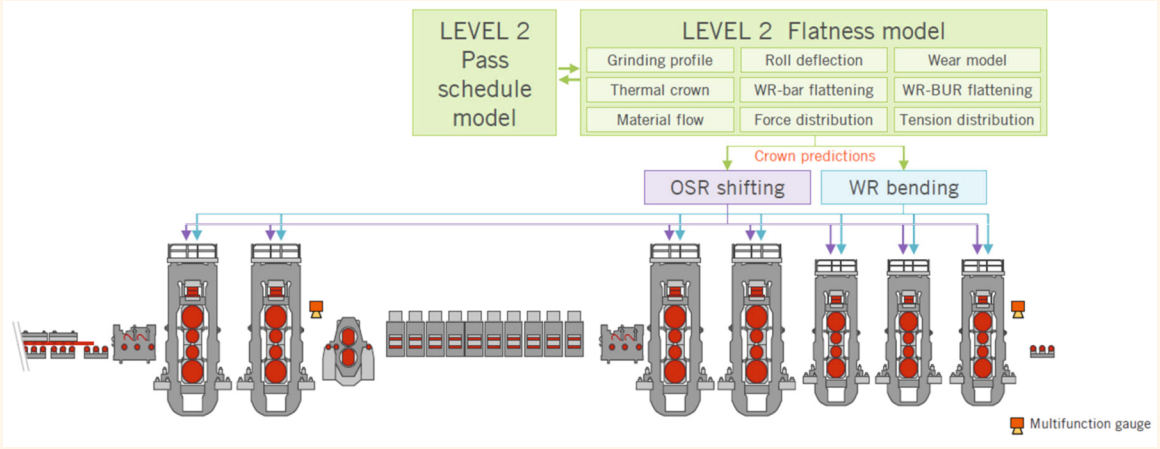

Figure 6 : Quali-HSM Setup Block Diagram

As commonly adopted in the majority of modern HSM, the setup is re-calculated at specific events, for example the end of the roughing stage.

Exclusive of the Q-HSM layout however is the opportunity for a re-calculation inside the finishing mill thanks to the presence of an additional internal multi-function gauge and enough time before threading the next stand: see the block diagram at Figure 7.

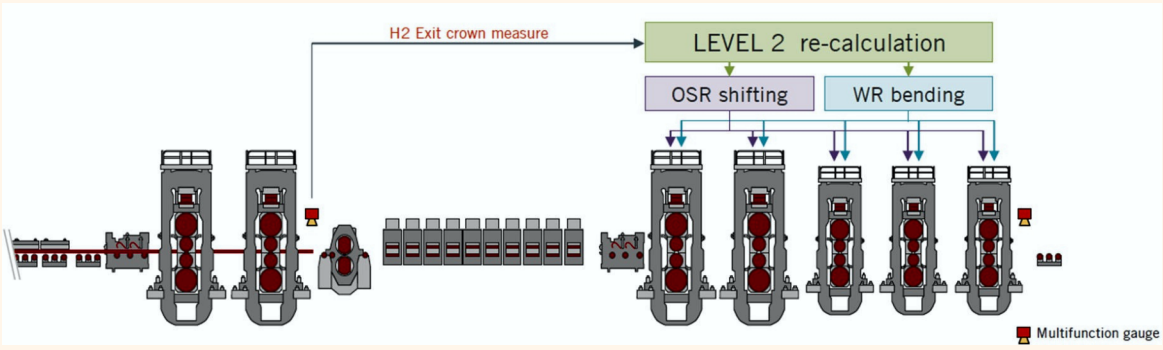

Figure 7 : Quali-HSM Setup Re-Calculation Block Diagram

The above control strategy coupled with the induction heating allow for a vastly improved control of the transfer bar.

This highly dynamic control is the key to achieve the highest uniformity in the final product, overcoming known issues like the skid marks originated in the walking beam furnaces.

In fact, a patented technologyiv was developed for the correction of the skid marks.

The skid marks are localized temperature profile defects on the bottom side of the transfer bar which affect negatively the final strip thickness tolerance. See for example the Figure 8 for an explanation of the phenomena.

The red line is the measure of the pyrometer at the entry of the FM and the skid marks are identified by the by the gray band.

The lower temperature at the skid mark is related to a defect in thickness and profileof the strip at the exit of the mill. The pyrometer reading is not precise enough to be used alone for the compensation, and the force readings of the RM last pass are difficult to track down to the FM.

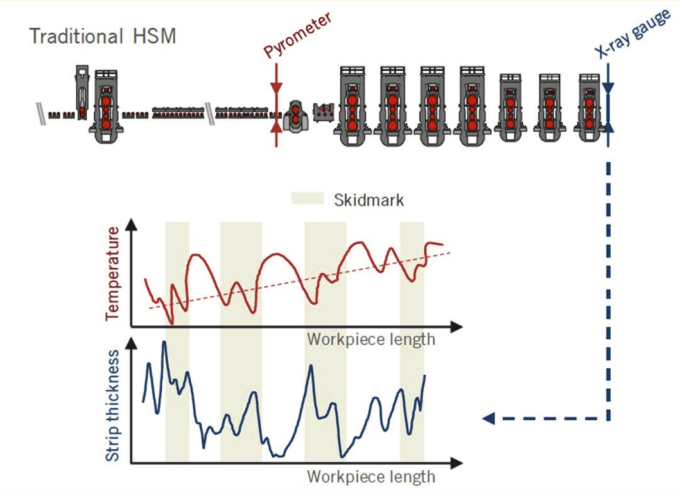

Figure 8 : Traditional HSM Skid Mark Compensation

In the Quali-HSM, a dynamic compensation of these defects can be achieved with the induction heaters, utilizing the input data from both the pyrometer A and the load cell of H2, see Figure 9. These two inputs are combined to perform a fine tuning of the compensation. Both the thermal profile (solid red line) and corresponding final thickness/profile (solid blue line) are improved; tighter tolerances in final strip thickness, as good as 1/5 Euronorm are possible.

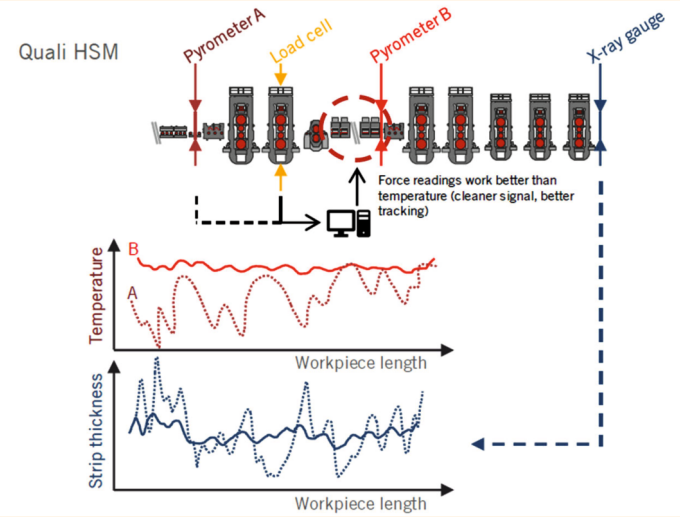

Figure 9 : Quali-HSM Skid Mark Compensation

2.4 Surface Quality

Surface quality is further improved by installing an additional descaler unit just 5 stands away from end-of-rolling, which will reduce the final layer of tertiary scale by 30% andminimize the risk for imprinted scale.

In Figure 10 we can see the difference of the scale layer thickness between the traditional HSM (dotted line) and the Quali-HSM (solid blue line).

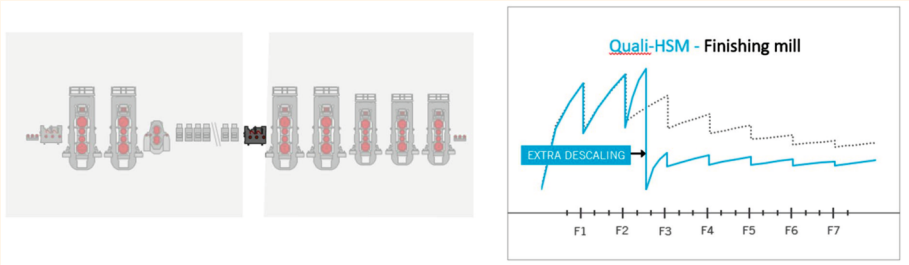

Figure 10 : Scale layer thickness comparison

The descaling concept of the Q-HSM result in a thinner scale layer at the negligible cost of a 0.14% yield loss increase.

The thinner scale layer grants a speed increase of 15÷20 % at the pickling line.

2.4 Market Opportunities

One of the standout advantages of the Quali-HSM technology is its economic efficiency. The ability to produce ultra-thin and hard strip opens new market opportunities, particularly in segments where traditional HSM face challenges.

- Thin Gauge HRC: The technology targets the market for hot rolled coils with thicknesses ≤2.0mm, a segment typically not well served by traditional HSM. This market segment is particularly lucrative due to the higher value of thin-gauge steel products.
- Premium grades which are demanding in terms of final rolling temperature, such as electrical steel or ultra-low carbon steel, are benefitting from a tool which can boost the final rolling temperature above 920 °C even when rolling thin gauges, which becomes an opportunity to sell on the market new products out-of-range for the traditional HSM, such as 1.5 mm Silicon steel, see Figure 11.
- Thermo-mechanic process: the Quali-HSM is a configuration well suited for thick thermo-mechanically rolled products; in this production mode induction heating is not used and is shifted offline.
- High Productivity, in excess of 5 million tons per year.
- Added Value Mix: The production of high-strength, thin-gauge steel adds significant value. The ability to produce high-quality steel with tight tolerances and uniform properties makes the Quali-HSM technology attractive to industries such as automotive, construction, and electrical.

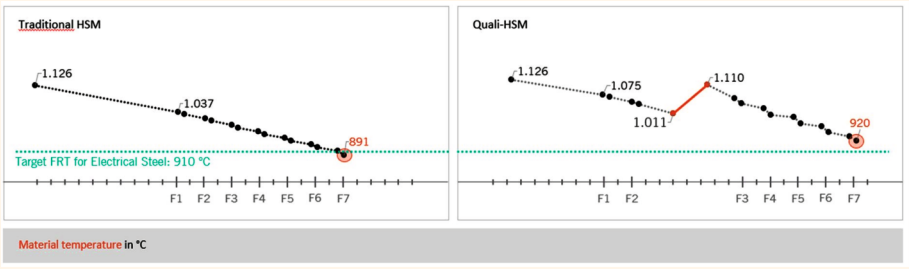

Figure 11 : Comparison of temperature trends for 1.5mm Si Steel

Light and strong grades, Superior quality and the capacity to supply products for Cold Rolled Substitution are the major competitive advantages granted by the Quali-HSM technology; a concept extremely comfortable in rolling Thin Gauges which are a very profitable market niche.

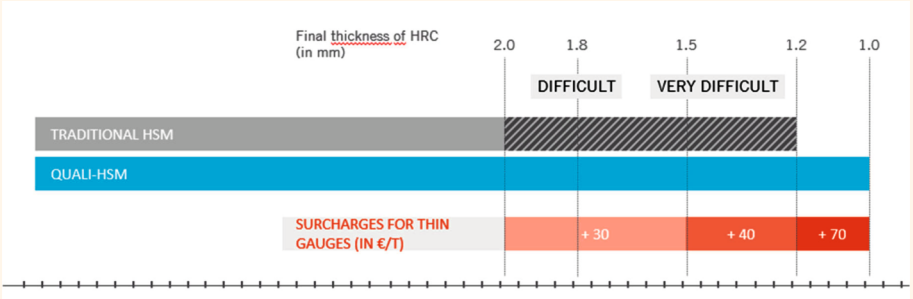

Figure 12 : Typical Surcharges for thin and ultra-thing gauges, LC grade

2.5 Induction Heating Technology

The need to heat the material through the rolling process requires a powerful tool combining high efficiency and control capabilities.

Danieli started developing a 100% in-house design since late 2000s and supplied the first LFH unit in 2012 and the first TFH unit in 2015.

These inductors have been extensively modeled in the R&D department before validation with real scale industrial prototypes and instrumented plates.

Industrial applications have successively confirmed the accuracy of the models



Figure 13 : TFH Inductor during real scale testing

It is known that a transfer bar can be heated by means of two possible induction heating technologies: the longitudinal flux technologies and the transverse flux technology (see figure below).

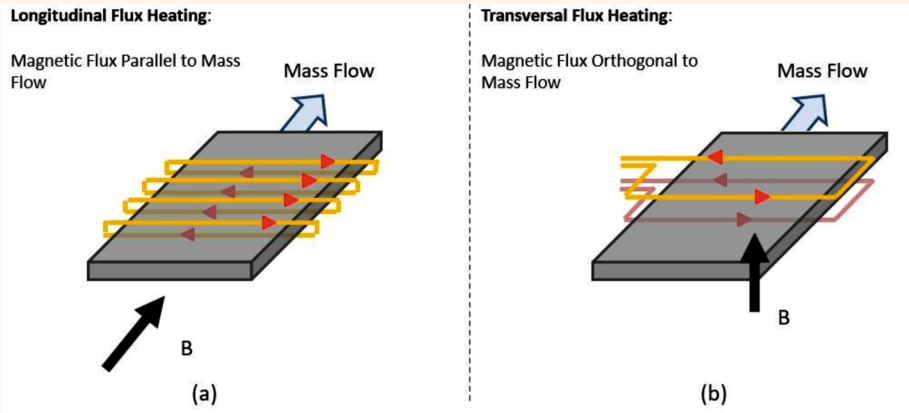

Figure 14 : (a) Longitudinal Flux Technology (b) Transverse Flux Technology

In the longitudinal heating flux technology (LFH), the magnetic flux (B) generated by the coil is parallel to the mass flow, while in the transversal heating flux technology (TFH) it is orthogonal.

This implies that these two different technologies provide two different heating patterns on the slab: while in the LFH most of the power is delivered on the slab surface, in the TFH it is delivered uniformly across the section, hence reducing the issues of an excessive superficial temperature. Furthermore, the TFH inductors allow an additional grade of freedom in slab heating, which is the possibility to manage the temperature on the slab edges.

The Danieli patentedv TFH inductor optimized design combines the high efficiency on the slab heating with the flexibility to selectively heat the slab edgesvi: it is the perfect tool for the Quali-HSM process.

2.6 Benchmark between Processes

The Quali-HSM technology has been tested and proven through various production cases, demonstrating its capabilities in producing high-quality steel. For instance, the production of non-oriented electrical steel (NGO) with 3% silicon content showcases the technology's ability to maintain consistent temperatures and achieve desired material properties.

A significant comparison can be drawn between the Quali-HSM and the previous generation HSM equipped with Inductive Heating upstream the finishing mill. Both concepts achieve the end-of-rolling temperatures and the same minimum gauge, but the traditional layout requires a higher number of modules.

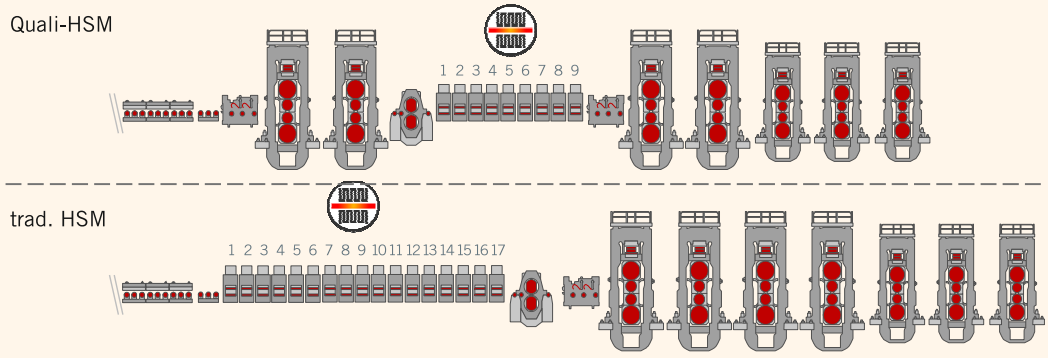

Figure 15 : Comparison of Induction Heating configuration

The production of a 1.5 mm x 1.600 mm, for a 3% Si NGO Steel, requires 9 induction modules on the Quali-HSM and 17 modules on the Traditional HSM.

This 89% increase means the traditional HSM needs additional 30MW of IH power to accomplish the same task.

The higher number of modules results from the less efficient utilization of energy: introducing heat to a material with higher temperature leads to significantly higher radiation losses. In other words, the Quali-HSM layout is more thermally efficient, having the last inductor 15 m closer to the last finishing stand.

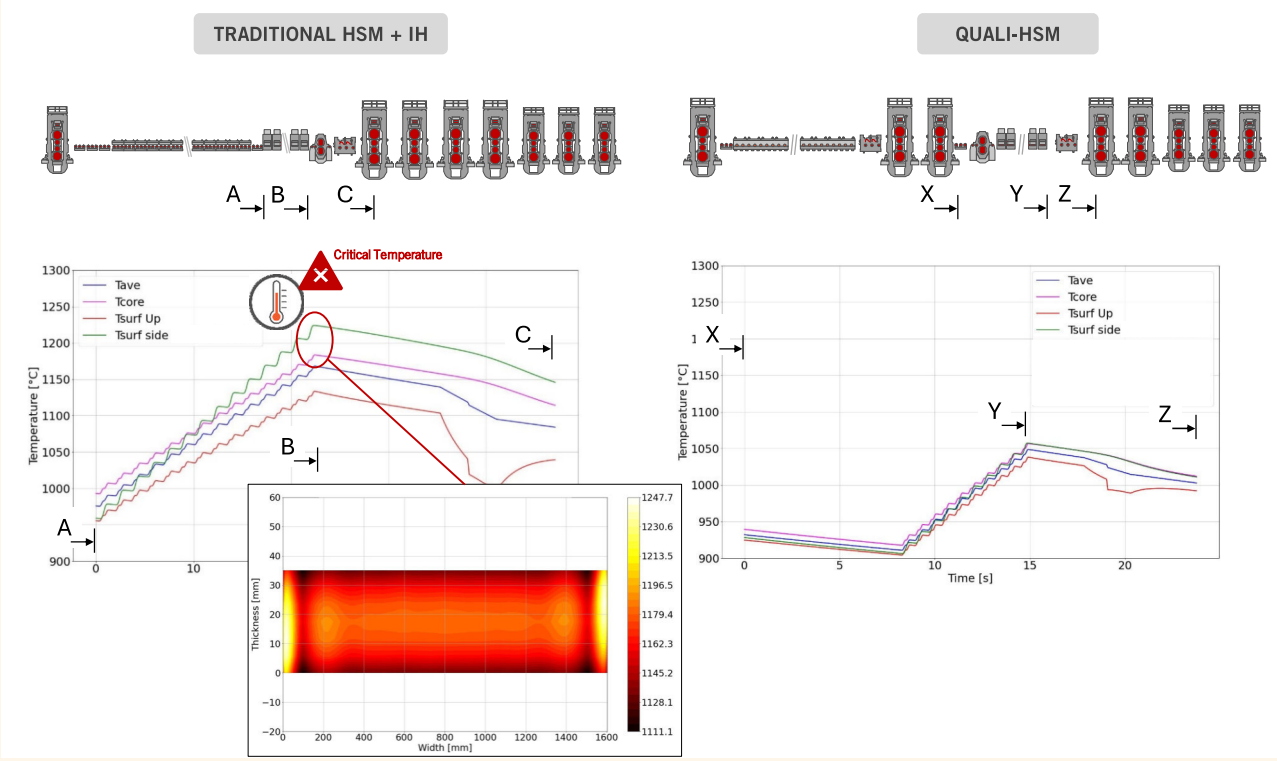

Figure 16 : Temperature Charts of IH area

The above comparison shows it clearly, the Quali-HSM solution is better suited for Thin Gauge Electrical Steel production than its traditional counterpart, being able to achieve the necessary temperature at end-of-rolling with less modules (9 versus 17) and by reheating to a safer temperature level.

The traditional HSM solution reaches temperatures higher than 1,200°C, posing the risk for scale remelting; a highly detrimental phenomenon for FM rolling.

In addition, at F1 entry the Q-HSM exhibits a better uniformity of temperature across the thickness compared to the traditional HSM (see Figure 17).

This ensures a higher uniformity of mechanical properties, which is a key parameter inthe production of Si Steel.

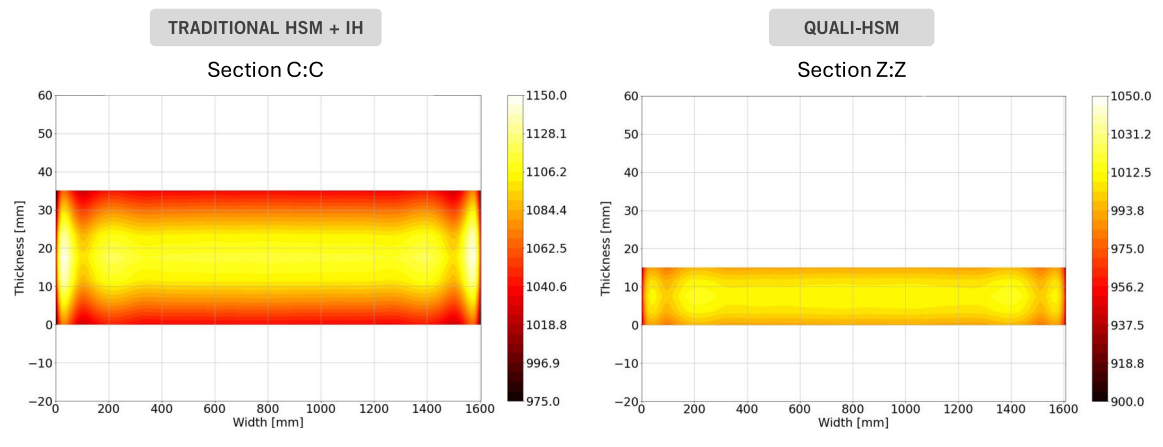

Figure 17 : Temperature modeling at entry of first stand after IH

3. CONCLUSION



The Quali-HSM technology represents a significant advancement in steel production, offering enhanced quality, efficiency, and environmental benefits. By leveraging innovative features such as induction heating, precise control systems, and advanced scale management, Quali-HSM sets a new benchmark in the industry.

The ability to produce high-strength, thin-gauge steel with exceptional surface quality and uniform properties makes the Quali-HSM technology a valuable asset for steel producers.

The economic benefits, including operational and capital expenditure savings, further enhance its appeal.

Environmental advantages, such as reduced energy consumption and lower CO2 emissions, align with global sustainability goals and regulatory requirements.

The traditional HSM technology has not evolved significantly over the past 50 years, and therefore it's now obsolete when faced by the challenges of today's steel production.

Trends in the automotive industry require increasing volumes of thin and hard grades for light vehicles, coupled with the booming market of electrical steel.

Mass production of these steels in a traditional HSM forces the producer to accept several compromises.

As the example of many successful companies attest, the market rewards those witha vision, who decide to differentiate from the status quo.

Danieli's Quali-HSM is a break-through technology which is posed to represent a game-changer in the steel industry: an industry that needs to evolve.

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EXPLORING THE FUTURE OF EAF MELTING AND CASTING

Author
Hirannyad Dutta

The EAF melting and casting session discussed several technologies, including the Digimelter® digital melting unit, the Q-ONE® power feeder, Octocaster®, DySenCaster®, and innovative solutions for water and heat conservation.

DIGIMELTER: REVOLUTIONIZING DIGITAL MELTING



The main focus of the ses- sion, Digimelter technol- ogy, was highlighted for the significant advancements it has brought in green steelmaking and the transition beyond blast furnace operation. Combining the Q-ONE power feeder with continuous scrap/ DRI charge and the Q-Melt process control suite, the Digimelter ensures automatic and optimal operation with zero impact on the power grid.

This advanced digital system transforms scrap metal into high-quality, environmentally friendly products, reducing resource consumption and carbon emissions.

In fact, as businesses face increasing pressure to curb emissions, solutions like the Danieli Digimelter demonstrate that it is possible to maintain a competitive edge while also spearheading sustainability and boosting productivity.

Presentations highlighted the Digimelter's unique design, enabling it to achieve remarkable performance with minimal CO2 footprint. The Q-ONE digital power feeding solution seamlessly integrates with renewable energy sources like solar and wind, making it a sustainable choice for modern steelmaking.

This technology is particularly crucial for jumbo-size furnaces, which require substantial electrical power supplies.

During the plant visits, DIM guests had the opportunity to explore the real-life applications of Danieli Digimelter technology at: ABS Sisak

The Q-ONE power feeder provides efficient and stable power delivery to the Danieli Digimelter with no impact on the power grid.

KEY FEATURES



Digimelter technology combines power, intelligence, and environmentally friendly equipment

to achieve 15,000 heats per year with minimal OpEx, lowest environmental impacts, and high flexibility for raw materials.

- The Q-ONE electrical feeder provides the highest power factor and very low network flicker due

to real-time arc control. It achieves unprecedented high-power transfer thanks to independent control of arc current, voltage, and frequency, for each electrode.

- The Q-Melt intelligent controller runs EAF melting processes automatically, in a stable and adaptive way by making use of the Q-Reg+ electrode regulator, Lindarc laser

off-gas analyzer, and Melt-Model self-learning optimizer.

- The Zerobucket concept is accomplished by the ECS continuous scrap charging and preheating

system as well as continuous hot-DRI feeding from the roof, for reduced environmental impact and enhanced energy saving.

- The Eco-Pro airtight design is conceived to reduce pollutants to the minimum. Compared to a conventional EAF with the same charge mix, Digimelter Eco-Pro reduces the CO2 direct emissions (Scope 1) by more than 50% and

overall CO2 emissions (scope 2) by 25%.

Steelmakers worldwide are relying on the Danieli Digimelter for BF technology transition. A notable project showcased was the voestalpine Stahl Donawitz initiative, where two new Digimelters will replace blast furnace #4 for special steel production, leading the transition from the BF route.

CASTING INNOVATION

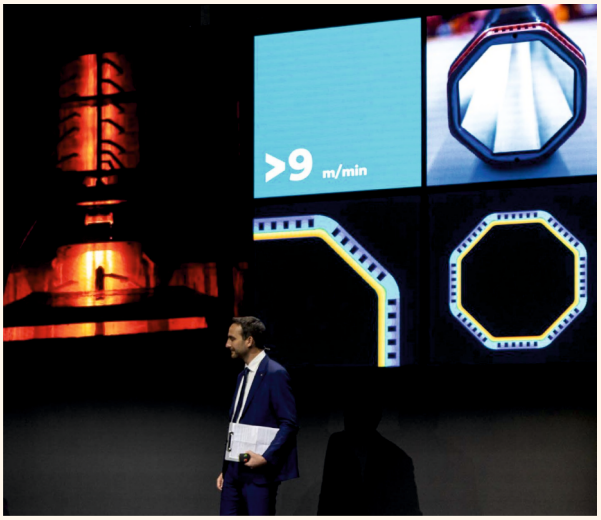


VOESTALPINE STAHL DONAWITZ GOES GREEN

voestalpine Stahl Donawitz GmbH recently awarded Danieli the contract to supply two advanced Digimelters for its Leoben, Austria, steel plant, aimed at producing ultra-high-quality green steel.

Powered by Danieli's Q-ONE power feeder, these Digimelters ensure dynamic arc control with minimal impact on the power grid, improving both energy efficiency and performance. Initially equipped with four modules, the system can be expanded to six, boosting production capacity to 1.7 million tons per year. Operations are set to begin in 2027.

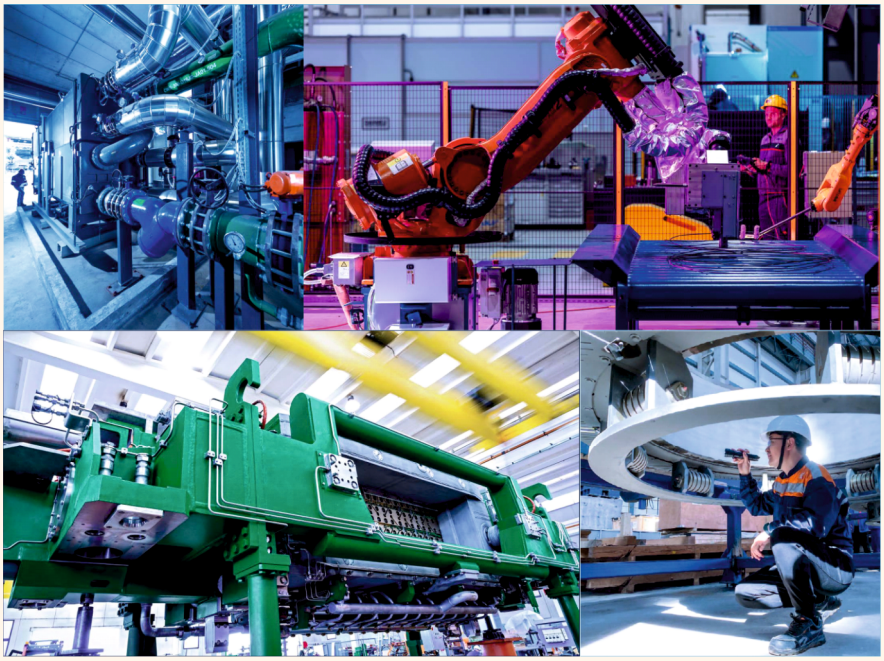
The session also highlighted the latest Danieli casting innovations, providing a comprehensive outline of available and future technologies.



Experts emphasized the importance of scrap preparation and sorting to enhance EAF efficiency, while case studies underlined how investing in plants for on-site scrap-processing with shears, pre-shredders, and shredders can significantly reduce operational costs and improve safety.

Danieli experience also demonstrated how high-quality, low-carbon steel grades for flat products are achievable through the EAF-LF-VD route, which maintains low-residual content and high steel cleanliness.

Danieli casters set the benchmark for both long and flat products, delivering exceptional qualities, internal soundness, high casting speeds, and productivity in large sizes. MI.DA QLP® minimills, incorporating Digimelter and Octocaster solutions, ensure stable, consistent endless casting-rolling, and competitive production of rebar and wirerod.



A focus on Danieli's jumbo bloom casters highlighted their ability to produce high-quality, heavy, and large round sections up to 1600-mm in diameter, essential for wind-based renewable energy plants. Vertical semi-continuous casters integrate traditional methods with modern technologies like induction heating, enhancing efficiency, quality, and sustainability.

Another discussion showcased DySenCaster technology. For flat- product casting, steel flow patterns in the mould are critical; this dynamic global mould-flow control technology allows high casting speeds and unlimited steel grade production.

Success stories from the installation of Danieli's 3.6-Mtpy slab caster at Jindal Steel and the CSP to QSP-DUE technology conversion at Nucor Steel Gallatin were also presented.

HEAT RECOVERY

Several innovative environmental technologies were outlined. These include the integration of fume quenching processes and heat recovery systems to reduce dioxin emissions. The Q-Water system saves water usage and energy consumption, while other technologies like Zero- Liquid Discharge, Zero-Scale Pit, and DanFilters ensure efficient, reliable, and economical water treatment plant operations.

INDUSTRY 4.0

Danieli Automation Q-Robots enhance performance efficiency and add value through intelligent solutions capable of learning and

optimizing operations. These robots work independently with minimal external input, improving accuracy, repetitiveness, and safety.

Shifting from product-based to service-based models, Danieli Automation offers advanced monitoring and maintenance services. By remotely monitoring assets, early signs of equipment failure can be detected, proactive maintenance scheduled, and the impact of breakdowns minimized.

From the left, clockwise: Danieli solutions for quenching and heat treatment, robotics, casting (VSCC Vertical Semi-Continuous Caster), and dynamic mould flow control (DySenCaster).

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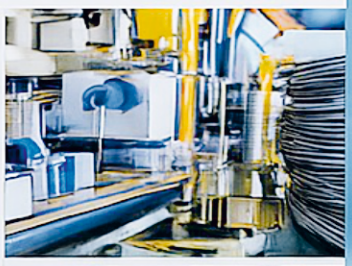





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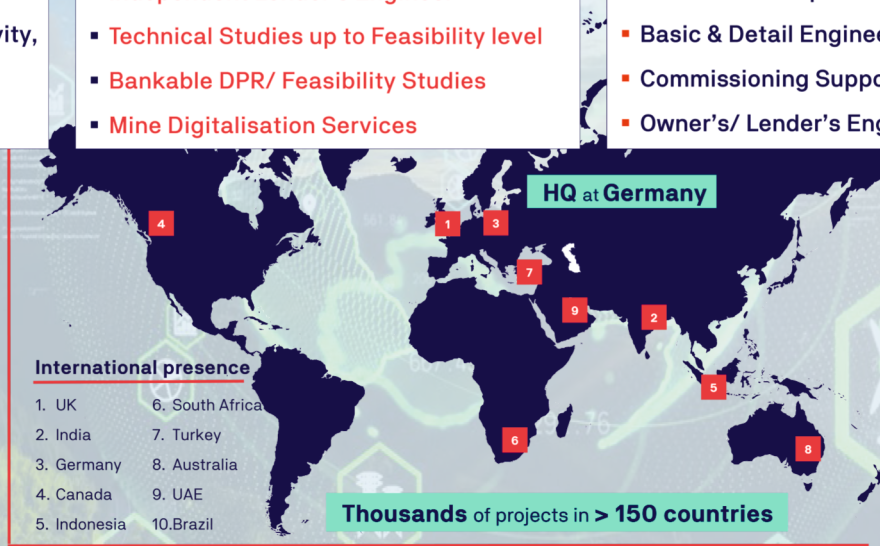

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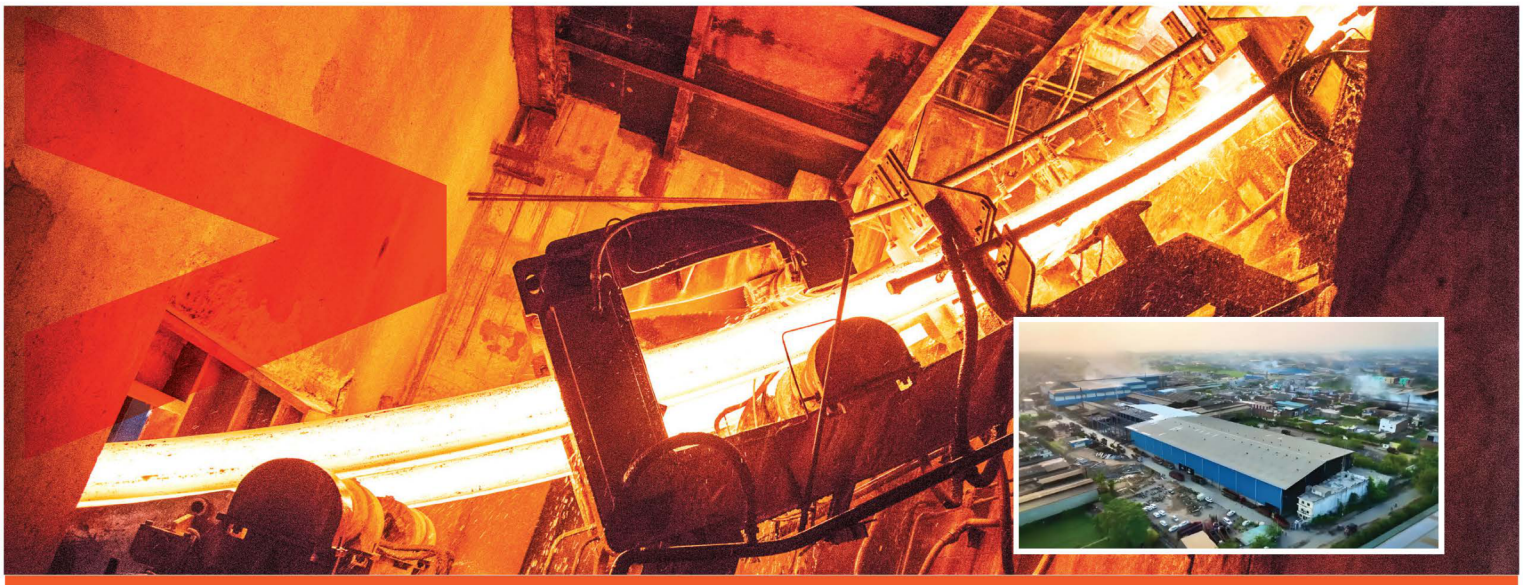

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SESSION

"SUSTAINABILITY THROUGH REDUCTION IN CARBON EMISSION & CARBON CAPTURE, UTILISATION & STORAGE"

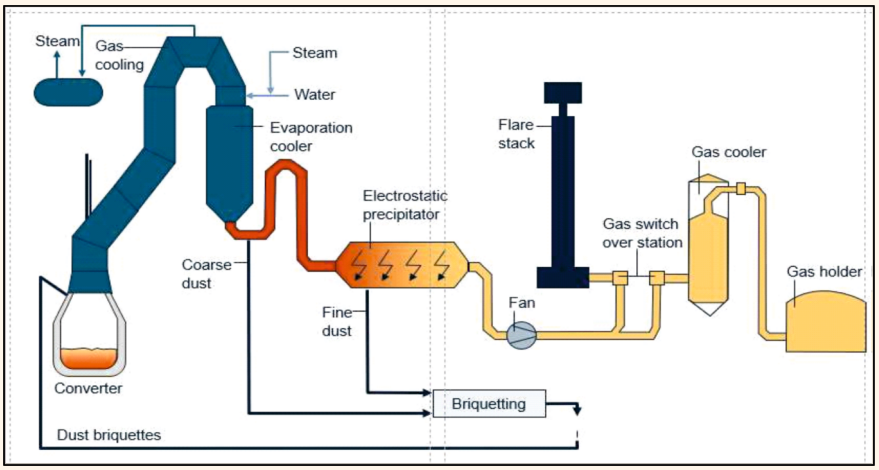
DRY GAS CLEANING TECHNOLOGY IN OXYGEN STEELMAKING PROCESS: A GREEN FUTURE

Author
Sanjit Biswas

Iron and Steel industry is considered as one of the major contributors of global pollution and carbon footprint. In India, more than 75% of crude steel is generated through BF-BOF route. Carbon present in hot metal generated from BF is oxidised to CO/ CO2 by oxygen blown through lance to produce steel. In conventional gas cleaning process which is predominant in Indian steel industry, gas is cooled through pressurised water circulation system comprising of cooling stack, circulation pumps and fin fan heat exchanger. Cooling stack takes off thermal energy from the gas generated during blowing process. Hot water out of cooling stack is cooled through fin fan heat exchanger which dissipates this huge thermal energy to the environment after exchanging heat from the ambient air. The gas is further cleaned in a water scrubber system where huge volume of water is used to scrub dust particles from gas by creating venturi effect. Due to high loss of pressure to overcome the venturi effect, radial fan is used with a very high suction pressure causing high power consumption. Slurry generated from scrubber is treated in waste water treatment plant. Dust emission level from stack is 50 mg/Nm3.

Primetals technologies introduced dry gas cleaning technology for LD converter in late 1970s and installed the first dry dedusting system in the year of 1979. The technology replaced water intensive scrubber with Evaporation cooler and Electrostatic precipitator. Dust separated from the BOF gas is dry in nature and collected through conveyor system into silo and recycled back. Moreover, Due to low pressure drop in the gas cleaning process, the power consumption of fan is also substantially reduced. Dust emission level from stack is reduced to 10 mg/Nm3 of gas. In advancement of this technology, the conventional hot water circuit is replaced by energy recovery system. This system, comprising of cooling stack (acts as boiler) and a steam circuit use the energy of BOF gas to produce steam. The steam is used in other metallurgical process like RH/ VD.

Primetals Technologies is the market leader in dry gas cleaning system having references of more than 70 running installations all over the world.



Process flow diagram : dry gas cleaning for BOF converter

FROM CARBON CAPTURE TO CARBON CREDIT

Author
Harsh Choudhry



sentra.world is an industrial sustainability platform built for steel industries to measure, mitigate, and monetise CO_2 emissions across their entire value chain. As India moves toward a low-carbon economy, sentra.world helps companies bring sustainability into their daily operations through clear, data-based digital carbon management platform. It supports compliance with key global and national frameworks such as India's Carbon Credit Trading Scheme (CCTS), the EU's Carbon Border Adjustment Mechanism (CBAM), the Green Steel Taxonomy and many more.

sentra.world combines technology, automation, and industry expertise to make carbon accounting and compliance simpler and more accurate. Its AI-driven digital suite provides end-to-end solutions for carbon tracking, certification, decarbonisation, and carbon credit management.

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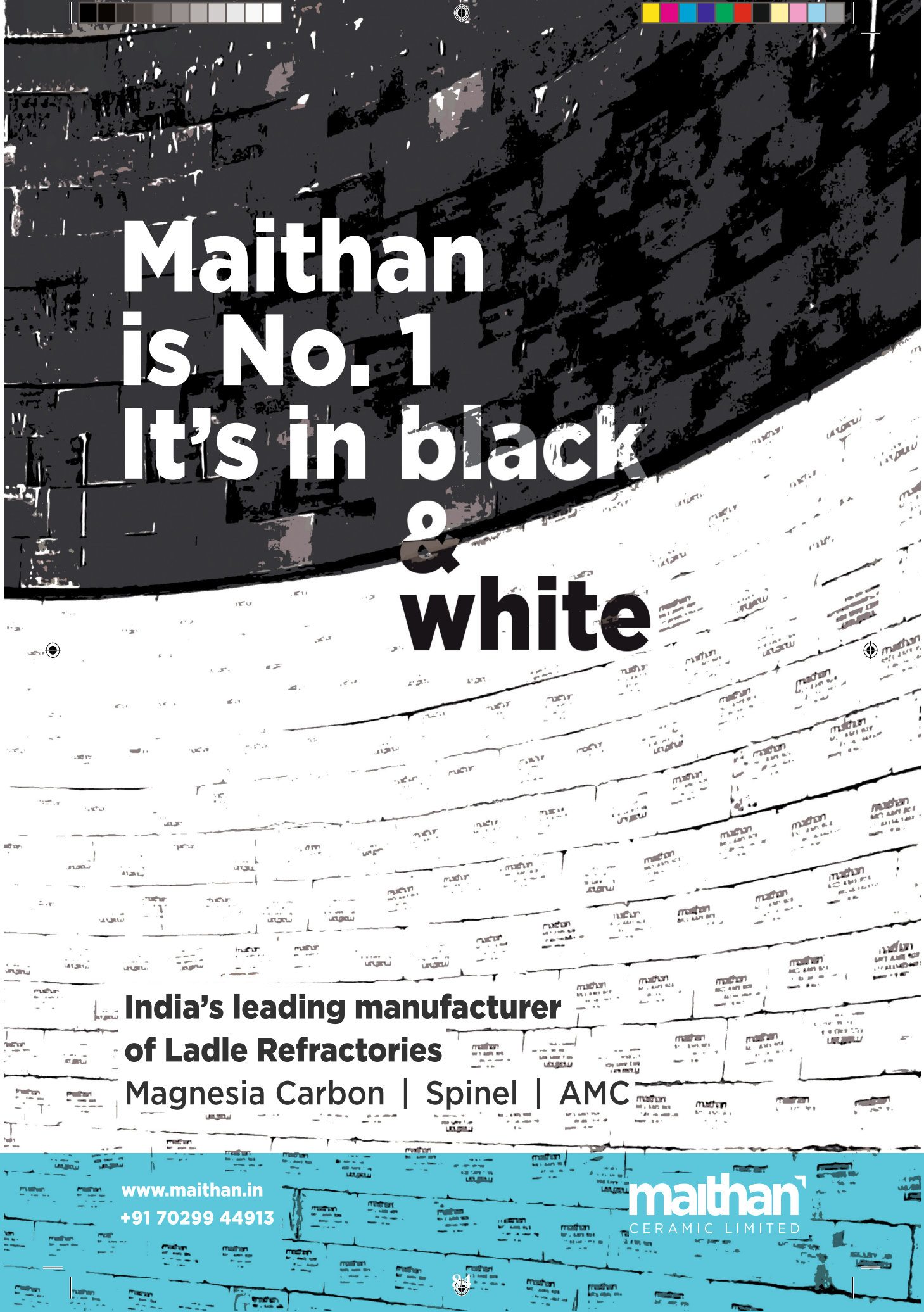
- ***Sentra.reduce** – Helps companies plan net-zero targets, choose decarbonisation projects, and build realistic roadmaps to reduce emissions.*
- ***Sentra.trade** – Provides a verified green marketplace where industries can source and sell sustainable materials and products with full traceability.*
- ***Sentra.carbcred** – Supports carbon credit management using verified product-level footprints, turning emission reductions into financial opportunities.*

These tools create a unified system that helps industries automate carbon data, stay compliant with changing regulations, and build trust through transparency.

As India aims for its 2070 net-zero goal, industries need to show clear progress on decarbonisation and compliance. New policies such as CCTS and CBAM are setting higher expectations for manufacturers and exporters. sentra.world helps steel companies stay ready for these changes by making sustainability measurable, reportable, and profitable.

***With its AI -** enabled digital platform and industry experience, sentra.world turns complex climate regulations into practical solutions, helping businesses move beyond carbon tracking to real, data-driven decarbonisation. Our digital platform is enabling India's industries to stay competitive in global markets while building a cleaner and more resilient manufacturing future.*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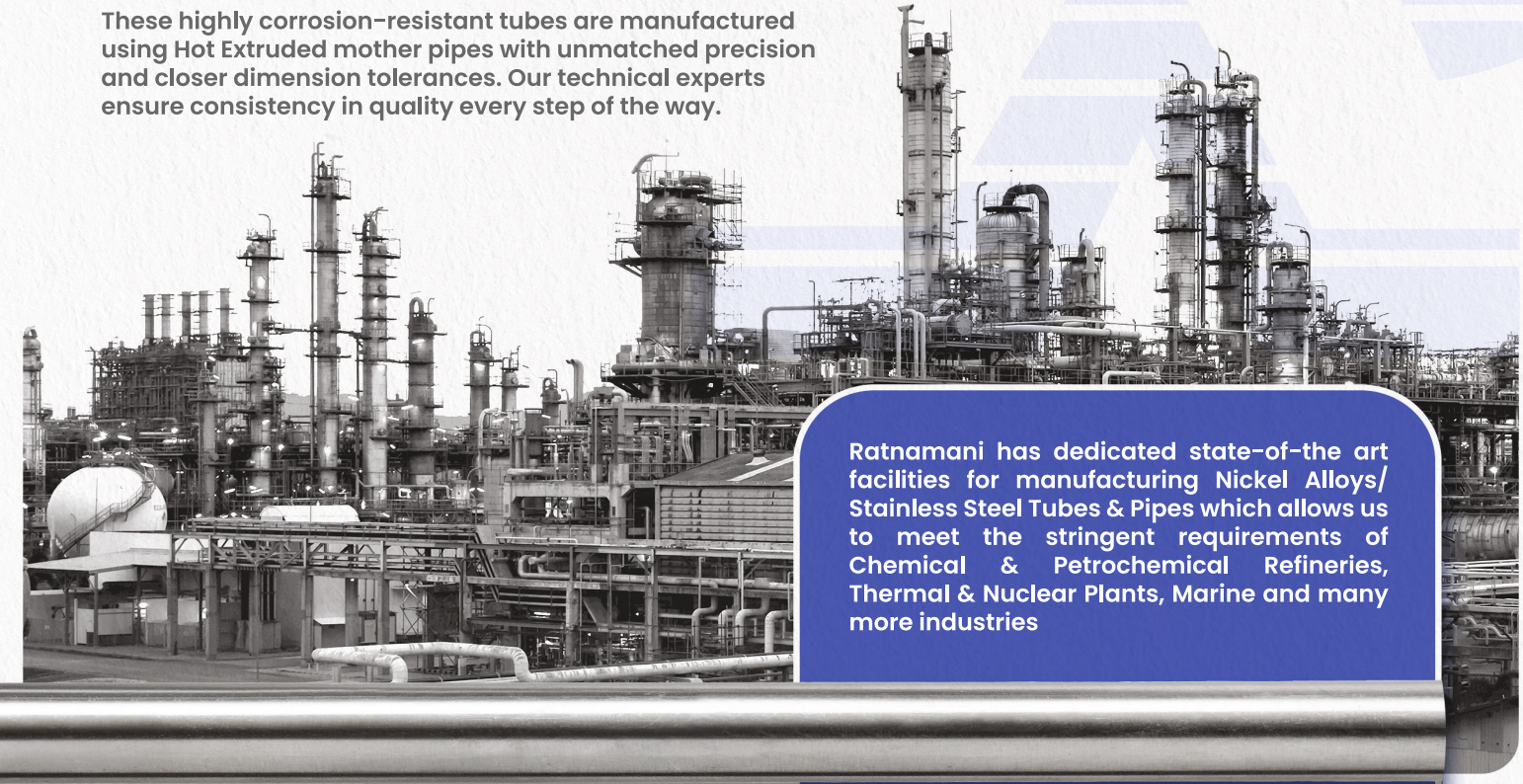

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SESSION

"EXPLORING OPTIONS THROUGH HYDROGEN & OTHER POSSIBILITIES"

SUSTAINABILITY THROUGH SYNERGISTIC INTEGRATION OF STEEL SUB-STRUCTURES AND FRP SUPER STRUCTURES

Bankim Chandra Ray
NIT Rourkela India

Steel has remained the pioneering structural material for both sub- and super-structures of major engineering marvels such as long-span bridges, skyscrapers, telecommunication towers, and industrial complexes owing to its superior load-bearing performance, ductility, reliable supply chain, joining reliability, and adaptability to large-scale prefabrication. However, as sustainability becomes a central global concern, steel demonstrates notable limitations such as high carbon emissions, energy intensive and massive corrosion issues. The steel-making sector currently emits about 2.6 Giga tons of CO2 per year (~62% higher than that of GFRP) and requires 18–20 MJ (~48% higher than that of GFRP) of energy for producing one kg of steel. In addition to this, steel's large self-weight, and its vulnerability to corrosion demands protective coatings, and regular and routine maintenance, thereby raising life-cycle energy. FRP composites offering exceptional lightweight, high specific strength-to-weight ratio, incomparably superior corrosion resistance, and remarkable durability, thus emerging as an effective alternative for superstructures, thereby promoting the development of hybrid structural systems. These hybrid systems employ steel for sub-structure components like foundations, pile caps, primary columns, and FRP composites for super-structures including secondary beams, decking, façade panels, and roof framing. Hence, integrating steel's proven reliability with FRP composites establishes a hybrid system that minimizes structural mass, resists corrosion, energy, and maintenance requirements. Recently FRP composites sector is rapidly advancing and especially where sustainability is an utmost priority on global stage, there uses of steel-FRP hybrids offer a practical and forward-looking approach to sustainable infrastructural development. Fiber Reinforced Polymer (FRP) composites are being considered in various secondary and non-structural applications onboard for their advantageous in the warship INS Vikramaditya, the Indian Navy's largest aircraft carrier.

Keywords: composites, steel, sub-structures, super-structures, sustainability

CIRCULATING FLUIDISED BED (CFB) GASIFICATION: PAVING THE WAY FOR GREEN STEEL

Varun Jindal
CEO, Dev Energy

WHAT IS GREEN STEEL?

Green steel refers to steel that is produced with significantly reduced or net-zero carbon emissions compared to traditional steel production. The term aimed at decarbonizing the steelmaking process while maintaining the quality and performance of steel. Key aspects:

Sustainable practices: Incorporating scrap steel recycling into production to lower the carbon footprint – Induction Furnace (IF) + Electric Arc Furnace (EAF)

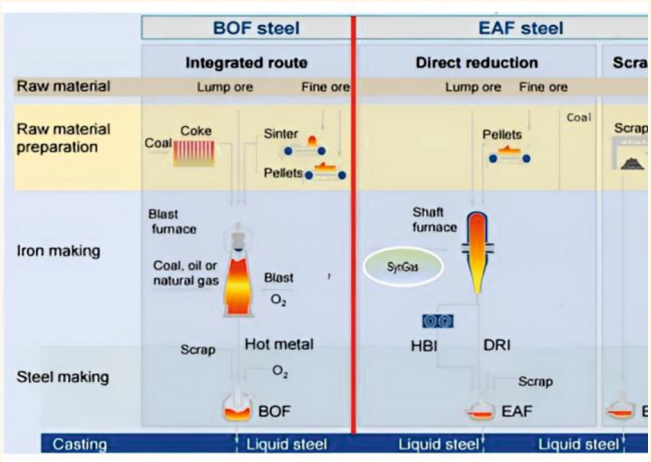
- Low-Carbon Steel Production – Renewable Power + Direct Reduction of Iron (DRI) + EAF
- Carbon Neutral Steel – 'Net-Zero' emissions, either by eliminating emissions entirely or by offsetting residual emissions through carbon capture, utilization, and storage (CCUS)
- Green Hydrogen-based steelmaking: Replacing coke or coal with hydrogen to reduce iron ore

It's important to note that global recognized organizations (WSA, IEA) neither define nor refer to the term green steel, instead, it defines low carbon steel in its climate change policy paper as "steel that is manufactured using technologies and practices that result in the emission of significantly lower CO2 emissions than conventional production."

Green steel is central to achieving global decarbonization targets, as the steel industry accounts for about 7–9% of global CO_2 emissions.

CONVENTIONAL STEEL MAKING

Currently as per global statistics, 71% of steel is currently made using the BF-BOF process, with 29% produced by the EAF method. (Source: World Steel Association -WSA



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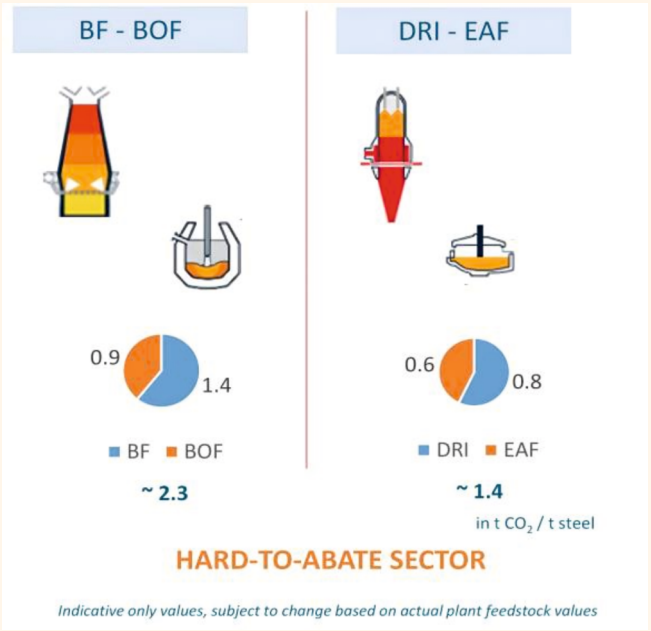
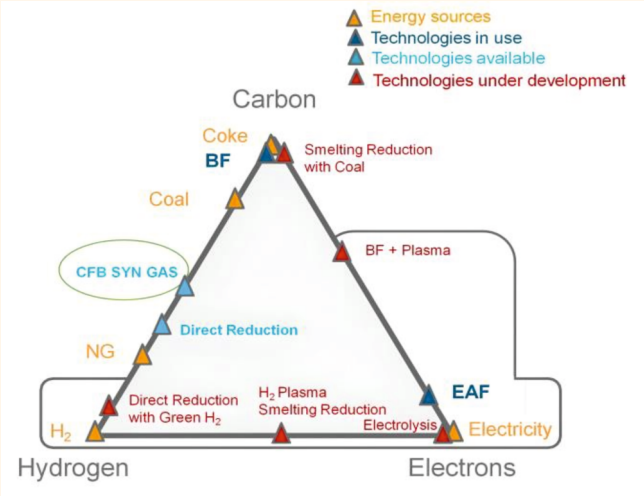


Dev Energy already has delivered end-to-end turnkey solution offering in scrap processing with Induction Furnace (IF) + Electric Arc Furnace (EAF) over a decade delivering 0.6 - 0.7 t CO2 / t Steel.

BASICS OF LOW-CARBON STEEL MAKING



As elaborated above we have three critical variables, and considering technological level of development as of now for making target of low-carbon steel it obvious that CFB + DRI + EAF is most viable option towards Green Steel.

TECHNOLOGY SELECTION – WHY CFB?

Commercial scale three technologies which are Fixed Bed, Entrained Flow and Fluidised Bed technologies below pros and cons:

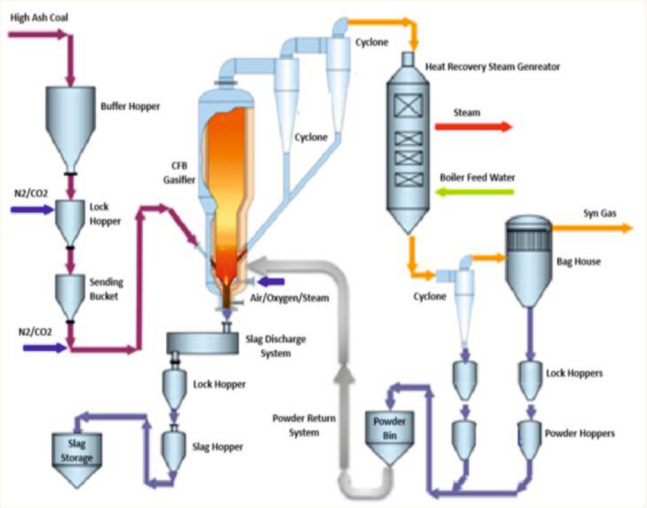


Based on various interactions organised by the Ministry of Coal for the implementation of the National Coal Gasification mission it is evident that all major technology developers such as Thermax, BHEL and CSIR-CIMFR have chosen CFB starting with pilot scale as the most suitable technology for Indian high ash coal.

FUTURE - SUSTAINABILITY

CFB gasification as detailed below is flexible coal gasification technology with advantage of handling high ash (as applicable to India scenario) and when combined with already matured technologies, water shift and CO2, H2S removal units can deliver flexible DRI SYN Gas composition at optimised pressure and temperature in overall high efficiency economical solution as compared to conventional Natural Gas reforming.

CFB TECHNOLOGY OVERVIEW



CFB TECHNOLOGY – HOW IT WORKS?

Circulating Fluidized Bed (CFB) technology is a coal gasification process where solid fuels are converted into a syn gas (majorly H2, CO, CH4) at high temperature in presence of gasification agents oxygen/air and steam.

Grinding, sorting, shredding, and/or drying may be required to bring the feedstock up to the gasifier feed system's standards of <10 mm particulate size.

The prepared feedstock is pneumatically supplied to the CFB gasifier vessel, which is a bubbling in circulating fluidized bed reactor. The feedstock

combines with air/oxygen and steam as gasification in the fluidized bed, uniform temperature of 1000 oC is maintained to provide high carbon conversion and non-slagging conditions for the feedstock's ash.

The CFB gasification process is carried out as partial oxidations as gasification of feedstock with agglomeration and separation of ash.

Ash is removed by gravity from the gasifier and is discharged into a system for depressurization and disposal. The gasifier maintains a low level of carbon in the bottom ash discharge stream and achieves overall carbon conversions that can exceed 96%.

CFB is more fuel-flexible, utilizing low-rank and other high-ash coals, and offers higher efficiency than competing gasification technologies, due to the fluidized bed design and resulting long residence times of the reacting particles.

Fines carried over from the fluidized bed are separated from the syngas prior to heat recovery and syngas cleanup. The product syngas is essentially free of tars and oils due to the temperature and residence time of the gases in the fluidized bed, simplifying downstream heat recovery and gas cleaning operations.

CFB gasification adopts three-stage waste heat recovery process, which can recover the heat of high temperature syngas to produce high temperature and high pressure steam along with air/oxygen preheating resulting in overall high thermal efficiency.

CFB TECHNOLOGY FEATURES & ADVANTAGES

Feed

- Use 0 – 10 mm Coal Fines, Dry Feed
- Up to 30% Ash
- Ash Fusion Temperature ≥ 1250 ^{o}C
- Air / Oxygen Fed

Performance

- Output of 80,000 Nm3/hr per gasifier
- Turndown ratio up to 30%
- Operating pressure ~ 15 bar
- Carbon conversion ≥ 98%
- High Energy Efficiency – WHRB

Effluents

- Fines recycle – Min Fly Ash
- No Tar
- No Phenolic Water Generation

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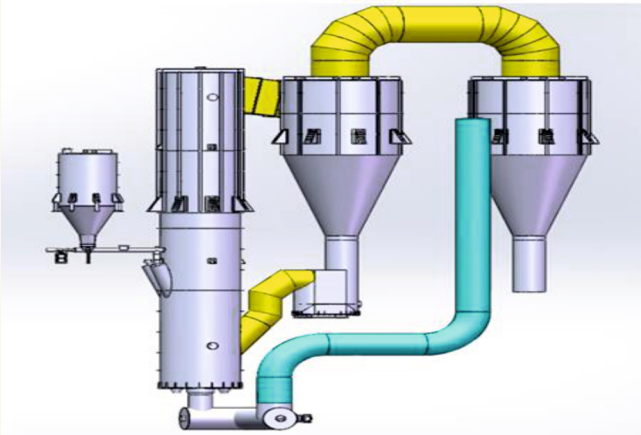

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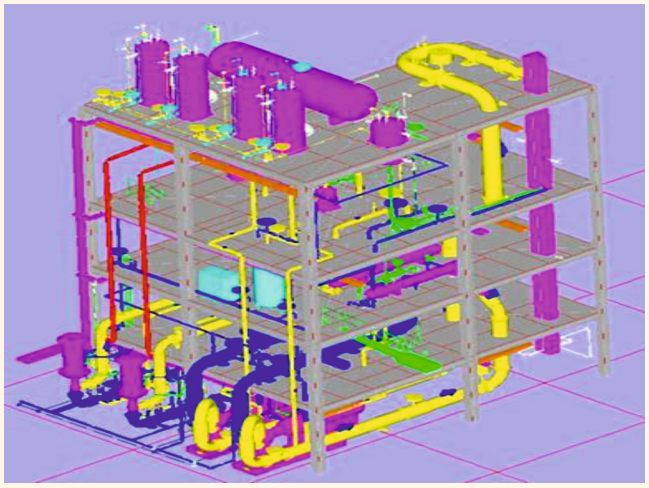
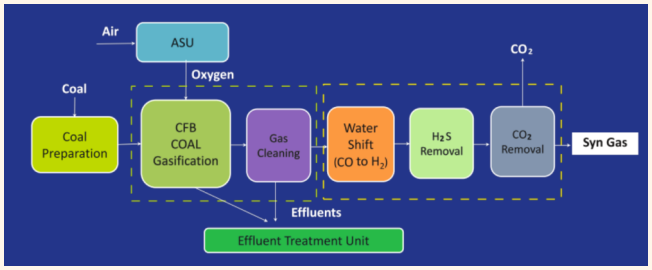


OPTIMIZED PROCESS CONFIGURATION



COMPATIBILITY WITH DOWNSTREAM DRI LICENSORS

CFB technology with complete package as DRI SYN GAS solution has full flexibility of H2/CO ratio such as 1.1, 1.6 or even future -proof 100% Blue H2 with CCUS.

Dev Energy offers as required by all global vertical shaft DRI technology Liensors making it wide adaptability for overall technical and commercial optimisation to make Green Steel.

COMMERCIAL DRI PLANT – READY FOR OFFERING

0.5 MTPA DRI – Vertical Shaft Kiln

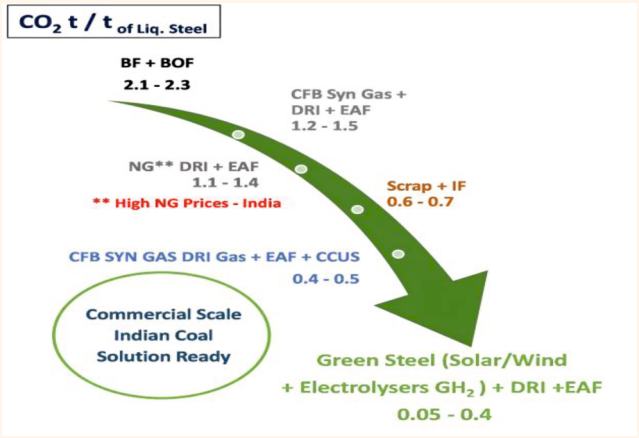
SYN GAS REQUIREMENT		DEV ENERGY CFB
FLOW RATE	62,500 Nm3/hr	✓
H_2/CO	≥ 1.6	✓
H_2	≥ 52.0%	✓
CO	≥ 32.5%	✓
CH_4	≥ 4.0%	✓
CO_2	= 2-3%	✓
N_2	≤ 5.0%	✓
Pressure	≥ 12 bar A	✓

FLEXIBILITY OF CFB OFFERING

CFB gasification adopts oxygen-enriched gasification, and the N2 content in syngas can be effectively controlled below 5% or lower. CFB gasification pressure is high avoiding any downstream compression requirement, and the CH4 content in the syngas can be up to Controlled ideal for DRI steel-making feedstock.

TECHNICAL & ECONOMIC ADVANTAGES

Stable Size of Kiln	1500 tpd
Metallization Rate	~ 94 %
Carbon % in DRI	~ 2.0 %
Iron ore Input	~ 1.38
Campaign life	~ 400 days
Pollution	Negligible
DRI Discharge	Hot
Solid Waste	Nil



CONCLUSION

DEV ENERGY with its successful Turnkey project design and implementation proven solution provider has delivered > 23 years and is committed to Sustainable Green Steel Solution with exclusive partnerships already in place. With experienced & qualified EPC solution provider not only can coal gasification projects for DRI SYN GAS as path forward for Green Steel on fast track but also provide after sales service and operational success.

WASTE TO WEALTH A BETTER RESILIENT WORLD



Anil Passary , Director **,** Passary Minerals Pvt. Ltd. & Urvarak Industries Pvt. Ltd.
E-mail: anilpassary@gmail.com

The steel industry, which has long contributed to meeting the nation's infrastructure and development needs, now holds the potential to support sustainable agriculture in India and strengthen global resilience by transforming steel slag into fertilizers. This initiative aligns with the principles of the Circular Economy, promoting resource efficiency and a low-carbon footprint to combat global warming.

Although the concept of producing fertilizers from steel slag is not new globally, it is gaining renewed importance in India in the context of doubling farmers income, low pesticides farm produce, sustainability and carbon reduction. Our company recognizes the availability of such technologies worldwide and takes an extra step forward by integrating them with our R&D expertise and technical capabilities.

Fertilizer, produced from domestically available steel slag, have the potential to meet the agricultural demands of the entire country. They enhances soil health, crop yield, and pest resistance, thereby reducing dependence on chemical Fertilizer and pesticides. They also improve the quality and aroma of farm produce. When used in combination with cow dung or farm manure the resulting crops can be considered organic. Furthermore, they reduce the required doses of conventional NPK fertilizers.

Unlike many chemical fertilizers, the steel slag fertilizer do not sublimate or leach away with rainwater. They remain in the soil until they are fully absorbed by crops, ensuring long-lasting benefits and contributing to sustainable agricultural productivity. Steel slag fertilizer reduces Greenhouse Gas emission.

Keywords: composites, steel, sub-structures, super-structures, sustainability

Biochar in coke making: A sustainable approach to minimize CO_2 emissions by partially replacing fossil coal with a carbon-neutral alternative.

ANIL PASSARY

The potential of biochar to compensate for fossil-derived fuels in metallurgical processes is largely unexplored. It also contributes to CO2 emission mitigation, which is one of the major challenges of the steel industry, emitting 2.6 Gt of CO2 annually (7-9% of global emissions). Our work focuses on the preparation of green coke by utilizing a biochar and coal blend, which could work as metallurgical coke in the iron-making process. An effort has been made to prepare metallurgical coke by adding different percentages of biochar (1-5%), with size variations of 1 mm and

2.83 mm, to coking coal for the coke-making process. The addition of biochar to coal in the coking process and understanding the impact of biochar properties on the coal blend and bio-coke reactivity has been explored. Coal and biochar have different structural and chemical properties; therefore, adding a small amount of biochar resulted in a deterioration of coke properties. Characterizations such as FTIR, ultimate analysis, proximate analysis, crucible swelling number, plasticity, and dilatometer tests were performed on coking coal blends. The plasticity and dilation of the biochar-coal blend decreased with increasing biochar percentage up to 2%. A comparable CSR and CRI were achieved after the addition of biochar. The study paves the way towards the utilization of biochar in sustainable coke making in steel industries.



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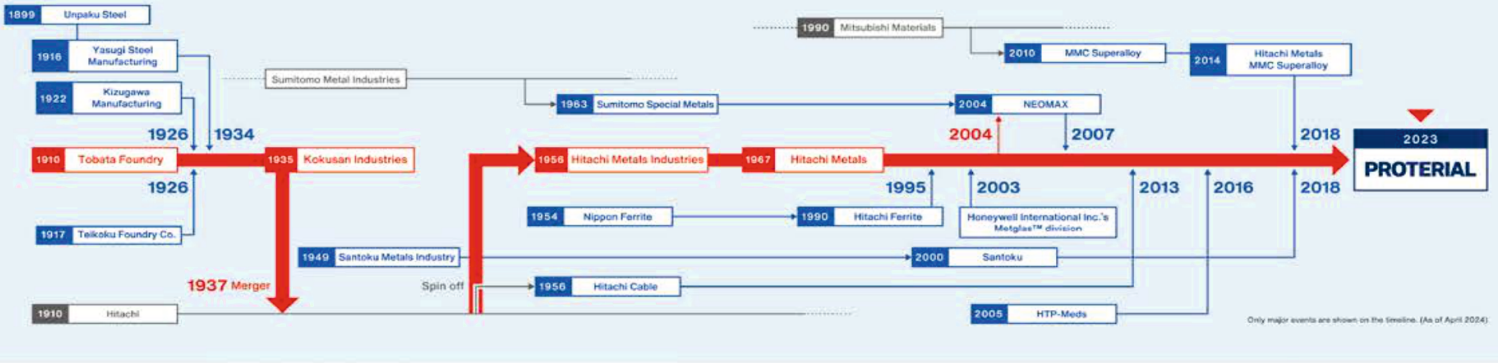

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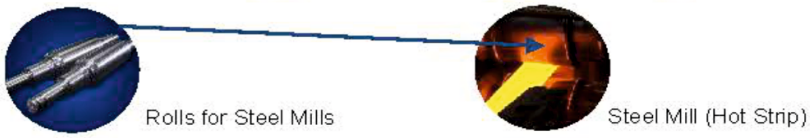

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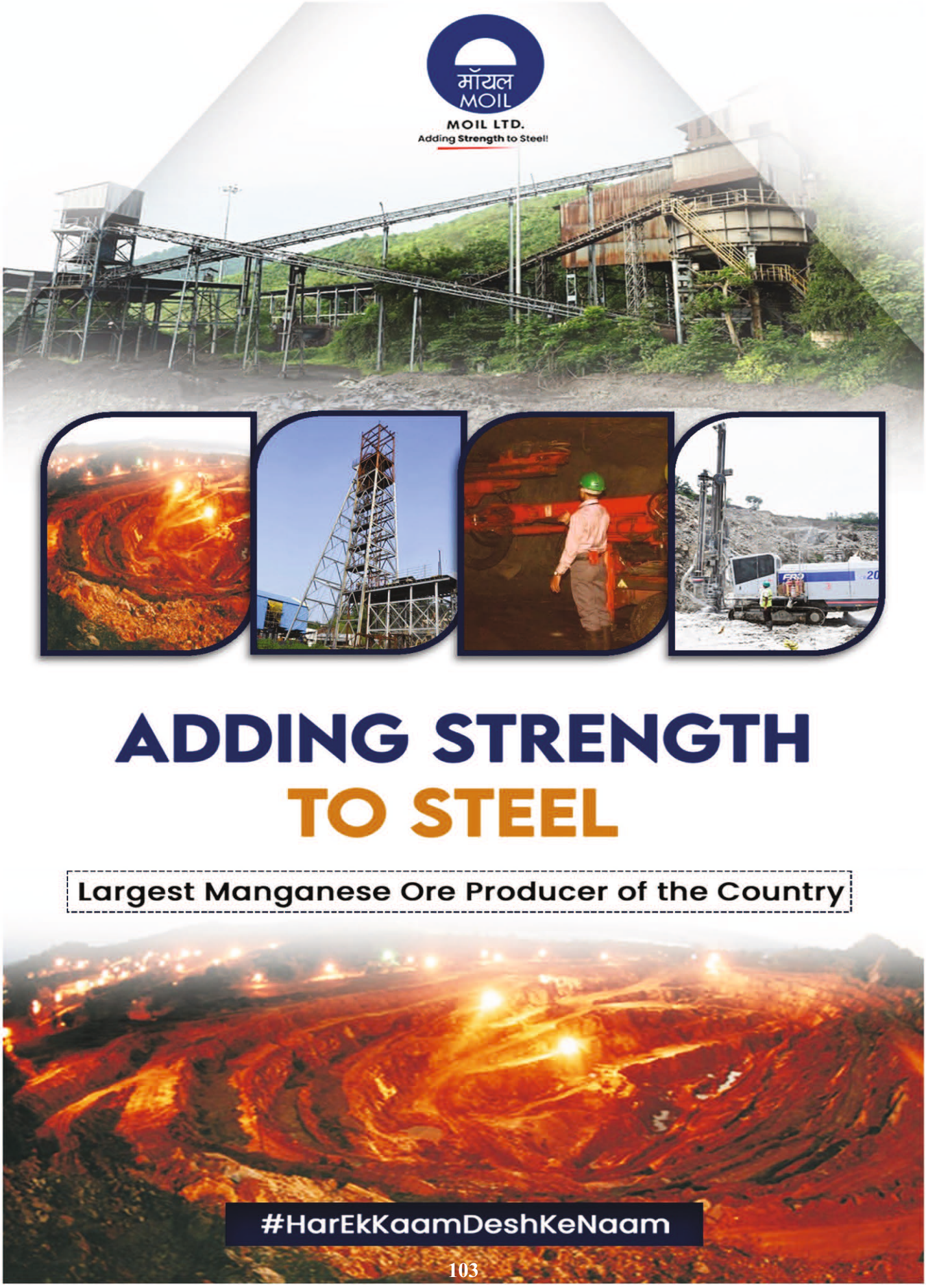
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SESSION

"SUSTAINABILITY THROUGH QUALITY"

IMPROVING RELIABILITY OF INCLINED CONVEYOR SYSTEMS: IMPROVEMENTS ON CONVEYOR BC-245 AT ROURKELA STEEL PLANT



Ujjal Kumar Mondal, Kevin Karren Bhengra
RDCIS, SAIL, Ranchi

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Contact No: +91 8986880322

Synopsis

The Conveyor BC-245 at Rourkela Steel Plant is a critical conveyor for iron ore transportation from the Raw Material Handling Plant to stock house ore bunkers of one of its Blast Furnaces. The horizontal length and the vertical lift of BC-245 is more than 230m and 45m respectively with an inclination angle of about 12 degree. The Conveyor operates at 1080 TPH. The conveyor underwent persistent operational challenges which resulted in frequent belt reversal during power or mechanical failures, causing iron ore accumulation, manual clean-up requirement, safety risks, and decreased productivity. The original holdback mechanism, combining an indexing wheel and a hydraulic braking piston, proved insufficient under heavy and monsoon loads. In response, RSP and RDCIS collaboratively implemented an upgraded solution featuring a sprag-type backstop clutch, a reinforced turbo drive pulley with heavy-duty plummer blocks, all engineered to fit within existing conveyor dimensions and optimized to necessary torque and drive parameters. Commissioned during capital repair and the enhanced system underwent comprehensive full-load trials. The modified mechanism demonstrated robust, consistent performance across all operating scenarios, eliminating belt reversal, reducing manual intervention, and prolonging component lifespan. This intervention highlights the necessity of reliable holdback systems in high-capacity, inclined conveyors for enhancing operational safety and plant efficiency.



Fig. 1: Fabrication and Erection of backstop clutch torque arm support/mounting bracket

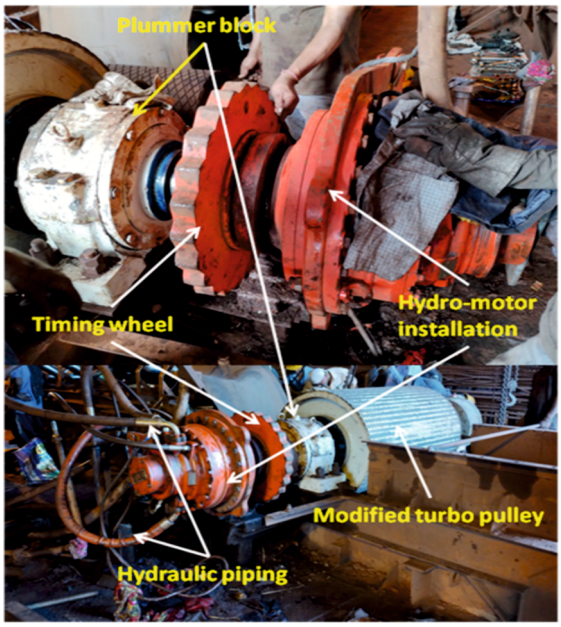

Fig. 2: Re-Installation of Conveyor existing hydro-motor drive

Keywords: Belt conveyor; Holdback; Backstop clutch; Conveyor reversal

HIGH-VOLUME PRODUCTION OF QUALITY REBAR USING INDUCTION FURNACE ECOSYSTEM

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Abstract:

The steel industry is undergoing a transformation toward energy-efficient and environmentally sustainable operations. This paper presents an integrated "Induction Furnace Ecosystem" a digital and operational framework designed for high-volume, high-quality rebar production using scrap-based induction melting technology. The ecosystem begins with a smart raw material yard that utilizes electrically operated excavators and an Intelligent Scrap Grading System (ISGS) to sort scrap grade-wise, thereby minimizing manual intervention and carbon emissions. Just-In-Time (JIT) scrap feeding, supported by GPS tracking and weighbridge checkpoints across three strategic yards, ensures continuous and traceable material flow to the steel melting shop.

The core melting section consists of five induction furnaces (two of 26 MW and three of 16 MW) equipped with Di-FOC panels, refractory erosion detection, and a Dust Collection System (DCS) for emission control.Enhanced feeding through stationary cranes, grabbers, and poker manipulators increases melt rate and process efficiency.

Billet production is handled by two billet casters (3-stand and 2-stand) integrated with Ladle Positioning Modules, Quick Nozzle Changers, and M-EMS (Mould Electromagnetic Stirring) to refine grain structure.

The hot billets are then passed through a series of rollers (stands) to achieve the final shape and diameter of the rebar. This process may require multiple passes to refine the dimensions. In our mill, we can produce rebar sizes ranging from 8 mm to 40 mm, and we've recently introduced 36 mm and 40 mm bars, as well as multi-slit technology for 8 mm, 10 mm, 12 mm, and 16 mm sizes.

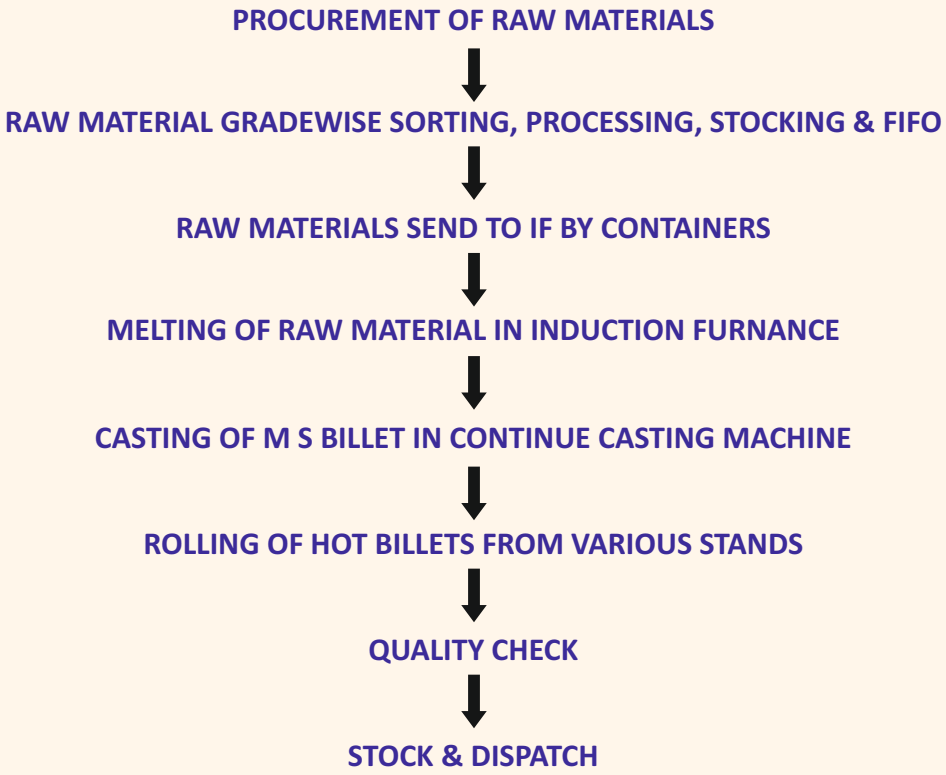
To enhance certain properties, the hot finished bars are sent through cooling boxes, known as quenching systems, which improve the mechanical properties of the bars. The bars then cut into 72-meter lengths and moved to a cooling bed for temperature equalization. Based on customer requirements, we can provide varying lengths from 6 meters to 18 meters.

ERP-based coordination completes the ecosystem, ensuring synchronized production, energy optimization and traceable quality. This ecosystem delivers superior productivity, lower environmental impact, and consistent rebar quality positioning it as a scalable model for modern green steelmaking. Also, the establishment of Plant (Plant Build-up Time) required 15-18 Month which is half of time required for other routes.

1. Introduction

Rebar demand in India and globally is surging due to rapid infrastructure expansion. Induction furnace (IF) technology has evolved into a viable, low-capital alternative to conventional blast and arc furnaces. However, challenges such as inconsistent scrap quality, poor traceability, and higher emissions have limited its potential in premium-grade rebar production.

The Induction Furnace Ecosystem was conceptualized to overcome these issues by integrating advanced control, automation, and sustainability practices across the production chain—from scrap yard to finished rebar.



2. System Architecture of Induction Furnace Ecosystem

2.1 Raw Material Yard and Handling

- Three-yard configuration: one open and two closed, providing weather protection and space optimization.
- Electrically operated excavators replacing diesel machines, reducing carbon footprint by ~25%.
- Intelligent Scrap Grading System (ISGS) classifies scrap by density, composition, and size, ensuring uniform charge mix.
- Process including: -

Unloading → Sorting as per Grade → Processing (Chopping/Shredder) →
Bundle Making → Stocking → Loading to Furnace

- Just-In-Time (JIT) movement of scrap via GPS-enabled vehicles monitored through weighbridges installed at strategic intervals for material traceability. For JIT, various machine helps to optimised productivity like Shredder, Chopping and Press Machine (Bundle making)
- Close loop monitoring process control through weighbridge integration with ERP software.
- All the scrap processing facilities area installed in concise manner in 30 Acre area with 30 Electrically operated sorting machines.

2.2 Induction Furnace Cluster

- **Five induction furnaces:** 2 of 50T × 26 MW and 3 of 30T × 16 MW.
- Di-FOC (Digital Field Oriented Control) panels optimize electrical efficiency and enable fault diagnostics.
- Using neutral ramming mass for long sequence life of furnace for production optimization.
- Furnace load cell for time-to-time Monitoring.
- Refractory lining erosion detection system ensures predictive maintenance and operational safety.
- Dust Collection System (DCS) captures emissions and allows safe disposal or reuse of metallic fines.
- Ensured safety operation by consistently run online monitoring system.
- Alloys & Mn addition conservation way of using available resources.
- Quality monitoring to ensure the Grade formation by tracking 18 elements by spectrometer. Ensuring this before tapping 4 number of samples taken.
- Gas level also monitor by LECO system.

2.3 Charging and Melting Optimization

- Combination of EOT cranes, stationary grabbers, and poker manipulators increases charging frequency.
- Continuous melt monitoring through PLC-based control improves power factor and reduces tap-to-tap time.

2.4 Billet Casting Section

- Two billet casters: one 3-stand and one 2-stand, both equipped for high-speed, long- sequence casting.
- Ladle Positioning Module (LPM) ensures alignment and minimizes metal loss during transfer.
- Quick Nozzle Changer (QNC) supports extended tundish campaigns.
- M-EMS (Mould Electromagnetic Stirring) improves internal soundness and grain refinement.
- Aluminium wire feeder at meniscus and gas purging station removes non-metallic inclusions effectively.
- Yield percentage of total production on caster has been increased.
- Billet Manufacturing from 6 Meter cutting length to 18 Meter which form in tonnage as from 900 Kgs to 3 ton.

2.5 Hot Rolling Mills Integration

- Three rolling mills operate in synchronization with caster output.
- Billet maintains temperature between range of 1000 to 1100°C by induction heater of billet.
- Direct Hot Charging eliminates the need for reheating furnaces, which results on reduction in emission generated by reheating furnace.
- Dimensional & surface defect monitoring systems ensure consistent product quality.
- Line 01: 8–32 mm single strand
- Line 02: 6–12 mm Slit + Block Mill (wire rods)
- Line 03: 8–40 mm multi-slit (commissioned 2024)
- Rolling involves 18–24 stands (roughing → finishing). Thermax & Tempcore systems provide controlled quenching and self-tempering, resulting in a hard martensitic surface + ductile ferrite-pearlite core. This produces Fe550D, Fe600 & CRS rebars for critical structures.
- With Hot rolling the energy conservation is done.

2.6 ERP and Digital Coordination

- Unified ERP system connects Yard →s Furnace → Caster → Rolling.
- Material Positioning module. (Ladle for molten metal and Hot material tracking in Mill)
- Tracks heat number, chemistry, energy consumption, and production time in real-time.
- Enables performance analytics, KPI-based monitoring, and collaborative decision-making.
- Close loop monitoring of Material.
- SCADA for monitoring system of furnace and CCM. Also, software in Mill.
- Continue data monitoring results in track material flow with optimized Process parameter.

3. Sustainability and Environmental Impact

- Electrification of handling equipment reduced CO_2 emissions
- The primary route incorporates 15% scrap steel, emitting approximately 2 tons of CO2 per ton of steel, while the secondary route utilizes more than 100% scrap steel, emitting only 0.36 tons of CO2 per ton.
- As a result, the recycling of scrap steel in secondary steelmaking plays a crucial role in reducing carbon emissions in steel production, with approximately 1.7 tons of CO2 saved per ton of scrap steel recycled when compared to the primary route.
- Dust and slag reutilization achieved through briquetting and sinter reuse.
- Energy optimization through Di-FOC control and ERP scheduling.
- Alignment with “Green Steel” initiatives and national carbon reduction targets.

4. Conclusion

The Induction Furnace Ecosystem demonstrates that scrap-based rebar production can achieve industrial-scale volumes while maintaining metallurgical quality and environmental compliance. Through digital integration, automation, and coordinated process management, the system delivers measurable improvements in efficiency, quality, and sustainability. This model is scalable and adaptable for modern steel plants aiming to align with the “Green Steel 2040” roadmap.

WASTE TO WEALTH MISSION TO STRENGTHENING THE STEEL INDUSTRIES

Innovators/Authors

Er. Uttam Chand Mehta, Chairman, Er. Tusar Tushar U. Mehta
M.D. Dr Anil kumar Chaturvedi, Director
Research & Development, Mangalam Alloys Ltd

Abstract :

Aims at rapid techno-commercialization of patented technologies-RnD Centre, Mangalam Alloys Ltd. & self sustainable industrialization by recycling wastes such as slag, chemical sludge & other wastes to recover value added elements & reuse them as primary raw material in metal & non metal industries as well as in other applications. It plays a major role in the techno-commercialization & environmental management by its contribution to overall industry production, foreign exchange earnings creation of employment opportunities & mitigating environmental impact. It will strengthen the Steel industries solid/chemical waste management system worldwide by identifying and validating innovative technology solutions and models to achieve a zero landfill and zero waste nation. In line with its vision, Mangalam Alloys Mission has taken several initiatives in different areas of waste management, including technology demonstrations in multiple waste management domains and community engagement which will act as a reference for all stakeholders i.e. Steel/Aluminum/Copper production bodies, sanitary production industries, technology companies, investors and citizens looking for comprehensive solution on waste management technologies, policies and investment opportunities.

Introduction :

Increased demand of metals has driven accelerated mining and metallurgical production in recent years, causing fast depletion of primary metals resources. On the contrary, the mining and metallurgical industry generates large amount of solid residues and waste such as metal dusts, slags, mill scales (rolling mill waste), ETP Sludge, flue dust and leach residues, with valuable metal contents. The current technology and processes for primary metals production are not readily applicable for direct metals extraction from these waste materials, so special adaptation and tailor-made processes are required. Our processes have been designed to recycle solid wastes & chemical waste (ETP sludge) which are generated in steel making industries. & recover value added elements/metal & reuse in melting as a raw material. The technology & process which have been used for recycling & recovering are invented by research center which is recognized by DSIR, ministry of science & technology, government of India & is integrated with Mangalam Alloys Ltd. The invented technology /method are patented by Managalam Alloys ltd. Above said recognized research center which has been conducted trials for all type of metal wastes & ETP sludge in their pilot plant & recovered value added elements. It recommends the proposed project for commercialization of patented technologies/methods to recycle wastes & reduce dependency of plants on basic material (ore base materials), save pollution & strengthen economic growth of industries. The generated waste during processing of wastes has been also processed & used in brick manufacturing. The concept of proposed project is based on zero solid waste.

Keywords: Zero solid, ETP Sludge etc.

The depletion of the mineral resources is attributed by both the limited reserve in this planet and the rapidly increasing demand in materials consumption. In 2010, the whole world produced 1,414 mt of crude steel, 41,400 kt of primary aluminium and 16,200 kt of primary mined copper . In total more than 1,500 mt of primary metals are produced in the world, among which almost 95% is steel, and the rest of the metals accounts for 5% (plus), according to the published figures for 2010 in USGS year book . The production figure of crude steel has already included the contribution of steel scrap, while the nonferrous metals figure of more than 90 mt does not include the production from scrap. It is clearly seen that in the past half century, the copper production has more than quadrupled, and the consumption figure shows even more clearly the fast increase since 1950s.

Looking into the total metal supply, recycling of metals has been playing a very important role in the total metal supply globally. According to various sources, over 35% steel and copper produced in the world comes from steel scrap, and about 30% of the aluminium and zinc supply originated from the scrap. This figure goes over 50% for lead. This means that for the total metal consumption, there is a significant contribution from the metal scrap recycled to the production. Steel is one of the few magnetic metals, which is easy to separate from waste streams. According to World steel Association, over 20 billion tons of steel remains in use today in a variety of products which will be available for recycling. It seems that the recycling rate, defined as the recycled metal compared to the total metal available for recycling, is relatively high for metals

Challenges and opportunities associated with waste management in India

India faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Current systems in India cannot cope with the volumes of waste generated by an increasing urban population, and this impacts on the environment and public health. The challenges and barriers are significant, but so are the opportunities. This paper reports on an international seminar on 'Sustainable solid waste management for cities: opportunities in South Asian Association for Regional Cooperation (SAARC) countries' organized by the Council of Scientific and Industrial Research-National Environmental Engineering Research Institute and the Royal Society. A priority is to move from reliance on waste dumps that offer no environmental protection, to waste management systems that retain useful resources within the economy. Waste segregation at source and use of specialized waste processing facilities to separate recyclable materials has a key role. Disposal of residual waste after extraction of material resources needs engineered landfill sites and/or investment in waste-to-energy facilities. The potential for energy generation from landfill via methane extraction or thermal treatment is a major opportunity, but a key barrier is the shortage of qualified engineers and environmental professionals with the experience to deliver improved waste management systems in India.

Methods

In this method, metal and nonmetals recovery from generated solid and chemical wastes and their conversion into products have been completed in three parts. In first part, waste collection, shorting, de-moistening and conversion into powder form of specific size including addition of antioxidants, flux etc have been formed and mix in designed mechanical system in various steps under specific environment. In second part, Chemical sludge has been processed to recover metal oxides i.e Fe2O3, Cr2O3 , Nio & MnO, and chemicals like CaSo4 and Na2So4 in powders form by using of designed reactors and filters in several steps like mechanical and chemical systems comprises plurality of crushing, milling, pulverizing & sieving system and reactors, filters, milling etc. The mix of formed powder and oxide powders including

reducing agents passes through different stages in milling system in successive steps to maintain homogeneity and is continued to get final desired particle size and homogeneous mix which is free from foreign particle and gases. Fine mix is preheated at 400 – 450 0 C and compacted in designed die by friction screw power press and formed compacts are transferred as charge material to melting department either transfer to electrolysis to recover precious elements.

In third part, recovered precious metal is re melted and transferred to AOD for addition of other elements and refining.

Outcome

Pilot plant of 40 Mt capacity Implemented and recovery of precious metal going on

- New products: Waste materials can be transformed into new goods.
- Waste-to-product outputs
- Economic gain: A circular economy model can lead to a net economic gain.
- Job creation: A robust waste management sector creates employment opportunities.
- Pollution and contamination reduction: Proper management prevents harmful substances from leaching into soil and water sources.
- Greenhouse gas emission reduction: Diverting waste from landfills minimizes the release of greenhouse gases.
- Resource conservation: Recycling and reuse reduce the need to extract virgin raw materials and save energy
- Cost reduction: Minimizes disposal costs and generates income from selling recyclables.
- Improved living conditions: Waste management improves the cleanliness and health of communities.
- Energy generation: Waste can be converted into energy through methods like landfill gas recovery or incineration with energy recovery.
- Compost and fertilizer: Organic waste can be decomposed into compost or humus.
- Land recycling: Closed landfills can be redeveloped for beneficial uses like parks or golf courses.

Discussion

The materials from recycled waste are materials created by transforming waste into high-value products through processes like advanced recycling and reprocessing which creates virgin-quality material, reduces the need for new fossil fuels, and can supplement mechanical recycling to increase overall recycling rates. It creates high-performance composites from recycled precious metal or other industrial waste streams. These methods can improve recycling rates and create materials suitable for demanding applications.

Need for Technical Advancement for Commercialization

There is need to add advanced technology/methods like usage of hydrogen in Steel making process to reduce carbon generation, AOD/VOD system with induction and caster, ,Hot powder forging system, Spark spectra ,Scanning Electron microscope etc to advancement of quality of recovered metals, and their usage to modify the economics of industries.

Conclusion

Advanced recycling and processing of metal waste are crucial for environmental sustainability, resource conservation, and economic growth, serving as a cornerstone of the global circular economy. Technological advancements are transforming the industry, making it more efficient, cost-effective, and capable of recovering high-purity metals from increasingly complex waste streams.

Acknowledgment

RnD, Center, Mangalam Alloys Ltd, would like to express sincere gratitude to Director & Team, MECON limited, Chairman, Director, Mangalam Alloys Ltd. and others for their invaluable guidance, insightful suggestions, and continuous encouragement project.



APC SOLUTIONS FOR STEEL PLANT

By Mr. Amit Chandra

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2. Overview of Steel Production and Pollution Sources.

Steel manufacturing involves multiple processes — raw material handling, sinter and pellet production, coke ovens, blast furnaces, basic oxygen furnaces (BOF), electric arc furnaces (EAF), and captive power plants.

Each of these units emits particulate matter (PM) and gaseous pollutants (SOx, NOx, CO, VOCs, dioxins, etc.) from combustion and material handling operations.

Key sources:

- **Raw Material Handling:** Fugitive dust, controlled by bag filters.
- **Sinter/Pellet Plants:** PM, SOx, NOx, controlled by ESPs and scrubbers.
- **DRI Kilns:** Dust, SOx, NOx managed through ESPs, bag filters, and wet scrubbers.
- **Coke Oven Plants:** Toxic emissions (tar, VOCs), controlled by tar precipitators, Wet ESPs, and bag filters.
- **Blast Furnaces & BOF:** Dust and gases treated using cyclones, scrubbers, and ESPs.
- **Hot Metal Desulphurization (KR/ Injection type) :** Primary and Secondary Fume **Extraction:** Network of hood and ducts connecting to Bag Filter
- Electric Arc Furnace (EAF)/ Secondary Refining/ Induction furnaces : Large amounts of dust, fumes (including metallic oxides), controlled by bag filters
- **Power Plants:** Flue gases treated with ESPs/bag filters and scrubbers.

3. Types of Pollutants

- **Particulate Matter:** PM10, PM2.5, heavy metals, tars, acid mist.

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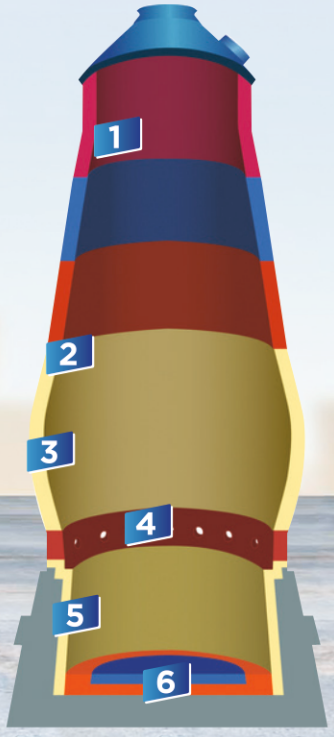
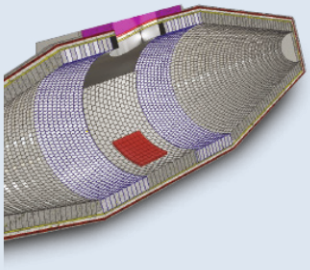


1. UPPER STACK
2. LOWER STACK
3. BOSH & BELLY
4. TUYERE BELT
5. HEARTH
6. CERAMIC CUP





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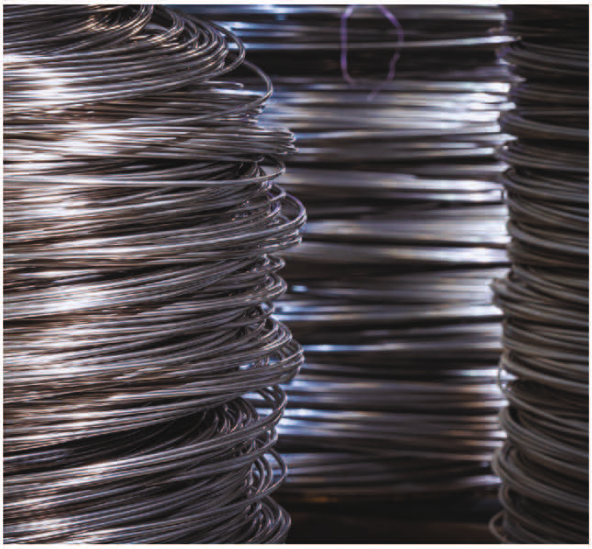

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OTHER PAPERS

OVER-ENGINEERED BUT UNDER-UTILIZED: THE PARADOX OF AUTOMATION IN INDIAN STEEL PLANTS

Ishan Gupta, AGM – (Instrumentation & Process Control), MECON Limited;
B. M. Sen Gupta, Sr. GM I/c - Electrical, MECON Limited

Abstract:

Steel plant units are generally conceived and built as overly automated – at least in the Public Sector – but, once they are commissioned and get into commercial operation, only a small part of the capabilities of the installed automation systems are utilised. Somehow, plant operators still look upon their automation systems with a degree of distrust. This is evidenced, firstly, by the fanatic insistence on having redundant automation systems, down to their lowest components; and secondly, by the all-too-common demand that backup secondary instruments like single-loop controllers and indicators should be provided in plants, side-by-side with 'latest state-of-the-art' automation systems.

On the other hand, microprocessor-based automation systems have vastly improved, in robustness, reliability and in capabilities, from the mid-1980s, when they were first adopted in Indian steel plants. Today's automation systems can do much more to drive process efficiencies and safety than they are deployed for. Also, the historical differences in capabilities between different 'categories' of automation systems - programmable logic controllers (PLCs) and distributed control systems (DCS) - has been completely obliterated now, so that the debate about which one to use for what applications is no longer relevant.

1. Introduction

Automation has been a cornerstone of steel plant design and operation since the 1980s, when microprocessor-based distributed control systems (DCS) and programmable logic controllers (PLC) were first deployed in India. Over time, these systems have evolved into highly reliable and capable platforms, offering opportunities not only for control and monitoring but also for optimization, predictive analytics, and integration with enterprise systems.

Yet, despite the availability of robust technologies, Indian steel plants—especially in the public sector—continue to rely on automation systems at a very basic level. Operators often view automation with a degree of distrust, resulting in redundant architectures, underutilization of advanced features, and reluctance to move away from traditional manual practices.

2. Current Practices and Observed Gaps

2.1 Over-Reliance on Redundancy

A strong insistence on redundant automation systems persists, extending down to the lowest component levels. While redundancy is important for safety-critical processes, excessive duplication adds cost and maintenance overhead. Despite the presence of modern fail-safe DCS/PLC platforms offering built-in diagnostics and self-healing networks, many project specifications still insist on stand-

Keywords: Zero solid, ETP Sludge etc.

alone single-loop controllers, annunciators and local indicators as secondary backups—reflecting traditional design approaches instead of modern reliability engineering philosophies.

Furthermore, many plants continue to demand secondary backup instruments such as single-loop controllers and local indicators, even when state-of-the-art automation systems are already in place.

- Typical practice: Redundant CPUs, power supplies, and I/O modules are demanded even for non-critical utilities or secondary systems.
- Impact: Redundant hardware can increase system cost by 15–25%, while also doubling maintenance requirements and spare parts inventory.



Figure 1: Instrument Panels with annunciators, recorder, single loop controllers, digital indicators etc.

2.2 Underutilization of Advanced Capabilities

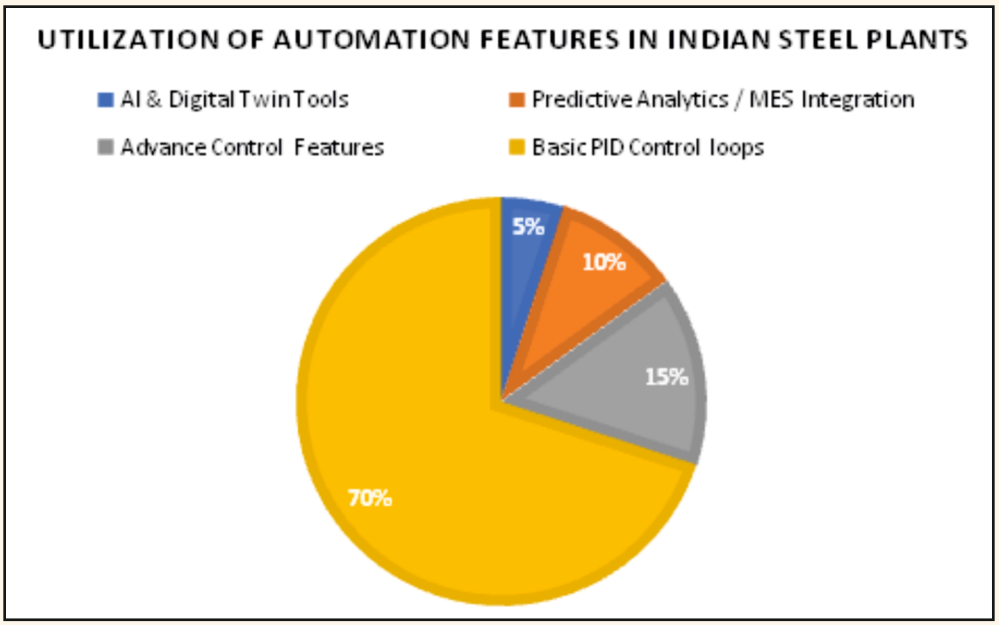
Modern automation platforms—such as DCS, PLC, and SCADA systems—are equipped with a wide range of advanced functionalities beyond conventional control and monitoring. These include Advanced Process Control (APC), model-based optimization, predictive diagnostics, asset condition monitoring, and integration with Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) layers. Collectively, these capabilities enable plants to achieve higher levels of performance, safety, and efficiency.

However, in most industrial installations, particularly in the steel and process sectors, these advanced features remain largely underutilized. Studies indicate that over 60–70% of installed automation systems operate below their designed capability, with plants relying primarily on PID-based control loops and basic alarm management. APC modules, soft sensors, and predictive analytics tools—often included as part of the automation suite—are seldom commissioned or are later disabled due to lack of trained manpower or integration challenges.

The consequences of this underutilization are significant. Without leveraging advanced diagnostics and optimization tools, plants lose opportunities for:

- Energy optimization, which can yield 5–10% savings in fuel or power consumption.
- Improved equipment reliability, through early fault detection and condition-based maintenance.
- Enhanced process stability, resulting in better product quality and reduced variability.
- Seamless data flow, enabling real-time decision-making and digital transformation initiatives such as Industry 4.0.

Key reasons for this gap include limited awareness of the benefits of APC and predictive tools, insufficient training of operating personnel, resistance to change from traditional operating methods, and lack of integration between automation and IT/OT systems. As a result, plants continue to operate below their potential, focusing on "keeping the process running" rather than "running it optimally."



2.3 Cultural and Mindset Barriers

A significant non-technical challenge in achieving higher levels of automation efficiency lies in the cultural mindset and operational behaviour of plant personnel. Despite the availability of modern control technologies and decision-support tools, operator confidence in automated systems remains limited in many industrial environments.

Operators and maintenance teams often exhibit a preference for manual control, perceiving it as more dependable and within their direct influence. This mindset has historical roots—many senior personnel have decades of experience managing processes manually, where human intuition and field adjustments were the primary means of control. Consequently, there is a lingering perception that automation systems, though sophisticated, may not adequately respond to unforeseen process variations or disturbances.

This cultural inertia leads to frequent manual interventions such as overriding automatic loops, bypassing alarms, or switching control modes from automatic to manual, particularly during upset or transient conditions. As a result, the true potential of advanced automation—such as adaptive control, model predictive control, and automated optimization—remains unrealized.

Industry studies suggest that up to 40–50% of process upsets and quality deviations can be traced back to manual interventions or the improper use of automated systems. This not only reduces operational efficiency but also increases variability, downtime, and safety risks.

Overcoming these barriers requires more than just technological upgrades—it demands a shift in organizational culture. Key enablers include:

- Comprehensive operator training on the logic, limitations, and advantages of automated strategies.
- Structured change management programs that build trust in automation through gradual implementation and demonstration of results.
- Performance-linked incentives to encourage adherence to automated operation modes.
- Collaborative feedback mechanisms between operators, engineers, and system integrators to improve system usability and transparency.

Ultimately, fostering a culture that values automation as a partner rather than a threat is essential for realizing the full return on investment in modern control systems.

2.4 Skill Gaps

Another key factor limiting the effective utilization of automation systems in steel plants is the shortage of skilled manpower proficient in advanced automation, control engineering, and digital technologies. While most plants maintain competent teams for day-to-day operation and maintenance of PLCs, DCS, and instrumentation systems, in-depth expertise in areas such as Advanced Process Control (APC), data analytics, system integration, and cybersecurity is often lacking.

As a result, plants tend to depend heavily on system vendors or external service providers for even moderate-level configuration changes, logic modifications, or troubleshooting activities. This over-reliance not only increases operational costs and downtime but also reduces flexibility, as internal teams are unable to adapt or optimize the system without vendor intervention. Furthermore, it constrains innovation within the plant, as personnel hesitate to explore new automation features or implement process improvements due to limited technical confidence.

In the steel sector specifically, the skill gap is more pronounced in disciplines such as process data analytics, predictive maintenance, and AI-based control optimization.

To bridge these gaps, organizations need to adopt a strategic workforce development approach, emphasizing:

- Establishment of in-house automation excellence centers for continuous skill upgrading.
- Collaboration with OEMs and academic institutions for certification-based training programs.
- Encouragement of cross-functional learning, where process and automation engineers jointly participate in performance improvement projects.
- Introduction of digital literacy programs covering cybersecurity, IoT, and data-driven decision-making.

Investing in workforce capability is as critical as investing in new technology. A well-trained team not only enhances plant autonomy but also ensures that the full value of automation and digitalization investments is realized sustainably.

2.5 Lifecycle and Obsolescence Management

A persistent challenge across the steel industry is the continued operation of legacy automation platforms well beyond their intended service life. Many plants still rely on Distributed Control Systems (DCS), Programmable Logic Controllers (PLC), and Human–Machine Interface (HMI) systems that were commissioned one or two decades ago. While these systems may still perform basic control and monitoring functions, they often operate without active vendor support, spare parts availability, or software updates, creating a range of operational and strategic risks.

The most immediate issue is hardware and software obsolescence. Components such as input/output modules, communication cards, and proprietary controllers are frequently discontinued by manufacturers, making replacements difficult or impossible to source. In some cases, plants are forced to procure refurbished or second-hand parts from third-party suppliers, which introduces reliability and compatibility concerns.

Equally critical is the cybersecurity vulnerability associated with outdated systems. Legacy automation platforms often lack modern security features such as user access control, encryption, or patch management. When these systems are connected to plant networks or enterprise IT environments, they become potential entry points for cyber threats.

The reliance on obsolete platforms also limits modernization and digital integration efforts. Older systems typically do not support open communication protocols such as OPC UA, MQTT, or REST APIs, thereby hindering integration with Manufacturing Execution Systems (MES), Enterprise Resource Planning (ERP), or cloud-based analytics platforms. This restricts the plant's ability to adopt Industry 4.0 technologies, predictive maintenance systems, and real-time performance monitoring tools.

3. Evolution of Automation Systems

The automation landscape in the steel and process industries has undergone a remarkable transformation over the past four decades. What began as a fragmented control environment dominated by relay logic, pneumatic systems, and early-generation Programmable Logic Controllers (PLCs) has evolved into highly integrated, intelligent, and data-driven automation ecosystems. This evolution has been driven by advances in microprocessor technology, networked communications, software standardization, and the growing demand for operational excellence, safety, and sustainability.

3.1 From PLC vs. DCS to Unified Platforms

Traditionally, Programmable Logic Controllers (PLCs) and Distributed Control Systems (DCS) served distinct purposes within plant automation architectures. PLCs, introduced in the 1970s and 1980s, were primarily used for discrete and sequential control applications—such as material handling, interlocking, and machine automation—due to their high-speed response and rugged design. In contrast, DCS platforms were deployed for continuous process control, such as in furnaces, rolling mills, and chemical treatment lines, where analog control loops and process stability were critical.

However, over the past two decades, technological convergence has blurred the lines between these two systems. Advancements in hardware and software architectures have enabled both PLCs and DCS platforms to offer comparable functionality.

Leading automation vendors now offer hybrid control systems that combine the deterministic control strengths of PLCs with the supervisory and visualization capabilities of DCS. As a result, the earlier debate of "PLC versus DCS" has become largely obsolete. The choice of platform today is guided less by functional differences and more by project scale, integration strategy, and lifecycle cost considerations. The modern trend is toward platform unification, where plants deploy a common automation infrastructure capable of addressing diverse control requirements—from batch operations to continuous production—within a single digital ecosystem.

3.2 Robustness and Reliability

Since the initial adoption of microprocessor-based automation systems in the mid-1980s, there has been a continuous and significant enhancement in system robustness, reliability, and fault tolerance. Early automation systems were prone to hardware failures, communication issues, and software instability due to limited processing power and immature design practices. Today, these limitations have been largely overcome through advances in both hardware design and software engineering.

Modern PLC and DCS platforms are built around high-performance CPUs, redundant architectures, and fault-tolerant communication networks that enable uptime levels exceeding 99.9% in many process industries. Key technological developments contributing to this robustness include:

- Hot-swappable I/O modules and redundant power supplies that prevent single-point failures.
- High-speed deterministic Ethernet networks for real-time communication between controllers and field devices.
- Self-diagnostic and predictive maintenance functions, enabling proactive detection of hardware degradation or network latency.
- Integrated safety and cybersecurity layers ensuring safe and reliable plant operation.

Moreover, improvements in engineering tools, such as unified development environments, version-controlled programming, and simulation-based testing, have enhanced the consistency and reliability of automation projects. Systems are now capable of autonomous fault isolation, automatic failover, and online maintenance, minimizing the need for manual intervention during normal and abnormal operating conditions.

4. The Global Perspective

The steel industry worldwide is undergoing a rapid digital transformation, driven by the convergence of Industrial Internet of Things (IIoT), advanced analytics, artificial intelligence (AI), and digital modelling. Leading steelmakers in Europe, North America, and East Asia are adopting Industry 4.0 practices to achieve higher efficiency, predictive operational control, and sustainable production. These initiatives are reshaping plant operations, asset management, and supply chain integration.

Key areas of global digital adoption include:

1. IoT-enabled Condition Monitoring and Predictive Maintenance International steel plants are deploying sensor networks and IoT-enabled devices across critical equipment, such as rolling

mills, blast furnaces, and reheating furnaces. Real-time data from vibration sensors, thermocouples, and motor drives feed predictive maintenance algorithms, enabling early detection of wear, misalignment, or overheating. By anticipating equipment failures before they occur, global plants reduce unplanned downtime by 20–30%, extend asset life, and optimize maintenance scheduling.

2. Artificial Intelligence and Machine Learning for Process Optimization Advanced analytics platforms powered by AI and machine learning are being used to optimize process parameters, improve product quality, and reduce energy consumption. For example, machine learning models can dynamically adjust furnace temperatures, rolling speeds, and cooling rates to minimize defects and maximize yield. Leading steelmakers report energy savings of 5–8% and throughput improvements of 3–5% through such AI-driven control strategies.
3. Digital Twins for Real-time Simulation and Scenario Analysis The adoption of digital twin technology allows steel plants to create virtual replicas of their production lines. These digital models simulate real-time process behavior, enabling operators and engineers to evaluate "what-if" scenarios, optimize process sequences, and plan maintenance interventions without impacting live production. Digital twins also facilitate rapid root-cause analysis for process deviations and enhance predictive planning for capacity expansions.
4. Closed-loop Optimization for Yield and Energy Efficiency Global leaders increasingly implement closed-loop control systems that integrate real-time measurement, automated control, and adaptive optimization. These systems continuously adjust process variables to maximize yield, reduce scrap, and minimize energy consumption, often achieving measurable improvements in product quality consistency and resource efficiency. Closed-loop strategies, when combined with AI, enable near-autonomous process optimization under dynamic plant conditions.

India in Comparison

While Indian steel plants are automation-intensive, they are still largely digitally-light, with limited adoption of advanced analytics, predictive maintenance, and real-time optimization tools. Most plants rely on traditional DCS/PLC-based control and conventional performance monitoring, which constrains data-driven decision-making and prevents full realization of process optimization and energy efficiency potential.

Bridging this digital gap is increasingly critical for global competitiveness. Indian steelmakers face pressure to adopt Industry 4.0 practices not only to improve productivity and sustainability but also to meet international standards for quality, efficiency, and environmental compliance. Strategic investments in IoT infrastructure, AI-enabled process control, and digital twin technologies will be essential for India to match the operational excellence and cost competitiveness demonstrated by leading global steel producers.

5. Conclusion

The paradox of Indian steel plants is that while they are built as highly automated facilities, they operate at only a fraction of their automation potential. The barriers are not technological but cultural, organizational, and strategic. By addressing mindset issues, bridging IT-OT gaps, upgrading lifecycle management, and embracing Industry 4.0 practices, steelmakers in India can transform their automation systems from underutilized assets into drivers of competitiveness, efficiency, and long-term sustainability.

POTENTIAL OF DRY & WET TECHNOLOGIES TO ENHANCE EFFICIENCY AND SUSTAINABILITY FOR IRON & STEEL INDUSTRY VALUE CHAIN

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The Indian mining sector holds a diverse portfolio of critical minerals that can meet both domestic and international demand. However, it faces significant challenges, including the depletion of high-grade ore reserves, mounting environmental and regulatory pressures, and the growing necessity to process low-grade, complex ore bodies. Traditional beneficiation methods, constrained by inherent design limitations, often fail to deliver the desired results. To address these gaps, this communication highlights the integration of Eriez's state-of-the-art magnetic separation and flotation technologies.

Founded in 1942 in the USA, Eriez has consistently invested in the development of advanced solutions for mineral beneficiation, aimed at maximizing recovery and improving plant performance to meet the future needs of industries demanding high-purity products. Eriez offers a comprehensive range of low, medium, and high-intensity magnetic separators—designed for both wet (slurry-based) and dry processing applications, in batch or continuous modes. Complementing these are advanced gravity separation systems and coarse-to-fine particle flotation technologies, enabling a complete flowsheet approach for both metallic and non-metallic ore processing.

In this presentation, we will showcase Eriez's extensive equipment portfolio along with global case studies that demonstrate our strengths and proven achievements in integrating dry and wet beneficiation technologies for processing low-grade ores.

Paper Presenter Name: Subhrangshu Mukherjee

Brief Profile: Subhrangshu Mukherjee is an electrical engineer with master's in business management from Narsee Monjee. He brings bring over 20 years of experience across leading organizations, including 9 years at Thermax followed by 7 years at FLSmidth, where he spearheaded sales and business development for mineral beneficiation products. At Eriez he is takes care of sales and business development of Magnetic Separation and Flotation technologies.

DANIELI'S QSP-DUE®: UNLIMITED FREEDOM FOR GREEN HRC PRODUCTION

Alessandro Pigani[1] • Riccardo Conte[2] • Santanu Rudra[3]

Abstract:

QSP-DUE direct casting and rolling technology allows three production modes: coil-to- coil, semi-endless, and full endless. These modes enable the production of various steel grades and strip formats, meeting end-user needs. The technology's maturity is evidenced by concrete applications.

The process offers a wide product mix, catering to various market needs, with perspective towards automotive exposed sector with dedicated features and production strategies. At the same time the commitment to sustainability is evident through the electrification efforts, setting new standards for high-quality, sustainable steel production, driving innovation, and meeting diverse market demands.

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1. INTRODUCTION

The QSP-DUE process developed by Danieli represents a significant advancement in high-quality hot-rolled coil production. This direct slab casting and rolling process is rapidly gaining market share due to its competitiveness and ability to meet diverse market requirements. Over the past 30 years, Danieli has continuously innovated the Quality Strip Production (QSP) family, developing the Danieli Universal Endless (DUE) layout. This technology offers numerous advantages over conventional routes, including substantial energy savings and enhanced product quality.

The combination of high casting speed and slab thickness provides high throughput, allowing slabs to be delivered to the tunnel furnace at temperatures exceeding 1150°C. This reduces the energy required for reheating by approximately 80% compared to conventional routes, ensuring consistent and efficient steel production.

QSP-DUE offers three production modes: coil-to-coil, semi-endless, and full endless. Full endless mode allows direct rolling of cast products without division into slabs, making it ideal for ultra-thin commercial grades. Coil-to-coil mode provides flexibility, with slabs cut by the pendulum shear and processed individually. Semi-endless mode balances efficiency and customization, with jumbo slabs cut and rolled, then separated into coils by a high-speed shear. These modes enable the production of various steel grades, thicknesses, and widths to meet diverse end-user needs.

2. BENEFITS

2.1 Global references confirm the success of the Danieli Universal Endless layout

Thanks to its proven performance and flexibility, QSP-DUE technology has beensuccessfully implemented by leading steelmakers worldwide.

Keywords: QSP-DUE, Slab, Rolling, Strip thickness, Automotive exposed

These installations demonstrate the reliability, productivity, and versatility of the Danieli Universal Endless layout across different production targets and operating conditions. As the industry evolves, QSP-DUE sets new standards for high-quality, sustainable steel production, driving innovation and meeting diverse market demands.

The following references highlight the real-world achievements and technological excellence of QSP-DUE in various regions.



Figure 1: induction heating system between roughing and finishing mill stands

Hoa Phat Dung Quat Steel Joint Stock Company / Vietnam

The Dung Quat QSP plant, operated by Hoa Phat Dung Quat Steel Joint Stock Company, has a design capacity of up to 3.9 million tons of steel per year, and it is one of the most productive plants operating in the world. To date, the QSP has produced over 13 million tons of hot-rolled coils, maintaining high quality. Operational efficiency allowed the achievement of 6 m/min casting speed and a sequence length of over 28 hours. The caster processed 50 heats without interruption, covering a total length of

7,342 meters, and achieved a production output of 13,040 tons in one day, with an average throughput of more than 470 tons/hour.

Class 1 quality hot-rolled coils maintain a stable rating of 97.5%, showing excellent strip surface quality and coil shape. QSP operations are consistently stable and reliable, even for thin gauges as low as 1.2 mm. New, high-value products developed include the weather-resistant grade SPAH with a strip thickness of 1.6 mm, which meets the required quality and mechanical properties for container-making applications.

Yukun Iron and Steel Group Co., Ltd. / P.R. China

Yukun Iron & Steel Group Co., Ltd. (Yukun) started up a new DUE plant in 2024 to produce up to 4.6 Mtpy of hot-rolled coils, setting a new world record for Danieli's in- line casting and rolling technology. The DUE line produces strip thicknesses from 0.80 to 25.4 mm and widths between 900- and 1,500-mm. Casting records have been set on the Danieli-patented DySen caster: 145-mm-thick slabs have been regularly produced, using a 152-mm mould. 165-mm-thick slab rolling was also tested.

Endless rolling has been established, reaching the minimum design thickness of 0.8 mm thick strip within the first seven campaigns from the beginning of the endless production. Coils showed excellent

surface quality, precise geometric dimensions, anduniform microstructure and properties. This followed the production of thicknesses of

25 mm in the same line, something unique in the world. Within 10 days of the DUE plant start, Yukun marketed and sold premium-quality HRC products.



Figure 2: rolling mill split design

Shougang Jingtang United Iron & Steel Co. Ltd. / P.R. China

Shougang Jingtang United Iron & Steel Co. Ltd. (SGJT) confirmed its trust in Danieli's technology by ordering the world's first Danieli Universal Endless (DUE®) plant, which has been operating at full capacity since 2019, exceeding the nominal capacity of 2.1

Mtpy. The caster reached a speed of 6 m/min for low-carbon grades, with stable casting conditions. Up to 37 heats were cast in 24 hours, equivalent to around 7,800 tons, with casting sequences exceeding 16 hours of continuous operation.

Endless production represents up to 97% of each casting and rolling sequence, with steady-state rolling conditions enabling thin-gauge production. Over 90% of QSP-DUE output is less than 2.0 mm thick, with over 50% ranging from 1.5 mm down to the recent plant record of 0.70 mm.



Figure 3: Coil with a strip thickness of 0.70 mm produced at SGJT

2.3 A wider product mix

The QSP-DUE process allows a wider product mix to respond to various market needs, especially in the automotive sector. Today, QSP-DUE operators can produce and deliver grades with superior mechanical properties and surface quality. The focus is on automotive applications, particularly for exposed panels. These grades are used in complex components, adding value, and yielding higher profit margins. Advanced high- strength steels (AHSS) are increasingly in demand, projected to exceed 85% of the automotive market in the future. AHSS grades include crack-sensitive types like peritectic, Dual Phase, Complex Phase, Martensitic, and TRIP steels.

Several innovations developed by Danieli in recent years are available to ensure the widest possible product mix. The funnel-shaped mould normally used in thin-slab casters deforms the shell during solidification, making it unsuitable for high surface- quality grades. Danieli has designed a flat mould for high-speed casting, improving fluid dynamics and eliminating chemistry limitations. Last year this mould was tested at high casting speed on a thin slab caster, showing excellent results in terms of surface quality and sequence duration.

Exposed grades are generally prone to clogging, which is counteracted by argon injection into the mould and the use of a quick-change submerged entry nozzle (SEN). These practices are now possible in the QSP-DUE process, thanks to increased mould thickness, a slim SEN design, and robotic operations that ensure high repeatability and safety.

Additionally, the argon-loaded flow in the mould is controlled by the MM-EMB+S, which combines two different technologies: an AC brake/accelerator, widely used in conventional slab casters, and the DC device, adopted in thin slab casting for a long time. The MM-EMB+S enables a wide variety of operating modes, including mould stirring, particularly useful for several reasons: temperature homogenization, inclusion floatation, prevention of inclusion entrapment and reduction of gas bubble entrapment.

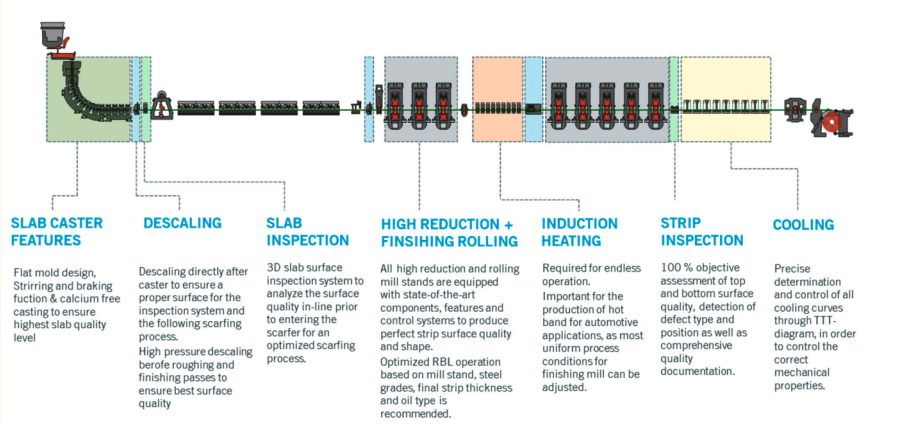

Figure 4: equipment specifically designed for automotive-exposed quality requirements

QSP-DUE features three descaling points: the first at the caster exit, the second just before the first roughing stand, and the last right before the first finishing mill stand. The combination of the three devices ensures coils are free from defects related to scale imprinting. Two surface inspection systems are foreseen, one at the caster exit and the second prior to the downcoiler area, providing immediate feedback on strip- surface quality and its compliance for auto-exposed applications.

To achieve the highest standards of surface quality and optimize the production of exposed panels, scarfing might be required. The scarfing process is performed using oxygen-fueled linear torches to remove a thin layer of material along with surface defects, such as cracks, non-metallic inclusions, or surface irregularities that can compromise the hot-strip surface quality. The precision of this process is vital to minimizing material loss while achieving a defect-free surface. The scarfer is integrated into the production process, conditioning slabs while hot to maintain the energy-saving approach of the QSP-DUE.

The scarfer operates at the same productivity as the casting machine and hot strip mill, ensuring that all the slabs produced in a sequence are surface conditioned.

2.4 Fossil-free steel

Compared to the conventional route, the DUE process reduces energy consumption by 70%, leading to a 90% reduction in CO2 emissions. While QSP-DUE is already anenvironmentally friendly technology, further electrification of processes that currently rely on fossil fuels – such as tundish and SEN preheating, and the gas-fired tunnel furnace – can reduce direct CO2 emissions to zero. The primary source of direct emissions in the DUE process is the tunnel furnace, which allows coil-to-coil and semi-endless production modes, in addition to the full endless production mode, significantly broadening the product mix. Additionally, the tunnel furnace serves as a buffer during work roll changes in the rolling stands, enabling longer production sequences with consistent surface quality. A clear advantage from an OpEx perspective.

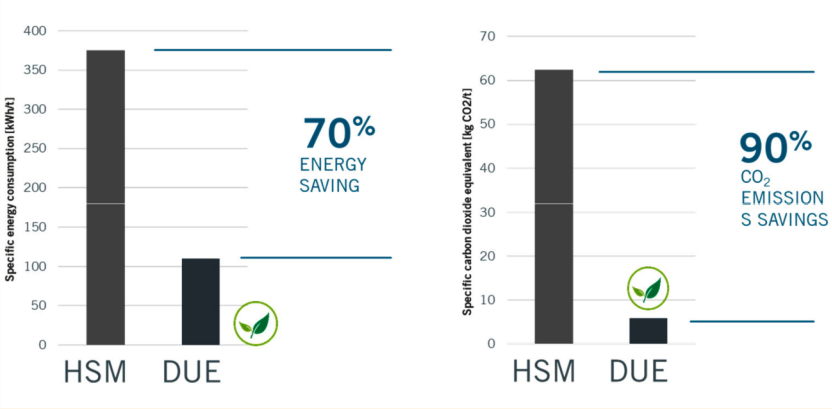

Figure 4: energy saving and CO2 emissions reduction: omparison between conventional HSM and DUE

Reducing emissions requires enhancing efficiency and rethinking the heating process. One effective strategy is to minimize heat losses by replacing the currently used water- cooled rolls with dry rolls, which can yield energy savings of approximately 25 to 30%. Transitioning the tunnel furnace toward full electrification necessitates a comprehensive overhaul of its components. Given the slab thickness, longitudinal flux induction heaters have been selected to maximize electrical heating efficiency. The layout of the electric tunnel furnace includes a combination of sections with induction heaters and sections equipped with electrical resistance.

3. CONCLUSIONS

QSP-DUE is a mature technology that has demonstrated advantages over the conventional route in terms of energy efficiency and its ability to cover an extremely wide product mix, as proven by actual results. QSP-DUE's focus on automotive applications and advanced high-strength steels highlights its flexibility, while the commitment to sustainability is evident through the electrification efforts. As the industry evolves, QSP-DUE sets new standards for high-quality, sustainable steel production, driving innovation and meeting diverse market demands.

INNOVATIVE APPROACHES FOR ENHANCING PRODUCTIVITY AND SUSTAINABILITY OF PELLETIZING PROCESS AT JSW BPSL

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Abstract:

Pellets constitute a major share of the iron-bearing feed for Direct Reduction Iron (DRI) and Blast Furnace operations at JSW BPSL. To enhance productivity and sustainability, a series of novel process and equipment improvements were implemented in the pelletizing plant. The initiatives targeted bottlenecks in filtration, beneficiation, and solid waste utilization. Installation of new Vacuum Pressure (VPA) filters reduced filter cake moisture from 11.3% to 10.7% and shortened cycle time from 22 to 17 minutes, thereby increasing productivity. Feed blend optimization using purchased concentrate with favorable silica and alumina ratios minimized filter cycle time and improved throughput. Incorporation of LONGI magnetic separators in the beneficiation circuit lowered tailing Fe from 50% to 47%, enhancing Fe recovery along with yield percent improvement. Utilization of SMS and iron oxide dust (~12.5 kg/t) reduced filter cake consumption from 1150 kg/t to 1138 kg/t, improving material efficiency.

Comprehensive corrective actions were taken for filter press and thickener operations, including replacement of damaged filter plates, improvement of cloth washing pressure (2.0–2.5 bar), water quality enhancement, and control of slurry and air leakages. Additionally, optimization of gland seal water and proper thickener feed management reduced slurry dilution and torque issues.

As a result of these integrated initiatives, plant production increased from 9000 TPD to 11800 TPD, demonstrating significant gains in efficiency, resource conservation, and environmental performance in line with JSW BPSL's sustainability objectives.

Keywords: Pelletizing plant, Process optimization, Iron ore beneficiation, Sustainability Productivity improvement.

COMMERCE & STEEL INDUSTRY: THE FOUNDATION OF A SELF-RELIANT INDIA

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Abstract:



Commerce and the Steel Industry play a pivotal role in building a Self-Reliant India by driving economic growth, industrial development, and global competitiveness. Commerce policies focus on attracting investment, promoting exports, supporting domestic industries, and enhancing the ease of doing business. Initiatives such as the Foreign Trade Policy 2023, SEZs, and APEDA strengthen trade and agricultural exports. The steel industry, a cornerstone of industrial progress, supports infrastructure, manufacturing, and engineering sectors, contributing significantly to GDP. India, the world's second-largest steel producer, aims to achieve a production capacity of 300 million tonnes by 2030–31 under the National Steel Policy. Government support, sustainable practices, and technological advancement are vital to the industry's growth. Together, commerce and the steel industry form the foundation of a robust, sustainable, and self-reliant economy, positioning India as a global industrial and commercial powerhouse.

Commerce and Industry policies are a set of policies made by the government to regulate and promote trade and industries. These policies focus on attracting investment, encouraging exports, supporting domestic industries and promoting ease of doing business.

Key elements of the policies of commerce and industry:

- **Attracting Investment:**

Governments provide favorable policies, regulations and incentives to attract domestic and foreign investments.The commercial policy seeks to create a conducive environment for investment in India.It comprehensively examines the policies, regulations and restrictions that are convenient for investors.

- **Promotion of Exports**

The Ministry of Commerce and Industry policies take several measures to promote exports, such as export subsidies, export promotion schemes, and the establishment of special economic zones (SEZs). Indian commercial policy introduces measures to promote the country's export sector. This includes export subsidies, export promotion schemes, incentives for the construction of industrial towns and foreign guidance.

- **Supporting Domestic Industries:**

Government helps domestic industries to adapt global standards and improve their competitiveness by providing financial assistance, technical support, and infrastructure development. Commercial policy encourages the development of industries that meet global standards, produce high-quality products, and are competitive in business. To achieve this, industries are supported by improving their financial

structure, technological innovation, and production processes.

- **Ease of Doing Business:**

Commerce and Industry policies focus on simplifying the process of doing business, reducing red tapism, and promoting e-governance to facilitate business activities.

- **Tax Policies:**

Commerce and industry policies focus on providing tax regimes that benefit industries. Commercial policy studies tax policy and determines tax regimes that benefit industries. It attempts to facilitate tax structure, assessment, organization, collection, and control.

- **Promotion of Commercial Marketing:**

The government provides support to industries for market research, marketing strategies, and quality certification. The policy supports industries in developing strategic markets and marketing channels. This includes marketing studies, new market structures, quality certifications and the development of innovative marketing techniques.

- **Industrial policies:**

Governments use industrial policies to promote or reshape specific economic activities such as providing support to firms based on their activity, technology, location, size or age.

Agricultural and Processed Food Products Export Development Authority (APEDA):

APEDA plays a vital role in promoting exports of agricultural products from India and linking producers to markets.

Examples:

- The Foreign Trade Policy 2023 focuses on promoting exports and enhancing the ease of doing business.
- The Department of Industrial Policy and Promotion (DPIIT) works to promote industrial development and attract investment in various sectors.
- APEDA undertakes various initiatives to boost agricultural exports, such as encouraging the export of coarse grains and exploring new possibilities for fruit exports.

The Indian Commercial Policy is a key strategic, economic, and commercial strategy that aims to enhance India's economic growth, trade, and industry. This policy aims to empower the country's business sector and contribute significantly to the country's prosperity through experience, employment, strategic growth, and economic growth.

Indian commercial policy not only helps strengthen the national economy but also benefits users, entrepreneurs, businesses, and citizens. It significantly contributes to building a strong and prosperous Indian economy and helps make the country a business-dominating nation by global standards.

Steel and Sustainability

The steel industry is a key industry under India's commerce policy and its development directly impacts India's economy. The steel industry is concerned with the processing of raw materials and the production of goods while commerce is concerned with the distribution of goods and services. The steel industry in India has developed by taking advantage of raw materials, cheap labor, transportation, and markets.

Brief Description of Commerce and the Steel Industry:

- **Commerce:**

Commerce includes trade and its subsidiaries, involving the buying and selling of goods and services.

- **Steel Industry:**

This is a heavy industry that is concerned with melting iron ore to make steel and producing a variety of steel products.

- **Steel Industry in India:**

India is the second largest steel producer in the world. The development of the steel industry in India began with the establishment of the Tata Iron and Steel Company (TISCO) in 1907.

- **Importance of the Steel Industry:**

The steel industry contributes significantly to the country's GDP and is essential for the development of infrastructure, manufacturing, and other industries.

Key Aspects of the Steel Industry:

- Raw Materials: Iron ore, coal, and limestone.
- Production: Steel is produced using blast furnaces, electric arc furnaces, and other technologies.
- Products: Rail tracks, rail wheels, plates, bars, tubes, and other finished steel products.
- Industry support: The steel industry is an important supplier to engineering, construction, and other industries.
- Government policies: The Indian government has implemented several policies to develop the steel industry, such as the National Steel Policy and tariff reduction.
- Future plans: India aims to produce more than 300 million tonnes of steel by 2030-31.

In short, the main functions of the Ministry of Commerce are:

- Import and Export Management: It sets regulations and policies related to imports and exports.
- Trade Policy Formulation: It formulates policies to promote trade and develop domestic industries.
- Industrial Development: It formulates and implements policies for the development of industries.
- Trade Facilitation: It simplifies procedures to facilitate trade.
- Export Promotion: It implements various schemes and programs to increase exports.
- Economic Development: It plays a vital role in the country's economic development.

For example, the Ministry of Commerce formulates the Foreign Trade Policy which is a strategic plan for export promotion and trade. Furthermore, it establishes and regulates Special Economic Zones.

Conclusion:

Commerce and the steel industry together form the backbone of India's journey toward economic independence and sustainable growth. Commerce, through its policies and frameworks, lays the foundation for trade expansion, industrial development, and global integration, while the steel industry provides the essential material strength required for infrastructure, manufacturing, and national development. The synergy between these two sectors ensures balanced progress — where policy drives production, and industry fuels commerce.

With initiatives like the Foreign Trade Policy 2023, National Steel Policy, and the promotion of ease of doing business, India is steadily creating an environment that attracts investments, enhances exports, and strengthens domestic industries. The steel industry, as a key pillar of industrialization, supports employment generation, technological innovation, and sustainable production practices.

Ultimately, a robust commercial framework and a dynamic steel sector are vital for realizing the vision of Atmanirbhar Bharat — a self-reliant India that is economically strong, globally competitive, and resilient in the face of changing global dynamics.





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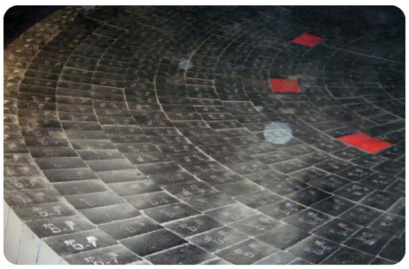
REVOLUTIONIZE STEELMAKING WITH OUR BOF SOLUTIONS!

Complete refractory material, engineering, and service solutions to optimize your BOF operations.



DESIGN & BUILD SERVICE

Our dedicated teams design and build all its BOF's to meet the steelmakers' exact operational requirements.



BRICKS & TAPHOLES OFFERING

Our design teams offer a complete solution for BOF brick lining, tapholes, and repair products.



REPAIR MIXES OFFERING

We provide solutions that allow our customers for continuous performance improvement (concrete development case) (upto 35% increase in life).

We combine installation technologies, tailored products to fit customer-specific purposes and plants, along with design and testing services to deliver real customer solutions.

For details, contact vesuviussales.india@vesuvius.com



LASER SOLUTIONS

Our patent pending, most advanced and fastest Laser System - ANTERIS* 360 measures in one minute of BOF time



ROBOTIC GUNNING SOLUTIONS

Our Advanced Robotic Gunning allows an increase in productivity with the highest safety and quality standards (upto 200kg/min).

TOKAI COBEX

INNOVATIVE SOLUTIONS FOR HIGHEST EXPECTATIONS.

Our advanced Carbon and Graphite Linings are designed for durability and longevity.
Benefit from increased productivity and extended campaign life with our expertly crafted materials.

Our solutions, including microporous carbon and precision-engineered pastes, are tailored to the specific needs of your furnace.

more Information:



Represented by;

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