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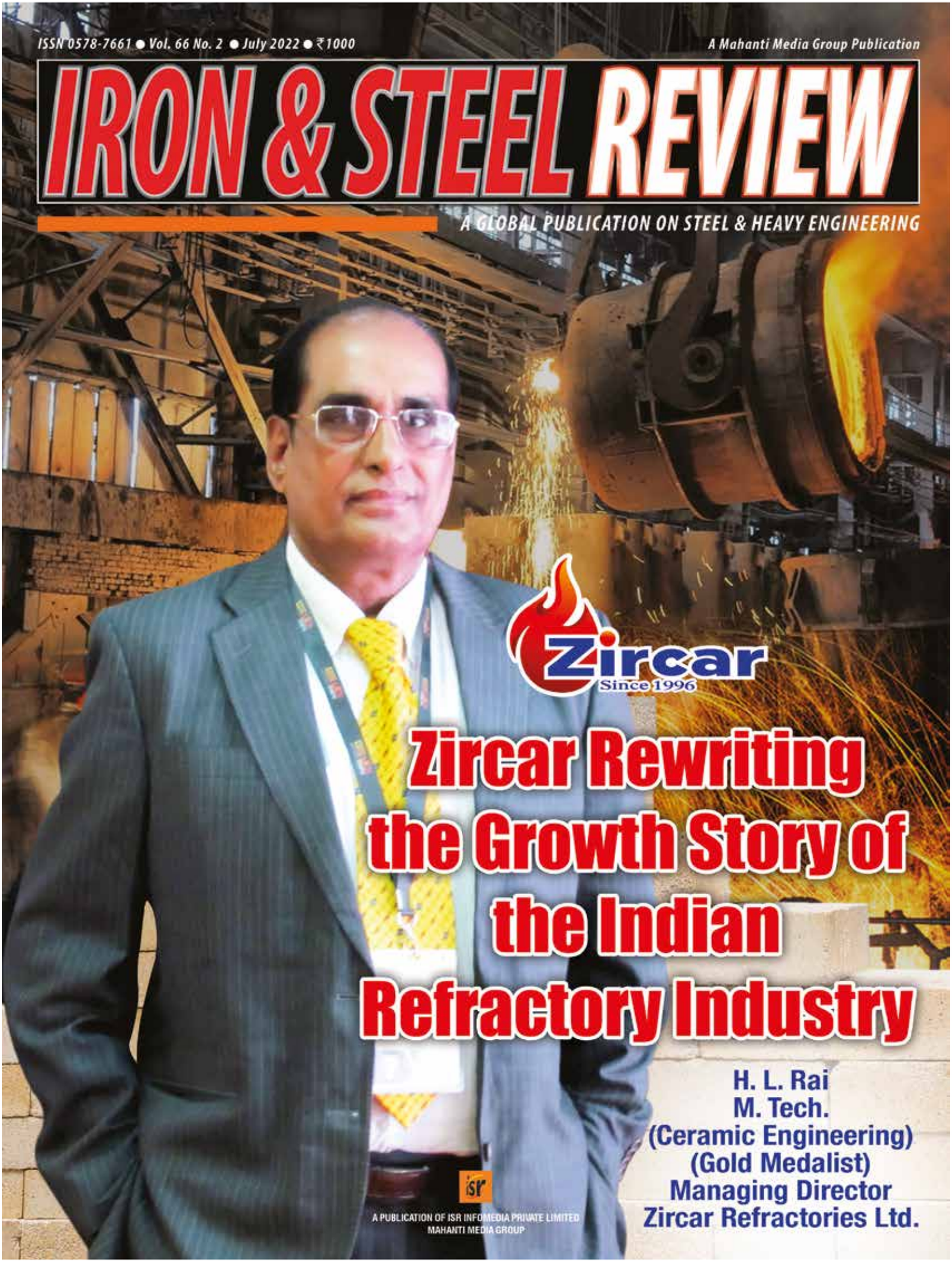

Zircar Rewriting the Growth Story of the Indian Refractory Industry

H. L. Rai
M. Tech.
(Ceramic Engineering)
(Gold Medalist)
Managing Director
Zircar Refractories Ltd.

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Dear Readers,

The steel industry has been dealing with multiple challenges for a pretty long time, one of them being the sky-rocketing steel price. On top of that, the government's decision to impose a 15% export duty on several finished steel products came as a surprise to the domestic steel industry. Moreover, the export duty on iron ores and concentrates was raised to 50% from 30%. The export levy imposed on steel to improve its availability in the local market and to curb soaring inflation is expected to soften prices in the short term. However, India's overall steel exports are expected to decline by 35-40% to 10-12 Million Tonnes (MT) in FY'23. 13.5 MT of finished steel had been exported during the last fiscal. Rating agency ICRA, in its report, said that this increased export duty hit nearly 95% of India's finished steel export basket, which, in turn, could exert pressure on domestic steel prices.

Following the tax imposed in May, exports of steel from the country more than halved in June compared to the corresponding month of the previous year. According to data, steel exports stood at 0.64 MT in June, down by 53% from 1.4 MT in the year-ago period. On a month-on-month basis, exports dropped by 19-20% in June.

According to industry sources, the government is expected to abolish or cut the export taxes soon to encourage the export of finished products. However, nothing has been finalised yet. This move comes after the meeting of top steel executives of domestic steel companies, under the aegis of the Indian Steel Association, with the Finance Minister. They had reportedly briefed the state of demand and supply and sought a reduction of the export duty.

As per trade sources, the average monthly prices of domestic benchmark hot-rolled coil (HRC) steel declined in May to Rs. 69,800 per tonne from Rs. 76,000 in April. Further, the average price dropped in June to Rs. 62,000 and Rs. 59,800 until July 6. Prices of HRC were hovering around Rs. 36,500-39,800 per tonne between January and July 2020, and in the first week of April 2022, steel prices hit an all-time high of over Rs. 78,800 a tonne.

The Indian steel industry is considered highly crucial for "Aatmanirbhar Bharat" and for the country to become a USD 5-Trillion economy by 2024-25. Therefore, the government's further decision regarding this matter would eventually stabilise the steel industry and help it grow in the coming years.

Santosh Mahanti
Editor & CMD

July 2022

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Zircar Refractories Ltd.

India's New Steel Policy: Vision, Mission & Objectives

The National Steel Policy (NSP) of India, which came into existence in 2017, has been functional in steering our economy to US$5 trillion by 2025. Since its inception, NSP's mission has been to build a globally competitive steel industry that fosters inter-sectoral growth. It also envisions creating an environment that enables India to become self-sufficient in steel production by boosting public sector units' capacities and giving policy support and guidance to MSMEs and big private sector steel manufacturers.

The objectives of NSP are:

- To increase India's crude steel capacity to 300 million tonnes by 2030-31
- To increase per capita consumption of steel to about 160 kgs from the consumption of 69 kgs in 2017
- To help India become a net steel exporter by 2025-26

The future roadmap laid out by NSP includes:

- Building of international-standard steel manufacturing facilities
- Boosting domestic steel demand through strategic promotion
- Acquisition of overseas raw material assets and cost-effective production
- Ensuring domestic availability of raw materials namely, iron ore, coking coal, and natural gas

With NSP, India has entered a new phase of infrastructural development. The growth that is happening despite the pandemic and other hindrances is creating a beneficial intersectional ripple effect across multiple industries and different segments. One industry that has emerged as key to this infrastructural growth is Refractory.

The Rise of the Black Refractory Manufacturer- Zircar Refractories

Zircar Refractories Pvt. Ltd. was founded by Mr. H. L. Rai, one of India's top notch technocrat entrepreneurs, in 1996 with an experience of over two decades in the refractory industry, Mr Rai established the company with the vision to make world-class products using world-class technology.

Today, Zircar boasts a state-of-the-art production facility in Mehsana, Gujarat. It is manned by a well-trained and experienced workforce and produces world-class products. Its pan-Indian and global distribution network has led to high exports over the years.

Admin Block

Mr. Rai, one of the rare technocrats, has worked throughout his 45+ years of Industrial experience on "BLACK REFRACTORIES" only. At that time, there was no manufacturing of Crucibles in India and our country depended on imports from England and Germany. Mr. H. L.Rai is the pioneer in Crucible manufacturing in India. He is the one who brought Crucible technology to India. The very first plant in India was started in Gujarat in 1981 with German collaboration. Mr. Rai, after getting trained in Germany, established this Project right from inception. He had to go for a

crash course in the German language to understand a bit of spoken German. Mr. Rai is the senior-most person in the Crucible industry in India.

SiC Crucibles

SiC Crucibles are used for melting ferrous and non-ferrous metals / alloys all over the world for generations. Copper, Brass, Aluminum, Zinc, Gunmetal, Gold, Silver, Cast Iron, and SS Scraps are melted in Crucibles ranging from a few kgs to a few tonnes of capacity.

Zircar is producing world-class black refractories like-

- SiC - Crucibles,
- Clay – Graphite Crucibles,
- Stoppers and Ingate Sleeves for Indian Railway,
- Graphite Converter segments and Liners for ductile iron manufacturing,
- Stopper Head for steel foundry,
- Slide Gate Refractories for steel continuous casting,
- CC Refractories like LS, MBS, and SEN for steel continuous casting.

All these products are very specialised with few at the global level.

Pic.1: Crucible's Pictures

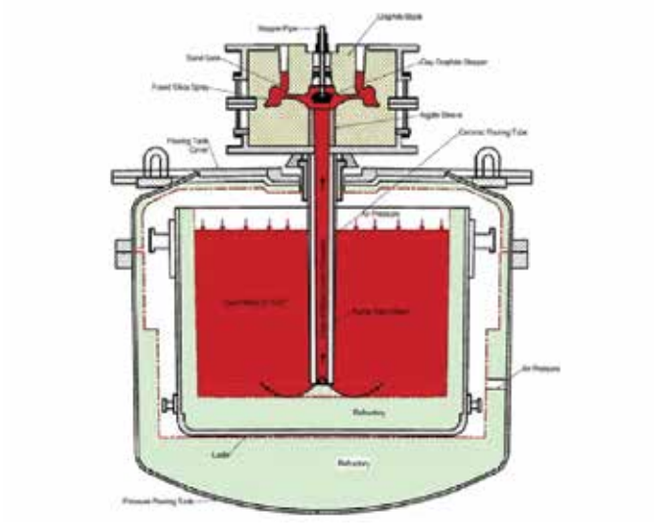
Stoppers and Ingate Sleeves for Indian Railway:

Indian Railways established a plant in Bangalore by the name "Wheel & Axle Plant" in the 70s with "Griffins" of America for manufacturing casted wheels for railways. Griffins have very special patented technology for the manufacturing of wheels. WAP was importing almost every refractory material from Griffins either as part of an agreement or as no alternates.

The Indian economy was in very bad shape during years 91-92, and our foreign exchange reserve was at its lowest level, just for a few weeks. RBI had asked everyone to minimize imports.

WAP exhibited all of their imported items to find Import substitutes in 1991. Mr Rai, through his in-depth knowledge of black refractories, could develop these two products for them for the first time in 1991-92. Import of these two products has stopped for the last 30 years saving millions of dollars as import substitutes.

Zircar is the primary supplier of these products even today. The controlled pressure pouring technique for wheel manufacturing is shown below.



Pic.2: Controlled Pressure Pouring

Pic.3: Wheels Manufactured by WAP

Pic.4: ingate Sleeve & Stoppers

Converter Segments & Liners for Ductile Iron Pipe Manufacturing

Ductile iron casting refers to a process in which magnesium/ cerium (as an alloy of magnesium/cerium) is added to cast iron. It reacts with the sulfur and oxygen in the molten iron and changes carbon to graphite. Zircar supplies the converter segment for Ductile Iron manufacturing. DI pipe manufacturers use liners to feed in their spinning machines.

Both the products are shown below

Pic.5: Converter Segment & Liner

Stopper Head for foundries

Pic.6: Stopper Head

These are used for pouring of steel in foundries.

Slide Gate & Continuous Casting Refractories

Pic.7: Slide Gate & Continuous Casting Revractories

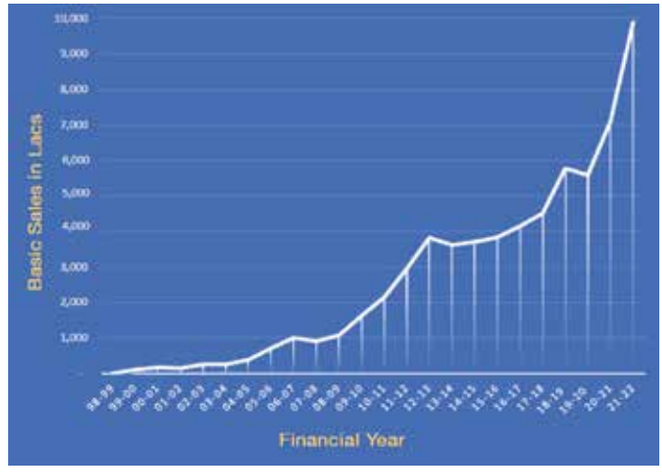
Pic.8: Cold Isostatic Press

Zircar has developed a modern, hi-tech infrastructure for manufacturing continuous casting refractories. They have the widest diameter isostatic press in India.

Milestones touched by Zircar in this long journey

Zircar is all set to celebrate its silver jubilee in a few years. Though Zircar was registered in 1996, commercial production started in June 1999. It took almost 3 years to set up the plant. It has crossed different market scenarios during these years and has seen many stagnant years & few with a high jump in sales.

They touched almost 100 crores in 21-22 and have plans to celebrate their silver jubilee grandly in 2024.



How did the company achieve business stability & growth amid an ongoing pandemic?

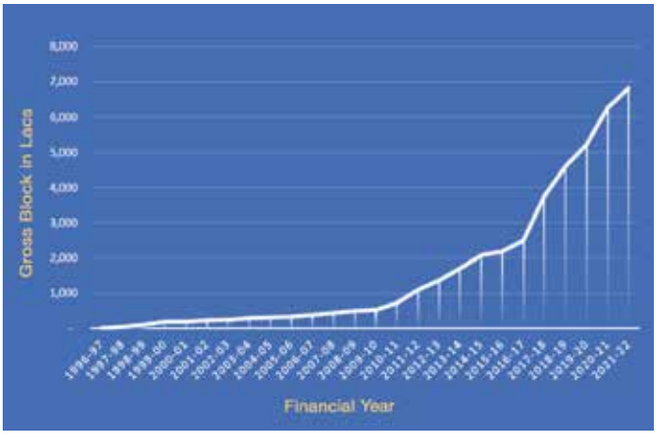
There is a saying, “When going gets tough, tough gets going”.

It was a really difficult period for every industry & particularly the industry dealing in metals. They had to use all their resources to keep growing. Their special product baskets helped them maintain their sales projections. High goodwill & ability to move, as per market expectations, came in handy to cross this phase.

Expansion plans & acquisitions

Zircar, as of now, doesn’t have any plans for acquisitions. They see a great future for their company & there is tremendous scope to grow in that respective field. Given below is the trend of capital investments made all these years. Judicious capital investments have been done year on year basis to take care of the emerging needs of the company. Their capital investments show that they have invested even during the pandemic period.

Focused Capital Investment



Zircar's ladle shroud supply & management journey to SAIL's Bokaro Steel Plant.

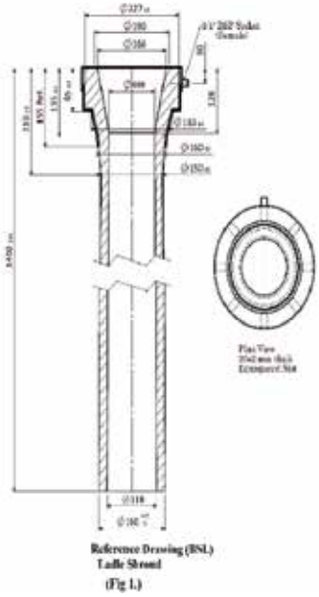
Challenges and tasks given to Zircar for 300 tonnes Ladle

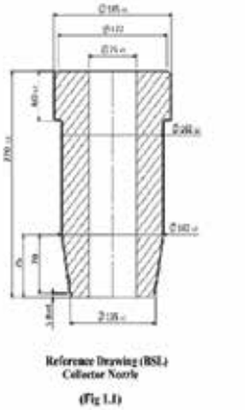
a) Regular supplies of LS were with a 6 heats guarantee. Normally BSL casts 14-16 heats in a tundish. Most of the time, LS was performing less than 6 heats resulting in more LS consumption.

b) Zircar received 12 pieces LS FOC trial order from Bokaro steel with 7 heats performance guarantee along with LS management.

Probable reasons for LS failure:

Zircar observed operations in SMS–2 on the caster for many hours. They tried to analyse failure patterns to arrive at possible reasons for the same. They were provided with LS and collector nozzle drawings as per Fig. 1 and Fig. 1.1 by BSL.





They identified the following nature of problems that needed to be addressed during LS designing:

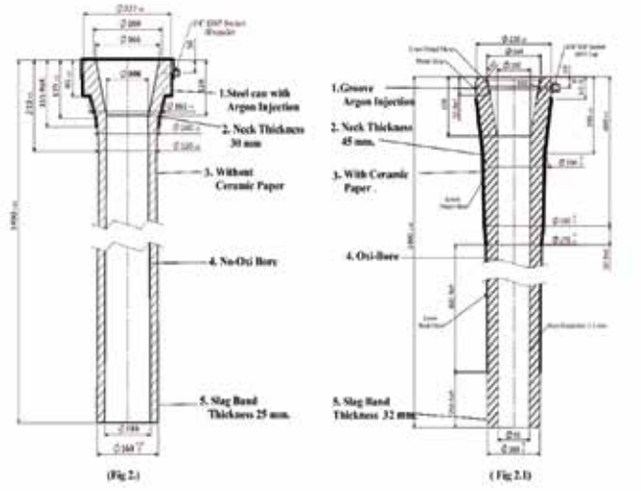
1. LS was breaking/puncturing at neck level
2. LS was breaking /corroding at slag band
3. LS was developing crack due to thermal shock
4. LS was developing crack due to mechanical jerks
5. LS was developing crack due to misalignment
6. LS was developing crack due to air ingress
7. LS was developing crack due to air lancing
8. LS was breaking due to the collector nozzle sticking

Design Features:

Zircar has customised design to overcome problems as mentioned below.

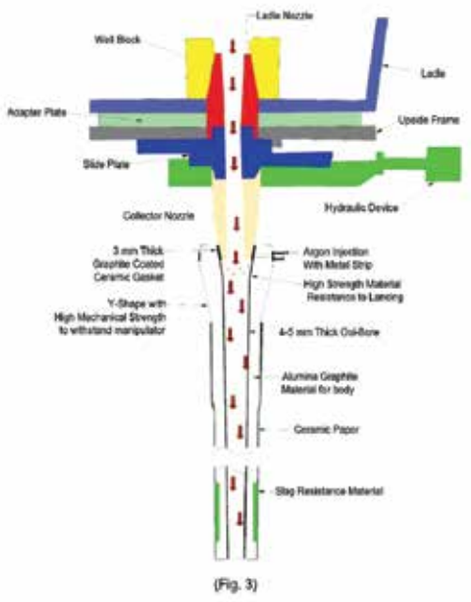
Sl. No.	Problem	Solutions	
a.	Neck breakage / Puncture / Air ingress / CN sticking	1	Y – shape design,
		2	Increasing the thickness at Neck area,
		3	High strength recipe,
		4	Air showering,
		5	Ceramic Gasket,
		6	Geometry matching with collector nozzle,
b.	Slag band breakage / corrosion	1	Increasing the thickness at slag band,
		2	Erosion resistant ZrO_2 – C mix,
		3	Oxidation resistant bottom mix,
c.	Thermal shock cracking	1	Higher thickness Oxy bore,
		2	High thermal shock resistant mix,
		3	Ceramic paper wrapping,
d.	Mechanical jerks / misalignment	1	Geometry matching with collector nozzle,
		2	Manipulator matching with LS outer taper ,
		3	Ceramic blanket cushioning,
e.	Air Showering	1	Better SS Shower ,

These changes were made as per Fig. 2.1:



Alignment:

Complete ladle bottom assembly with ladle shroud is shown below in Fig. 3. This assembly comprises a ladle well-block, ladle nozzle, fix plate, moving plate, collector nozzle, and ladle shroud. Fitment and alignment with each other are of high importance to have smooth and turbulence-free steel teeming.



(Fig. 3)

Design changes as mentioned in above point (E) is shown in Fig. 3.

Air Shower:

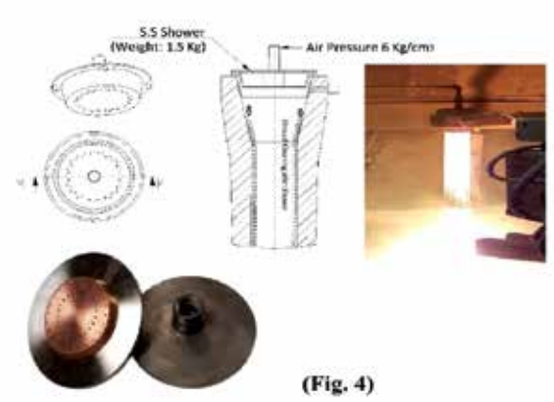
Zircar designed an air shower having a castable lining with an ss body. In this case, the weight of the shower was 7.5 Kg, and it was very difficult to handle during the ladle changeover.

It was redesigned without any castable to reduce the weight and to make it user-friendly. Finally, they made an air shower with a combination of ss & copper, as shown in Fig. 4.

The air shower was designed in such a way that it rests fully on the LS top rim and does not deflect during air showering at an air pressure of 5.5 – 6.0 Kg / cm^2.

This design of air showering was very comfortable and safe in operation. Earlier, oxygen lancing was creating splashing, which could hurt the operator.

This design is simple and cost-effective. It can easily be repaired through welding on the shop floor.



(Fig. 4)

Manipulator:

Zircar designed and manufactured their manipulator weighing about 22 kg. This was rejected by BSL officials due to being heavyweight. BSL officials said that their present hydraulic mechanism could not handle a manipulator weighing more than 17 kgs.

Manipulator had to be redesigned, which should be lightweight, easy to operate, and user-friendly.

The focus was to see that LS stands vertical in assembly with collector nozzles.


(Fig 5.)

Management Scope:

Zircar had supplied 12 pcs of LS to BSL as per PO. They had the responsibility of applying also.

The scope of the job was as follows:

a) LS fitting

b) Manipulator operation,

c) Ceramic Gasket fitting

d) Air Showering

e) LS stock maintenance on the shop floor

f) Manpower management

g) Liasioning with BSL officials

h) Reporting & documentation

Trial Result:

Though it was the very first experience to go for LS supply and management for 300 tons ladle, Zircar was successful not only in achieving the set target of 7 heats but crossing substantially, even though BSL did not have experience in LS supply and management earlier. All the pieces crossed 7 heats, and in fact, some pieces achieved a life of 8, 10, and 12 heats also. Moreover, not a single LS stopped during use due to LS failure. All stoppages were due to sequence breaks.

The corrosion/erosion pattern of LS at different areas had enough thickness to go through a few more heats. Slag deposition was minimal; and the neck area had a very uniform erosion pattern and negligible corrosion in the slag band even after 12 heats.

Zircar succeeded fully as per BSL's expectations. They see great potential for their company in the near to midterm. The company has grown about 74% in the last 2 years and expects to grow at the same pace for the next couple of years.

■

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Azadi Ka Amrit Mahotsav

A Case Study on a 4.5 MTPA Steel Plant in Rourkela

Background

A steam turbine blower was to be commissioned in a steel plant by a leading EPC company. As per the standard operating procedure listed by the steel plant owner company, the pipelines were erected on the site, and the flushing was completed with a single auxiliary pump at 1500 LPM. However, during the trial run of the turbine, the inline lube oil filters would clog very frequently and lead to halted operations.

Problem Statement

Frequent clogging of inline lube oil filters was hindering operations and delaying the steam turbine commissioning project.

Underlying Issues

On inspection, a root cause analysis was done, and the required rate for effective flushing was calculated as 3500 LPM. The particle contamination level was also found to be NAS 10. Hence, the following things were concluded:

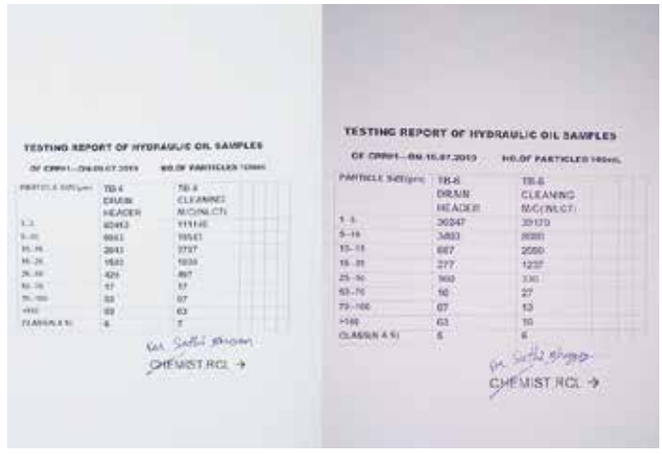
- The rate at which flushing was done was too low and led to ineffective flushing, leaving a lot of debris and scale inside the pipeline
- Absence of a system other than the inline filters to arrest the particles which would come along with the flushing flow
- The maximum flow rate that could be achieved on-site was 3000 LPM

What Minimac Did?

1. The calculated effective rate for flushing was 3500 LPM. But as only 3000 LPM was achievable on-site, the temperature of the fluid was increased by regular heating arrangement to bring down the required flow rate requirement to 2500 LPM.
2. Both the auxiliary pumps were employed for flushing activity, and a separate filtration skid was offered, which could handle the full flow volume that was getting generated.
3. Duplex-type filtration housing on the lube oil return side was also provided to arrest any future debris. Subsequently, turbine governing and heat exchangers were also taken online to clean the system in totality.

Result Achieved

The lines were successfully flushed, and a NAS 5 lube oil cleanliness level was achieved.



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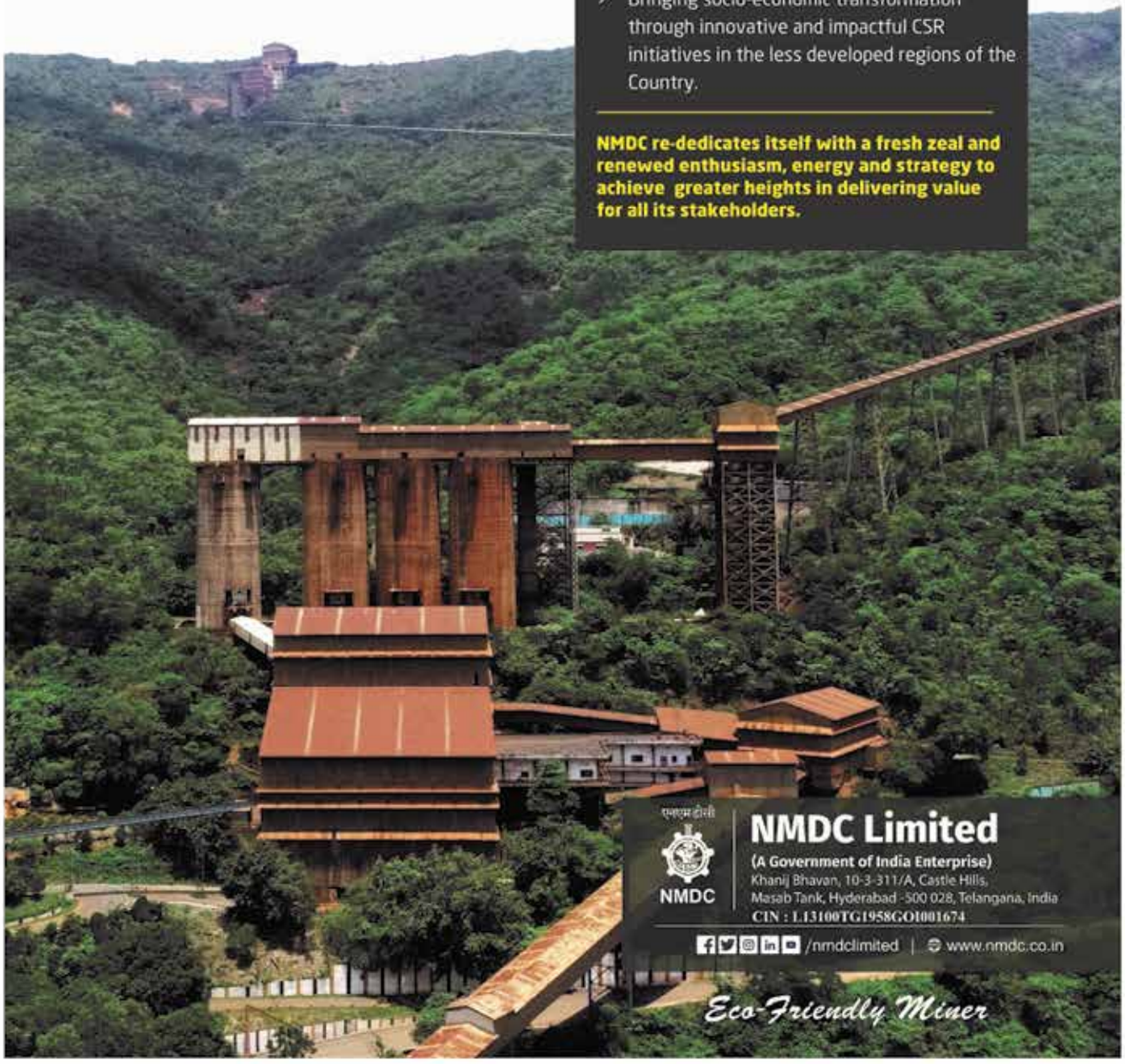

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Eco-Friendly Miner

NMDC Hosts a Seminar on Increasing Steel Consumption

Celebrating Azadi ka Amrit Mahotsav Iconic Week of the Ministry of Steel, mining major NMDC conducted a seminar on 'Increasing Steel Consumption' at its Head Office in Hyderabad.

The company invited opinion leaders from the iron and steel industry, including P. Madhusudan, Former CMD, RINL; Yogesh Daruka, Partner, PWC; and Rajib Maitra, Director, Deloitte, as panel members. NMDC's Senior Management – Director (Finance) Amitava Mukherjee and CVO B. Vishwanath (IRSS) encouraged the NMDC employees to participate and be interactive during the technical talk show.

Addressing the employees, Amitava Mukherjee said, "Increasing Steel Consumption – the theme of this seminar is indicative of the development aspirations of our country. As the largest producer of iron ore in India, we must measure up to the development demands of our country by enabling production and promoting consumption of steel."

As a keynote speaker, P. Madhusudan emphasised on enhancing steel consumption in the rural economy. He recommended the building of ecosystems that will demand steel, such as Smart Villages and Advanced Agriculture systems, as the way to increase the usage of steel in rural landscapes of India.

Yogesh Daruka talked about the positioning of the mining industry in society and the need to revamp the brand from an exploitative industry to a development industry. He then declared that this is possible when the mining majors of the country double down on ESG. He was accompanied by Shri Praveen Mishra, Director, PWC, who delved into the iron and steel scenario and laid down the key enablers in achieving the New Steel Policy target - "Investment in R&D, Funding towards ESG, Policies around Consumption, and Skill Development."

NMDC Projects at Kirandul and Bacheli in Chhattisgarh, Donimalai in Karnataka, and Panna in Madhya Pradesh conducted this talk on 'Increasing Steel Consumption' in the townships and nearby villages with 400 participants.

Tata Steel India Reports Stable Q1 Production Results

Tata Steel India has recorded crude steel production of 4.92 Million Tonnes (MT) during the first quarter (Q1) of FY'23, up by 6% Year-on-Year (YoY). Its deliveries stood at 4.06 MT in Q1 FY'23, down by 2% YoY due to moderation in exports following the imposition of a 15% export duty. However, domestic deliveries were ramped up leveraging our strong marketing network & agile business model and increased by 5% YoY.

'Automotive & Special Products' segment deliveries rose by 22% YoY on a broad-based recovery across all sub-segments. 'Branded Products & Retail' segment deliveries were broadly similar. Tata Tiscon registered its best-ever first-quarter sales enabled by expanded physical and virtual reach. 'Industrial Products & Projects' segment deliveries grew by 8% YoY, primarily driven by an increase in sales of value-added products to key segments like engineering, etc. Revenues from Tata Steel Aashiyana during the June quarter, an e-commerce platform for Individual Home Builders, increased by 77% YoY to Rs. 457 Crores.

Tata Steel Europe produced 2.43 MT of steel in Q1 FY'23, up by 5% QoQ but was lower on a YoY basis (2.67 MT in Q1 FY'22). Delivery volumes in Europe stood at 2.16 MT, lower on a YoY basis in line with production.

Tata Steel Completes Rs. 12,100-Crore Acquisition of NINL

Tata Steel Long Products Limited (TSLP), a subsidiary of Tata Steel, has completed the acquisition of 93.71% in 1 Million Tonnes Per Annum (MTPA) Neelachal Ispat Nigam Limited (NINL) from MMTC Ltd., NMDC Ltd., MECON Ltd., Bharat Heavy Electricals Ltd., Industrial Promotion and Investment Corporation of Odisha Ltd., Odisha Mining Corporation Ltd., President of India and Government of Odisha for an aggregate consideration of Rs. 12,100 Crores.

The acquisition has been completed as per the terms and conditions of the share sale and purchase agreement entered on March 10, 2022, and in accordance with the process being run by the Department of Disinvestment & Public Asset Management (DIPAM).

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Important: Appropriate Personal Protective Equipment (PPE) must be worn by anyone in proximity to molten metal.

Located in the close proximity to Tata Steel's state-of-the-art facility at Kalinganagar, NINL is a strategic acquisition for Tata Steel as it provides synergies of shared infrastructure, resources, management, etc., and an opportunity to build a dedicated and sustainable long products complex.

Tata Steel said that it will not only restart the 1 MTPA steel plant expeditiously but also work simultaneously to expand the capacity by building a 4.5 MTPA state-of-the-art long products complex in the next few years, and further expand it to 10 MTPA by 2030.

Commenting on the completion of the acquisition, T. V. Narendran, CEO & Managing Director, Tata Steel, and Chairman, TSPL, said, "The acquisition of NINL is a historic achievement and a significant milestone towards building a dedicated long products facility for the Tata Steel Group. The completion of the transaction is a testimony to the Government of India's focus on its disinvestment programme. The acquisition also reflects Tata Steel's commitment to the state of Odisha and the communities around its operations."

The acquisition of NINL is in sync with Tata Steel's plan to grow its long product capacity as India focuses on infrastructure spending, which is expected to boost steel consumption. Tata Steel will leverage its capability in the long products business using its strong brand equity, particularly in the retail construction segment, and its extensive, pan-India retail and distribution network to drive scale in long products.

JSW Steel's Q1 Crude Steel Output Stands at 5.88 MT

JSW Steel posted a 16% Year-on-Year (Y-o-Y) jump in its consolidated crude steel output at 5.88 Million Tonnes (MT) during the first quarter (Q1) of FY'23. The company had produced 5.07 MT of crude steel in the year-ago period.

The crude steel production was 2% lower sequentially due to the preponement of certain scheduled shutdowns during FY'23.

Source: PTI

RHI Magnesita Discloses CO_2 Footprints for All Products

RHI Magnesita has become the first company in the refractory industry to make the CO_2 footprints of its 2 lakh products transparent and comparable.

Gustavo Franco, CSO, RHI Magnesita, said, "Competitiveness, sustainability and transparency are becoming increasingly connected, and valid data is key to laying the groundwork for sustainable decision-making. With full CO_2 transparency for all our products, RHI Magnesita is establishing new standards for the refractory industry and is addressing our customers' needs: suitable sustainable solutions can be now easily identified and included in product circles and sustainability reporting."

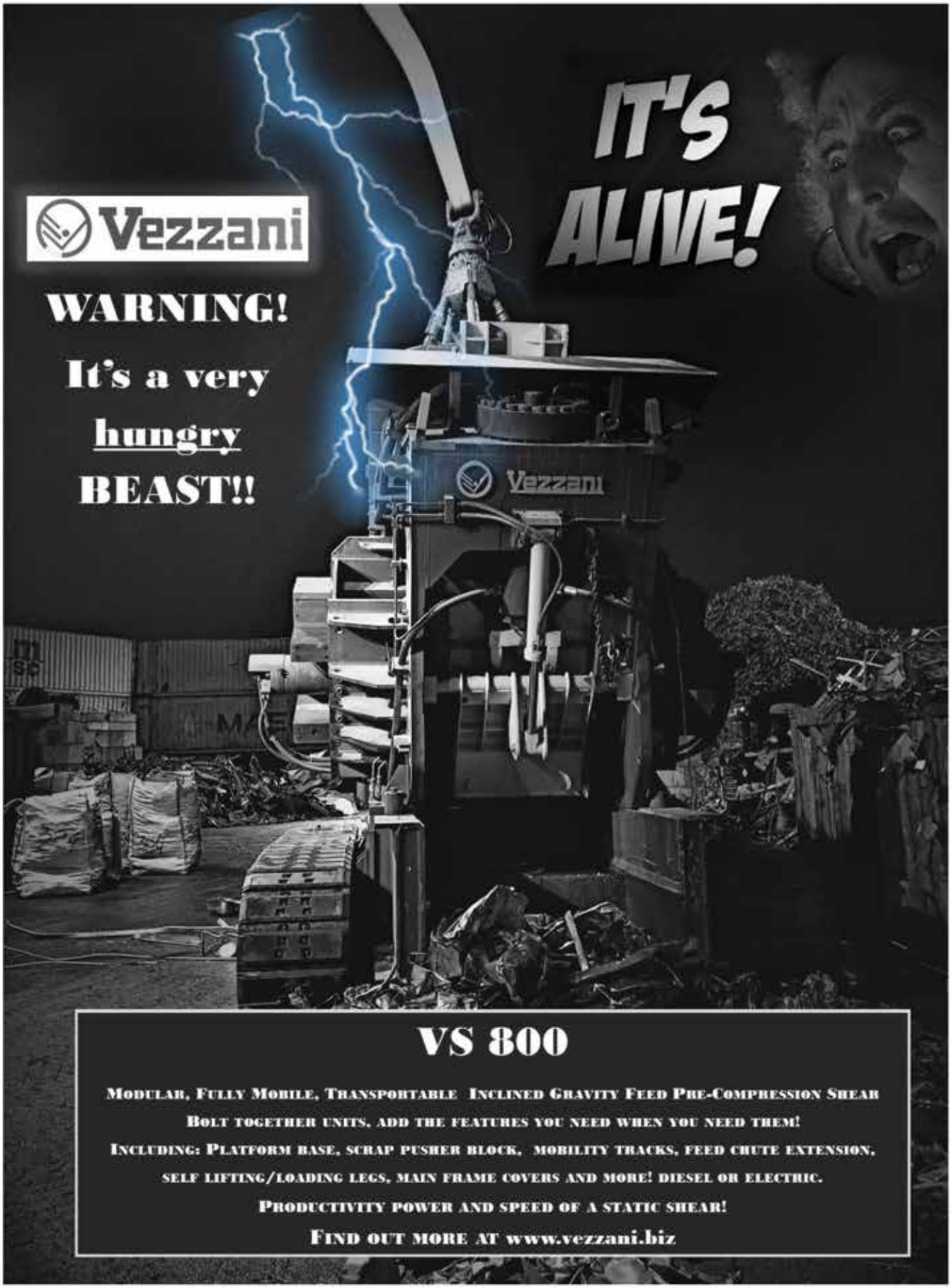
Gustavo Franco, CSO RHI Magnesita

Parmod Sagar, MD & CEO of RHI Magnesita India Ltd., said, "Full disclosure of CO_2 footprint of our products is yet another step towards fulfilling our sustainability commitments. In our Indian plants, we have been working continuously on reducing our carbon footprint. There has been a high emphasis on building energy efficiency in our production process. And also, on increasing our recycling share."

Parmod Sagar, MD & CEO RHI Magnesita India Ltd.

As of now, all RHI Magnesia's Technical Data Sheets include a field "Environmental Indicators", in which the CO_2 equivalent emission of one metric tonne of the product is listed. The calculation method for these indicators is developed with and supervised ongoingly by external experts under the principles of ISO standards. All greenhouse gases "cradle-to-gate", from raw material extraction to production to packaging to the gate, are considered in these CO_2 footprint calculations.

"This project marks an important milestone towards a green transformation. Thus, one of RHI Magnesita's main targets is to significantly reduce emissions over the next few decades, with the long-term goal of achieving net-zero operations in all areas of the company. It is clear that a solid basis for sustainable decisions and developments can only be achieved by creating a valid audited database," added Gustavo Franco.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TRL Krosaki Dispatches the First Batch of Alumina Graphite Refractories from its Belpahar Plant

TRL Krosaki Refractories Limited dispatched the first batch of Alumina Graphite Refractories products manufactured in its Belpahar Plant on July 15, 2022.

Hirdesh Sehgal, Executive Vice President (Operations), flagged off the consignment in a programme organised to celebrate the special moment of shipment of the first batch of the products manufactured in India.

Speaking on this occasion, Shri Sehgal recapitulated the thoughts behind conceiving the idea to put up a state-of-the-art Alumina Graphite Plant at Belpahar. Further, he emphasised on the challenges faced in getting the proposal approved and executing the project in an extremely challenging situation posed by the COVID-19 pandemic and the restrictions imposed due to that.

Shri Sehgal thanked Krosaki Harima Corporation, Japan and the Japanese Colleagues like Hiroshi Nagata, Takahiro Kuroda, Minoru Kaneko, etc., and Soumesh Sahu and his entire project team for their unwavering support and contribution for ensuring the completion of the project within the stringent time frame. Shri Sehgal wished best of the luck to the employees of the plant and reaffirmed his confidence that, with superior quality products and performance, the plant will be able to live up to the expectations of its valued customers.

The programme was attended by Hiroshi Nagata, Executive Vice President (Technology & TSS), Department Heads of Production, Maintenance, Projects, Logistics, Packaging, Quality Control and Quality Assurance, etc., and employees of Alumina Graphite Plant and Projects Department.

TRL Krosaki Refractories Limited has commissioned a state-of-the-art 100 MT per month new Alumina Graphite plant in its Belpahar Works on March 7, 2022. Set up with an investment of nearly Rs. 65 Crores, this plant will enable the company to produce world-class continuous casting refractories for steel plants in India and abroad. The project was commissioned with the technology of Krosaki Harima Corporation of Japan, known for its superior technology and quality.

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Men in News

A. K. Tulsiani Assumes Charge as SAIL's Director (Finance)

Anil Kumar Tulsiani has assumed charge as the Director (Finance) of Steel Authority of India Limited (SAIL) on June 20, 2022.

A. K. Tulsiani, Director (Finance), SAIL

Shri Tulsiani joined SAIL in 1988 in the company's Durgapur Steel Plant as Junior Manager (Finance). Rising through the ranks, he became the Executive Director (F&A) in SAIL before taking over as the Director (Finance) of the company.

In his last role as the Executive Director (F&A) at SAIL since June 2021, he has been working towards improving the top line and the bottom line for the company and ensuring efficient fund management and resource allocation.

A Cost & Management Accountant (CMA) and MBA (Finance), Shri Tulsiani holds an experience of almost 34 years in various areas of finance and accounting in different plants/units of SAIL.

He has taken several new initiatives during his tenure in areas like budget & budgetary control, fund management, finalisation of accounts, smooth transition to GST, etc. He also played a key role in the preparation of the cost manual for SAIL mines.

Tridib Majumder Receives Business Leader of the Year Award

Tridib Majumder, Managing Director, Quaker Houghton India, has received the 2022 "Business Leader of the Year" award. Renowned leaders from across the corporate world were present for the event.

Dieter Laininger, SVP Managing Director, Asia Pacific, said, "Tridib is a seasoned professional with more than three decades of experience spanning a variety of industries

and cultures. His leadership and strategic planning abilities capitalise on existing and emerging opportunities and people development. He has a track record of successfully managing market entry, turnarounds, and consistent growth through people development. Now, we are fortunate to have him helping lead Quaker Houghton's India operations."

Speaking on the occasion, Shri Majumder said, "I am truly humbled to have received such an honour. I believe you are only as good as your team, and dedicate the award to them. We motivate each other to go that extra mile to achieve our targets."

Through the award, Shri Majumder was recognised for his ability to focus on the strategic business, provide clear communications, and develop people. During the company's 2019 integration, he worked seamlessly across cultures and systems to help bring together and form Quaker Houghton.

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Maithan Steel, West Bengal – Dia 8mm @ 28 m/s on 78m Cooling Bed
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JSW Orders a New SuperGrinder Plant from Danieli Centro Maskin

JSW has awarded Danieli Centro Maskin an order for a new SuperGrinder plant to be installed at Dolvi, Maharashtra, India.

This project will represent one of the most important technology milestones for slab conditioning, reconfirming Danieli Centro Maskin solid technology and market leadership.

The new slab-inspection and grinding plant will process a wide array of ultra-low, low and medium-carbon grades and alloy steel grades, with an average of 2 mm removal depth.

Structured in two phases, the project will start with the supply of a first grinding unit equipped with the latest-generation, 710-kW power oil-lubricated spindle that will initially ensure an output of approximately 800,000 tpy.

With the installation of the second grinding unit (phase II), the SuperGrinder plant will reach an overall output of 1.3 Mtpy.

Featuring a U-circuit plant layout, a newly designed edge-grinding unit with a double-grinding cart configuration will serve the two grinders. The plant will feature an exclusive Danieli Automation TWS platform, along with the E-Cube, Hi-Grind and CastGrind technologies for processing hot slabs up to 800°C.

The new JSW plant will also feature the latest-generation IntelliGrind surface-defect inspection system, which makes use of combined high-definition image acquisition and laser sectioning, with functions for automatic detection and classification.

The new SuperGrinder plant will start operation by the summer of 2023.

Optimus Steel Relies on Danieli for Complete Rolling Mill Modernisation

Since the acquisition of the minimill in Orange County, Texas, USA, Optimus Steel has chosen Danieli for a complete rolling process modernisation plan, to improve competitiveness and product quality, and to operate with high production flexibility.

The project covers different technology areas and is being carried out in steps. A first modernisation step, related to the two-strand wirerod mill, has already been implemented.

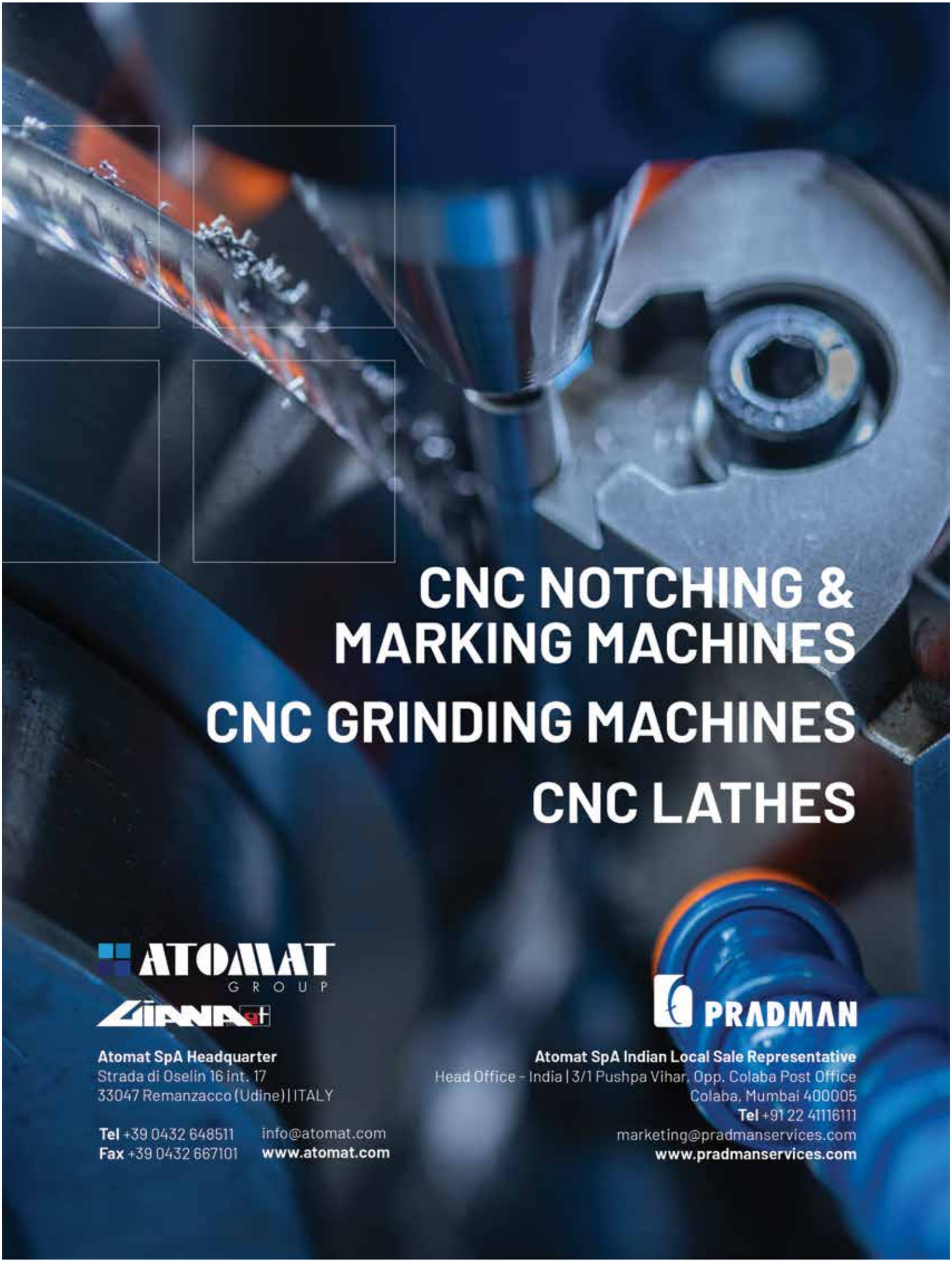
Two new HSS High-Speed Shears for automatic bar cropping have been installed between the wirerod finishing blocks and the new Danieli oil-film bearing laying heads, equipped with patented double-pipe rotor technology to perform consistently at finishing speeds up to 115 m/sec. A new, Sund Birsta, all-inclusive coil-finishing end completes the wirerod mill modernisation.

The installation of a new, 140-tph high-speed bar-finishing line is in progress, and it will be completed by 2023. Supplied with two Danieli HTC High-speed double Twin-Channel systems and automatic bar counting, it will enable Optimus Steel to produce 9.5 to 36-mm-dia, high-quality rebar (#3 to #11) at a stable working speed of 45 m/s.

Recently, to complete its modernisation vision plan, Optimus Steel has approved an investment for a new re-heating furnace and a new twin rolling mill.

The new, 140-tph Danieli Centro Combustion low-scale, low-NOx, energy-saving walking-beam furnace will feed two independent rolling lines, which in turn will feed either the two-strand wirerod line for special steel or the HTC bar line. The new mill will operate energy-saving, cantilever-roll stands to minimise installation and production costs, maintenance time and personnel, by fully applying the 4.0 concept, which also improves operator and operational safety.

To be installed at the entry side of the two new rolling lines, an energy-efficient Q-Heat induction heater will improve material



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quality, especially on the wirerod products, by controlling scale formation.

The automation control for the entire process will be guaranteed by Danieli Automation systems.

The upgrade of the existing water-treatment plant serving the minimill, along with the supply of a new one to guarantee higher environmental standards and comply with local requirements, is part of the contracted package.

Full rolling mill modernisation is expected to be completed by the beginning of 2024.

Cognor Taps Danieli for a Spooler Line and a Light Section Mill

Cognor, a vertically integrated Polish producer of rebars, merchant and quality steel bars, has contracted Danieli for two strategic projects, a new spooler line and a new light section mill, to widen its product portfolio whilst performing at the most competitive OpEx.

The spooler line will be installed downstream the existing Cognor bar mill in Krakow and produce compact rebars-in-coil up to 3.5 tonnes, from 8 to 20 mm, at a pace of 75 tph. It will consist of a complete series of a 4-pass fast-finishing block, quenching-water cooling boxes, and two coiling machines, including finishing services.

Two new Danieli roughing stands will be placed between the existing reheating furnace and rolling mill to enable feeding with 160-mm square billets.

The new light-section mill will produce a wide range of profiles, including flats, equal and unequal angles, HE/IPE/IPN beams, UPN/UPE, as well as tee, round and square profiles at a pace of 80 tph (450,000 tpy finished material).

A new walking-beam reheating furnace will feed an 18-housingless-stand rolling mill with 160-mm square billets. The mill supply will encompass complete finishing services, including a straightening and cut-to-length machinery, rolling guides and consumables for a full production mix. The rolling mill technological layout has been designed to allow the installation of two more roughing stands at the continuous mill head, to enable the use of 200-mm square billets, with the aim to expand the product mix.

Both contracts comprise engineering, technological supply, on-site training and advisory services.

The spooler line is expected to start operation by the end of 2022, whilst the light-section mill is intended to be operational by the end of 2023.

Gerdau Awards a Rolling Mill Upgrade Contract to Danieli

Gerdau has selected Danieli do Brasil Service Team to provide and install a new surface quenching and self-tempering system for Bars-QTB at its Araçariguama plant.

The new installation will replace the existing bar treatment line. The main purpose of installing a Danieli QTB process is to improve the mechanical properties of deformed bars (rebars), made from the basic chemical composition, at low production costs.

For steel grades presenting yield strength equal to or higher than 500 MPa, it is possible to save up to 18% of the bar production cost as compared to low-alloy steel grades.

Bars processed with the QTB system achieve international standards (ASTM, DIN, BS and ABNT) without the need of any downstream cold-working practice. Furthermore, a very low content of alloying elements, along with a better homogeneity of the mechanical properties, leads to good values of ductility and elongation, improving bar weldability.

By using Danieli QTB, a lower quantity of scale on the treated bar is also produced.

The new QTB system provided by Danieli will include tools for quick replacement, aligning, and setup of cooling elements,

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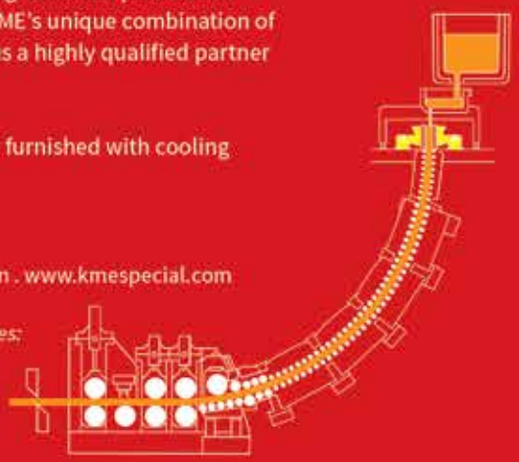

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including boxes equipped with beams. This will drastically reduce changing times and increase operational safety.

The startup of the QTB is planned for the second half of 2022

Danieli Corus Receives a Contract from ESL to Revamp Two Converters

Electro Steel Limited (ESL), a Vedanta Resources subsidiary, has placed an order with Danieli Corus for the replacement of the vessels of both 60-Tonne converters in operation at the Siyaljori, Jharkhand plant, located east of Bokaro Steel City, India.

The existing vessels, which have detachable bottoms, will be replaced by new vessels with technologically advanced, Danieli Corus Lamella-type vertical and Daniella-type horizontal suspension systems.

The upgrade of the two converters, which is the first such project for Danieli Corus in India, reflects the ambition of ESL to implement state-of-the-art technology and increase the efficiency and stability of operations, while relying on the longest possible lifetime capability.

The upgraded converters will be available for operation in the second half of 2023.

CMC Steel Operates Q-One Digital Power Feeder from Danieli

The existing ladle-furnace transformer at CMC Steel Arizona has recently been replaced with a Danieli Automation Q-One digital power feeder, allowing the operation to begin without any delay to production in the commissioning stage.

The innovative features of Q-One allow furnaces to operate at variable frequencies. Tests have been executed operating the furnace at CMC Steel Arizona down to 20 Hz instead of the nominal 60 Hz.

As already experienced in previous installations, the use of low frequencies made it possible to achieve better energy performances, with a constant power factor of 0.96 and minimum disturbances on the power grid.

A Danieli QLP MIDA endless casting-rolling minimill with a design capacity of 350,000 tpy of quality rebar in bundles and spools was supplied to CMC Steel Arizona in 2009. CMC is operating another Danieli QLP MIDA minimill – CMC Steel Oklahoma – and a third one, still supplied by Danieli, will be started up in 2023.

Shaoguan Iron & Steel Group Co., Ltd. Grants FAC to KOCKS for New 3-roll RSB®

Chinese steelmaker Baosteel Group Guangdong Shaoguan Iron & Steel Co., Ltd., known as Shaoguan Iron & Steel (SGIS), issued the Final Acceptance Certificate (FAC) for the new KOCKS RSB® 370++/4 in 5.0 design.

This is the 115th Reducing & Sizing Block of KOCKS worldwide. Despite all adversities due to the pandemic and current world situation, the order was completed on time, on target and on budget.

The RSB® 370++/4 is located as a finishing unit after 20 stands in H/V rolling mill arrangement

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REVOLUTIONARY DANIELI MIDA HYBRID MINIMILL

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DIGIMELTER®, OCTOCASTER® DYSENCASTER® AND DUE® TECHNOLOGIES

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SCRAP MANAGEMENT
20 kWh/ton saving

Lateral and top continuous charging system (ECS).

ENDLESS SCRAP CHARGE
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11% lower electrode consumption; Zero power grid disturbances.

DDM - DANIELI DIGIMELTER: THE EVOLUTION OF THE EAF
30 kWh/ton saving

HYBRID VIA Q-JENIUS
50 kWh/ton saving

Use of alternative power sources at site to Q-One via patented Q-Jenius DC link and Q3-Jenius energy management.

DR+DDM PRODUCTION ROUTE

CO_2 reduction: 800 $kgCO_2$/tls DR+DDM route vs. 1,800 $kgCO_2$/tls BF+BOF.

DRI HOT CHARGE
100 kWh/ton saving

DRI PRODUCTION USING HYDROGEN

324 $kgCO_2$/tls using up to 70% hydrogen instead of 100% natural gas (without compromising DRI quality).

Note: energy savings expressed in kWh/ton (1 kWh/ton = 3.6 MJ/ton)

QSP-DUE®
Danieli Universal Endless for flat products

Up to 260 kWh/ton saving.

DYSENCASTER® UP TO 6.5 M/MIN CASTING SPEED

Q-HEAT FLAT INDUCTION-TEMPERATURE CONTROL

WIDE RANGE OF QUALITY HOT-ROLLED STRIP

DUE® Three rolling modes. Coil-to-coil, semi-endless, and endless for no steel-grade production limits.

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BARS, WIREROD, MERCHANT SECTIONS

Up to 330 kWh/ton saving.

DIGISAVER
20 kWh/ton saving

Additional digital overall plant optimization

Please visit **www.danieli.com** to learn about the orders for the first MIDA Hybrid minimill received from CMC Steel in the USA, and a new 2.5-Mtpy direct reduction plant that allows the use of hydrogen and natural gas, for OMK in Russia.

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SGIS produces premium steel products with high added value. Relying on the performance of KOCKS 3-roll technology, the company intends to further expand and strengthen its share in the demanding SBQ sector for high-quality engineering steels, primarily for the automotive industry. The KOCKS RSB® 370++/4 in the existing 490.000 t/a bar mill line will produce straight bars seamless in a range between Ø17 to 80 mm with a very tight tolerance level and an excellent surface onto the cooling bed.

The RSB® 5.0 is located as a finishing unit after 20 stands in H/V rolling mill arrangement. Further scope of supply for this order was a roll shop for offline 3-roll stand and guide preparation, as well as supervision for the installation and commissioning.

SteelAsia Chooses Tenova for its Green Technology to Promote Sustainability

SteelAsia Manufacturing Corporation, the flagship steel manufacturing company in the Philippines, recently inked a partnership with Tenova for Consteel® Evolution, a state-of-the-art low-impact technology for steel manufacturing.

It will be the first of its kind in the country and will be employed in SteelAsia's new melt shop in Lemery, Batangas, in 2024.

Tenova's scope of work includes the EAF (Electric Arc Furnace) Consteel® Evolution, the secondary metallurgy station, the billet caster, the Fume Treatment Plant (FTP) and the material handling systems, along with all engineering services for the civil works and the balance of plant.

Seated L-R: Sean Andre Y. Sy, Chief Operating Officer, SteelAsia; Paolo Stagnoli, Commercial Director for Electric Arc and Ladle Furnaces, Tenova; Benjamin O. Yao, President & CEO, SteelAsia; and Davide Masoero, Area Manager for Europe, Melt Shops, Tenova

Standing L-R: SteelAsia Executives Rafael C. Hidalgo, Senior Vice President for Business Development; David Wu, Consultant; Derek Matthew Y. Yu, Vice President for Engineering, Procurement and Construction; and Pek Hoong Chong, Chief Technical Officer

Benjamin O. Yao, President and CEO of SteelAsia, said, "Our company's long-term vision is to develop the Philippine steel industry because this is the backbone of industrialisation. We have seen our neighbouring Asian countries grow faster because they can manufacture their steel. The Philippines needs to catch up. As we do so, we want our technology to be at par with global standards in efficiency and environmental sustainability. Thanks to our partnership with Tenova, we can increase our steel productivity to support nation-building while ensuring that we also take care of the environment."

The new melt shop will recycle local scrap metal to produce high-grade billets for steel sections. The advanced Lemery facility will be one of the cleanest steel plants in the world. It will generate the lowest carbon emission, providing Filipinos with top-quality steel sections produced with the most environmentally friendly technology.

The Consteel® Evolution technology saves energy, decarbonises steel production and reduces environmental impacts through efficient energy recovery and pollution control innovations. Scrap metal is a vital national resource used in steel production with low carbon emission, and SteelAsia targets to increase its output by maximising the use of scrap metal.

Paolo Stagnoli, Commercial Director, Electric Arc & Ladle Furnace in Tenova, said, "Thanks to Tenova's continuous efforts to enable a more sustainable metals production, SteelAsia found in our portfolio the most suitable technologies to produce high-quality steel from recycled scrap. We are honoured to support SteelAsia in the green industrial development of the Philippines."

SteelAsia's partnership with Tenova to further pursue its decarbonisation efforts aims to make steel production more sustainable without compromising its output and financial returns.

Nucor Contracts Fives for a Recoiling and Inspection Line

Fives has won a contract for the supply of a recoiling and inspection line to support automotive applications at the new Nucor steel plant in West Virginia.

Previously, Fives also received orders for two galvanising lines for this same greenfield facility. With a total investment of about $2.7 Billion, Nucor is building a new steel mill for sheet metal production on the Ohio River, which is expected to start operations in the second half of 2024.

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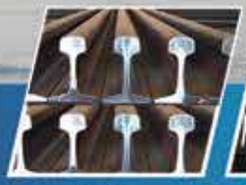
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The recoiling and inspection line includes Fives' state-of-art digital solution EyeronTM, an intelligent quality management system that collects upstream process data, checks consistency with quality rules and automatically assesses product quality grading. EyeronTM will be tracking quality on the vertical galvanising line and the recoiling & inspection line to ensure the products meet the automotive quality standards.

John Farris, Vice President & General Manager of Nucor Steel West Virginia, said, "We choose Fives to supply an inspection line as an extension of our galvanising line N1 using their automotive expertise supported with a real-time quality system."

Metso Outotec to Supply Planet Positive comminution technology in South America

Metso Outotec has been awarded a major contract for the delivery of sustainable crushing, screening, and grinding technologies to a greenfield iron ore project in South America.

The concentrator plant has a targeted production of premium pellet feed. The total value of the order is around EUR 45 Million.

The comminution circuit flowsheet developed for the new concentrator plant in cooperation with Metso Outotec represents the most sustainable technology currently available. Conventional horizontal mills have been replaced with the combination of HRC™e high pressure grinding rolls and Vertimill® grinding mills to achieve the best energy-efficiency with the lowest operating and life cycle costs.

Metso Outotec HRC™e

Metso Outotec Vertimill®

By utilising this flowsheet, the plant is expected to save 25% of installed power compared to a conventional HPGR/ball mill circuit and over 40% compared to a conventional SABC circuit.

Christoph Hoetzel, Head of Grinding business line at Metso Outotec, said, "Metso Outotec is honoured to be chosen to deliver these state-of-the-art comminution technologies. The plant's Planet Positive comminution flowsheet combines the best solutions available, allowing to achieve superior energy-efficiency and lower wear rates."

Metso Outotec's scope of delivery includes the engineering, manufacturing and supply of SuperiorTM MKIII Primary Crusher, HP SeriesTM cone crushers, HRC™e HPGR high pressure grinding rolls, and vibrating feeders, as well as banana, horizontal and dewatering screens and Vertimill® grinding mills. In addition, Metso Outotec will provide installation and commissioning advisory services and wear and spare parts.

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TO COMBAT ABRASION, EROSION AND CORROSION

Conforma Clad's technology enables densely-packed tungsten carbide to be uniformly applied to complex geometries, providing a protective barrier that wears at a consistent, predictable rate and lasts **3 to 5 times longer** than other technologies.

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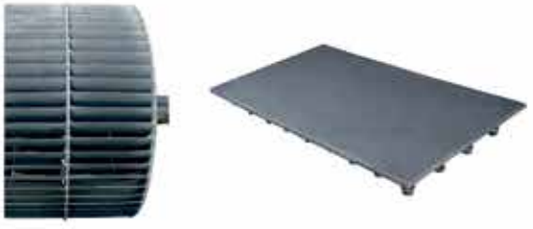

Cladding enhances life of liners and allows trouble-free operation of the plant. Applications include—updraft drying fan, wind box recuperation fan, wind box exhaust gas fan, hood exhaust gas fan, dedusting fan

CONFORMA CLAD™ Mixer Blades

Unique, hybrid design protects primary wear area with solid carbide, and secondary wear area with our patented tungsten carbide cladding technology

CONFORMA CLAD™ Conveying Pipes

UltraFlex™ cladding applied on difficult to reach areas on the inner diameter of the pipes results in unmatched wear resistance

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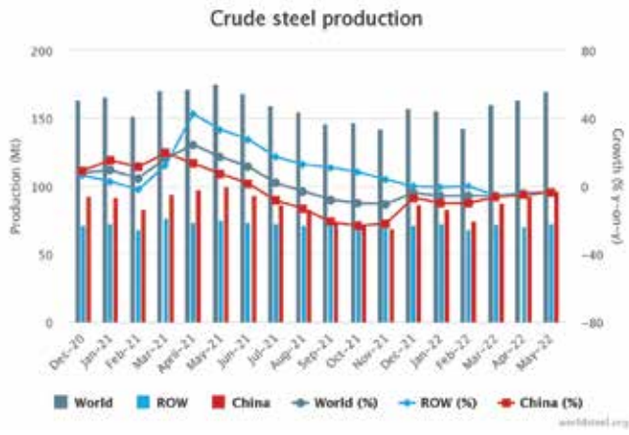
Global Crude Steel Production in May 2022

Production of crude steel by 64 countries reporting to the World Steel Association (worldsteel) was estimated at 169.5 Million Tonnes (MT) in May 2022, registering a decrease of 3.5% compared to May 2021.

In Asia, China's crude steel production totaled to 96.6 MT in May 2022, down by 3.5% from May 2021. India produced 10.6 MT of crude steel in May 2022, up by 17.3% over May 2021. Japan came up with 8.1 MT of crude steel production in May 2022, a decrease of 4.2% from May 2021. South Korea's crude steel production stood at 5.8 MT in May 2022, down by 1.4% since May 2021.

In the European Union, Germany recorded 3.2 MT of crude steel production in May 2022, declining by 11.5% from May 2021.



In North America, the production of crude steel by the United States in May 2022 amounted to 7.2 MT, decreasing by 2.6% since May 2021.

In the C.I.S., Russia is estimated to have produced 6.4 MT of crude steel in May 2022, down by 1.4% from May 2021.

In other Europe, Turkey's crude steel production stood at 3.2 MT in May 2022, declining by 1.4% since May 2021.

In South America, Brazil produced 3.0 MT of crude steel during the month under review, down by 4.9% from May 2021.

In the Middle East, Iran is estimated to have produced 2.3 MT of crude steel in May 2022, decreasing by 17.6% from the year-ago period.

Source: worldsteel

■

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- Common Roll Unit for all stands thus reduced capital investment
- Roll balancing & Roll gap adjustment through eccentrics that allows easy maintenance. Very rigid design
- Quick Roll changing feature reduces size change time
- Neck Diameter of 150mm for Wire Rod Block

ISR/NOV/2021

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Decarbonising the Indian Steel Industry – Issues & Challenges and the Way Forward

N. M. Rao
Consultant (I&S), Visakhapatnam

Introduction

The World Meteorological Organisation, in its 'State of the Global Climate Report-2021', has said that four key climate change indicators: greenhouse gas concentrations, sea-level rise, ocean heat and ocean acidification, have set new records in 2021. According to the report, the past seven years have been the warmest seven years on record. The average global temperature in 2021 was about 1.11 +/- 0.13 degree Celsius above the pre-industrial level. Sea level increased at an average of 4.5 mm per year from 2013-2021. This has caused heat waves, flooding, drought, hurricanes, etc., resulting in an economic loss of hundreds of billions of dollars, food & water scarcity, and loss of lives. The United Nations has called for immediate action by member countries to arrest this trend and take all necessary actions so that the temperature increase is kept below 1.5 degree Celsius above pre-industrial levels to avoid harmful and long-lasting ramifications for sustainable development and ecosystems. As per the Paris agreement 2015, the rise in global temperature is to be kept below 2 degree Celsius above pre-industrial levels by the end of the century, ideally below 1.5 degree Celsius. Every increment of a degree in temperature translates into increased risk for people, communities, and ecosystems. In the Glasgow

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2021 meeting, it was felt that global emissions must halve by 2030 and reach net zero by 2050. Many countries like the EU, UK, USA, Japan, South Korea, Australia, etc., have committed to achieving net zero by 2050. China will achieve this by 2060. Honourable Prime Minister of India has committed that by 2070 India will achieve net zero. The Power and Transport sectors are the greatest emitters of carbon dioxide. In the industrial sector, steel, cement, fertilisers and plastics have high emission intensity, and decarbonisation of these sectors is not easy. Therefore, the Indian steel sector has to draw up an action plan and fix targets to be achieved in the years 2030, 2040, 2050 and beyond, up to 2070. This article looks at the current situation, various issues involved and the challenges for the steel sector in India to achieve net zero emissions by the year 2070.

Current Situation

In 2020, the average carbon dioxide emissions by the world steel industry were 1.85 t/tcs. Crude steel produced during the year was 1,860 Mt, and hence, total emissions were 3.441 (3.7 as per IEA) Billion Tonnes (direct emissions are estimated at 2.6 Billion Tonnes). This is about 7 to 9% of global CO_2 emissions. In that year, 73.2% of the world's crude steel was made through the BF-BOF route. China, which accounted for 56.75% of total world production in the year, made over 90% of crude steel through the BF route. On the other hand, among other major steel producers, the USA made 70% through the electric route. France, Germany, Russia and South Korea made between 30-35% through the electric route. Japan made 75% through the blast furnace route. Carbon dioxide emission intensity is below 1 t/tcs in case of the USA, between 1.5 to 1.9 t/tcs in case of Germany, Japan, Russia, and South Korea and above 2 t/tcs in case of India and China. Nucor Steel Corporation, USA, which uses the DRI-EAF route, generates about 0.8-0.9 t of CO_2 per tonne of crude steel. CO_2 emissions in case of POSCO (South Korea) and Nippon Steel Corporation, Japan, who use the BF route, are in the range of 1.9-2.0 t/tcs. ArcelorMittal (BF-BOF route) achieves 2-2.1 t/tcs (overall) and around 1.75 t/tcs (Europe).

India makes about 55% of its crude steel through the electric route (Electric arc furnace + Induction Furnace). In spite of such a high proportion of electric process, average CO_2 emissions in the year 2020 were 2.5 t/tcs. It is estimated that the share of the steel industry in the total CO_2 emissions in India is around 10%. The high emission of greenhouse gases in the Indian steel industry is due to high energy intensity. Table 1A shows energy intensity and carbon dioxide emissions in case of select Indian companies and the global average in the last three years.

Table 1A

Company	Energy Intensity GCal/tcs			CO_2 Emissions t/tcs		
	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21
SAIL	6.50	6.47	6.48	2.57	2.54	2.55
Tata Steel: JSPR	5.68	5.61	5.61	2.29	2.27	2.29
Tata Steel: KNGR	6.31	6.24	6.27	2.54	2.45	2.44
JSW Steel	6.24	6.57	6.38	2.74	2.52	2.49
RINL VSP	5.98	6.02	6.25	2.59	2.62	2.69
Global Average*	4.66	4.79	4.93	1.81	1.85	1.89

**For calendar years 2018, 2019 and 2020*

Higher emissions in 2020-21 were due to disruptions caused by COVID-19.

Energy intensity (in GCal/tcs) and CO_2 emissions (t/tcs) in respect of major Indian companies in the year 2021-22 are shown in Table 1B.

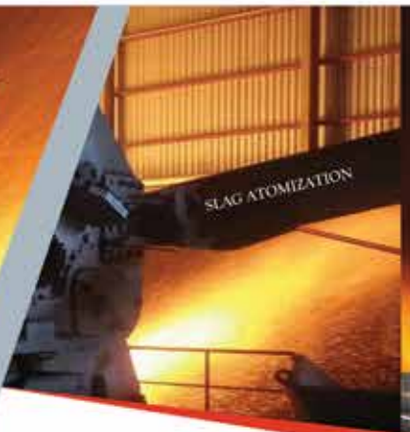
Table 1B

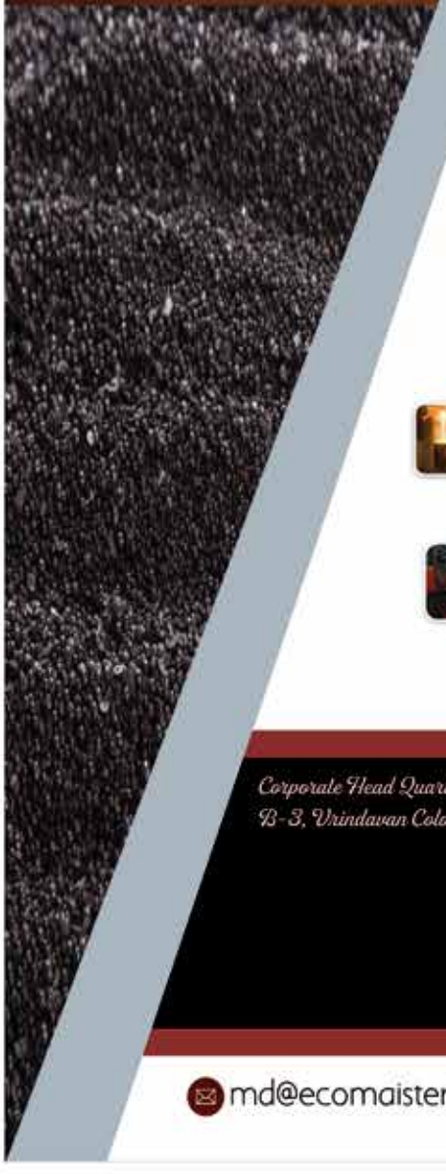
Particulars	Tata Steel			JSW Steel	SAIL
	Jamshedpur	Kalinganagar	Meramandali		
Energy Intensity	5.43	5.76	6.01	6.04	6.36
CO_2 Emission	2.26	2.38	2.82	2.50	2.51

When Essar Steel (now AMNSIL) and Ispat Industries (now JSW Steel) were having DRI (natural gas-based)-EAF route of steel making, they were achieving energy intensity of around 5.5 G Cal/tcs and CO_2 emission intensity of around 1.7-1.8 t/tcs. Both of them now make part of the steel through the BF-BOF route.

Higher energy intensity in Indian plants (BF-BOF) compared to international performance is due to the operation of some lower capacity blast furnaces with low process intensification, higher ash in BF coke, higher alumina in iron ore leading to higher slag volume and higher coke rate. Some measures taken by the companies to improve energy intensity are:

- Coke dry quenching and power generation from waste heat
- Heat recovery from sinter plant cooler and power generation from waste heat
- High top pressure (including power generation) in blast furnace
- Pulverised coal injection and oxygen injection in blast furnace
- Hot stove heat recovery in blast furnace
- Converter gas recovery in BOF
- Hot charging of continuously cast semis in rolling mills
- Thin slab casting and rolling
- Near net shape casting, bloom-cum-beam blank caster and bloom-cum-round caster
- Using Regenerative burners in reheating furnaces of rolling mills





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However, process intensification in blast furnaces still falls short of international standards. For instance, PCI rate varies between 150-200 Kg/THM (~100 Kg/THM in case of SAIL and RINL) against 200-225 Kg/THM internationally, resulting in a higher coke rate of 350-380 Kg/THM (400-450 Kg/THM in case SAIL and RINL) against around 300 Kg/THM internationally. Further, coal emits more emissions compared to natural gas. Coal-based DRI emits more emissions. India does not have adequate natural gas reserves. Scrap usage in BOFs is generally around 10%.

Crude steel production through the electric route (EAF + IF) in India ranged between 55.5% and 56.5% during the last four years. Induction furnaces use mainly scrap and DRI (pig iron, if available, is also used). India has a capacity of about 48 MTPA DRI, of which 12.6 MTPA is gas-based (9.6 MTPA natural gas, 1.8 MTPA coal syngas and 1.2 MTPA Corex off-gases), and the rest is coal-based. Several coal-based units are small in size (100 TPD or lower) and do not have waste heat recovery systems. Besides, Indian coal has a very high ash content. A study has revealed that the average energy intensity of coal-based DRI plants in India is about 6.5 GCal/t DRI, and CO_2 emissions are 2.8 t/t DRI. Tata Steel Long Products Limited, which has a coal-based DRI plant, achieved CO_2 emissions of 4.29 t/tcs in the year 2020-21. Capacity utilisation of gas-based plants is only around 50-60% due to a shortage of natural gas. The proportion of coal-based sponge iron was 82% in 2020-21 and 77% in 2021-22. Therefore, EAFs in JSW Steel Dolvi, JSPL, Tata Steel (Meramandali) and AM/NS India and some other plants in the medium category use blast furnace hot metal also along with scrap and DRI. The estimated use of hot metal (figures are in Million Tonnes) in EAFs during the last few years is shown in Table 2.

Table 2

Particulars	2017-18	2018-19	2019-20	2020-21	2021-22 (P)
1. Total Hot Metal Production	68.016	74.376	73.011	69.266	78.123
2. Pig Iron Production	5.728	6.414	5.421	4.877	5.759
3. Hot Metal for the above*	6.226	6.972	5.892	5.301	6.260
4. Hot Metal for Steel making (1-3)	61.790	67.404	67.119	63.965	71.863
5. Crude Steel Production thro' BOF	47.392	49.455	48.573	45.085	54.003
6. Liquid steel for above!	49.367	51.516	50.597	46.963	56.253
7. Metallics for the above@	54.852	57.240	56.219	52.181	62.503
8. Hot Metal in the above#	49.367	51.516	50.597	46.963	56.253
9. Hot Metal used in EAFs (4-8)	12.423	15.888	16.522	17.002	15.610
10. Crude Steel Production thro' EAF	26.518	28.476	28.366	29.407	32.402
11. Liquid steel for above$	27.623	29.622	29.548	30.632	33.752
12. Metallics for the above&	31.390	33.661	33.577	34.809	38.355
13. Hot Metal in Metallics %	39.58	47.20	49.21	48.84	40.70

**92% yield, !96% yield, @90% yield, #90%, $96% yield, &88% yield*

The total hot metal used in EAFs varied between 40% to 49% of metallics in the five years. DRI usage was between 30% and 35%, and scrap usage was around 25%. For the steel industry as a whole, the average metallics ratio for the five years was 50-52% hot metal, 27-28% sponge iron and 20-22% scrap. Blast furnace hot metal is being used in EAFs due to high power tariffs and insufficient availability of scrap and sponge iron, particularly gas-based sponge iron.

Targets for 2030

National Steel Policy 2017 has envisaged energy intensity of 5.0-5.5 GCal/tcs and CO_2 emission intensity of 2.2-2.4 t/tcs in the BF-BOF route and 2.6-2.7 t/tcs in the DRI-EAF route in 2030-31 (average around 2.4 T/TCS). The targets for CO2 emissions are higher than the current global average. Tata Steel and JSW Steel have announced their targets for the year 2030 at 1.8 t/tcs and 1.95 t/tcs, respectively. JSW steel has earmarked Rs. 10,000 Crores for this. As against this, ArcelorMittal's targets for 2030 are 1.54 t/tcs for the company as a whole and 1.11 t/tcs for European operations. Most of the steel producers in the US and Europe have plans to reduce their emissions by 30% by 2030 compared to 2020.

Projections of International Energy Agency

The international energy agency (IEA) prepared a report titled 'Iron and Steel Technology Road Map' in October 2020. As per this report, the steel industry will achieve net-zero emissions by 2070, and CO_2 emissions intensity should decline by 60% by 2050. Of this, 40.2% is proposed through material efficiency, 16% through carbon capture & storage, 7.7% through the use of hydrogen, 5.7% through the use of bio-energy, 4.3% through the electrification, 21% through technological improvements and 5.1% through the shift to other fuels. The process route (in %) projected by IEA for India up to 2050 and for the world in 2050 is shown in Table 3.

Table 3

Process Route	INDIA						WORLD
	2025	2030	2035	2040	2045	2050	2050
BF-BOF	47	47	47	37	30	23	30
SR-BOF	1	1	-	-	-	-	-
DRI-EAF	24	21	18	16	13	11	9 + 2*
Scrap based EAF	28	27	26	25	24	25	38
SR-BOF with CCUS	-	2	4	10	15	20	10
100%H2 DRI-EAF	-	2	2	6	11	16	8
BF-BOF with CCUS	-	-	3	6	7	5	3
Scrap in Metallics %	30	30	30	29	28	28	

**indicates DRI-EAF with CCUS*

60% reduction in CO_2 emission intensity will mean that India has to achieve 1.0 t/tcs intensity by 2050, and the world average has to be around 0.76 t/tcs.

Wood Mackenzie Report

Wood Mackenzie, in its new report, has said that the world steel industry's carbon emissions will reduce by 30% by 2050 compared to 2021. Steel production by EAF will account for 48% of the total in 2050 compared to 28.9% in 2021. The emissions will reduce from 3,338 MT (1.71 t/tcs) to 2,332 MT (1.01 t/tcs). Hydrogen-based production is projected at 10% of the total in 2050. The reduction will be more in advanced economies like the EU and US. Emissions in China are expected to halve during the period, mainly due to a fall in steel production. India's emission profile will worsen as crude steel production through the BF-BOF route increases. However, the intensity will reduce as production will triple while carbon emissions will only double.

Suggested Progress for the Indian Steel Industry

The suggested progress in reducing the carbon dioxide emission intensity is shown in Table 4 (intensity in t/tcs). Between 2050 and 2070, the Indian steel sector has to further increase the use of hydrogen, scrap, and renewable energy to be able to become carbon neutral.

Table 4

FY'20	FY'25	FY'30	FY'35	FY'40	FY'45	FY'50	FY'60	FY'70
2.5	2.2	2.0	1.8	1.6	1.3	1.0	0.5	0

Issues and Challenges

1. Proper information is not available on CO_2 intensity. Among the major producers, Tata steel only gives emissions intensity plant-wise, while SAIL and JSW Steel give company averages. Many companies do not give the information in their annual reports.

2. About 40% of the steel in India is produced in the secondary sector through Induction furnaces or small EAFs. Besides, there are small pellet plants, DRI units, mini blast furnaces, etc. They have existential issues. Many of them are struggling. They require hand-holding from the government to improve current operations and reduce emissions.

3. About 80% of sponge iron production in India is coal-based. Several coal-based units are small (100 T or lower). Converting them to non-fossil fuel is not easy. The three natural gas-based DRI plants are unable to work at full capacity due to a shortage of natural gas. JSPL has a coal-based synthesis gas plant at Angul, for which adequate coal supply has to be ensured. JSW Steel is having Corex off-gases-based DRI plant at Vijayanagar. Production of DRI from this plant at full capacity depends on the utilisation level of the Corex plant, which depends on imported anthracite coal.

4. There are a number of mini-blast furnace-based plants producing pig iron, DI pipes, other castings, or steel products. Some of them have coke and sinter plants. It will be a great challenge to convert them to non-fossil fuel.

5. Major producers like SAIL and Tata Steel, Jamshedpur, have small capacity blast furnaces. They are 50 or even 100 years old. POSCO has permanently shut down BF No. 1 at Pohang after 48 years of commissioning. Even JSW Vijayanagar, JSPL Raigarh and Tata steel Meramandali have below 2000 cu. m volume blast furnaces. Process intensification is not at the desired level in these furnaces. Several high-capacity blast furnaces have been commissioned since the year 1990 (3,000 cu. m or above), and it is not certain whether they can be permanently shut down even by 2050.

6. Industrial power tariffs are very high in India. It is 6 times that in the US, 4 times that in Canada & Russia and 2.5 times that in China & Japan. High power cost is forcing many EAF-based steel plants to use blast furnace hot metal as a charge material to control the production cost. Higher production of hot metal than that required for BOF increases CO_2 generation.

7. Scrap usage in India is currently around 20% of metallics or about 25 MTPA at current levels of steel production. Against this, scrap usage is around 70% in the USA, 55-60% in the EU, 35% in Japan, 24% in China and around 30% globally. In the year 2021, global consumption of scrap was 620 MT, and crude steel production was 1,951 MT, while it was about 24 MT and 118 MT, respectively, in India. Imports account for about 20% of scrap consumed in India. At the same usage rate, scrap requirement will go up to about 60 MT in 2030 (255 MT crude steel production). Steel demand is expected to be around 500 MT in 2050 and 800 MT in 2070. The scrap requirement at these levels of production will be about 180 MT and 275 MT, respectively, at 30% scrap usage. India is a developing country, and over 60% of the steel is used for infrastructure and construction. Steel in such applications has a long life and will not be available for recycling for 40-50 years after construction. Scrap also arises from end-of-life vehicles, ships and other manufacturing places. Scrap generation in China is estimated at 270 MT in 2021, when crude steel production was around 1.03 Billion Tonnes. They are targeting a scrap generation of 370 MT by 2030. India has put in place a scrap recycling policy and vehicle scrappage policy. However, vehicles per 1,000 people are only about 30 in India (2019) against 980 in the US, 850 in the UK, 591 in Japan and 164 in China. India has to continue importing scrap since domestic availability will not be adequate. Importing scrap will not be that easy since all countries are trying to increase scrap usage. Besides, since the entire steel will be produced through

EAF, high-grade scrap will be required. Every tonne of scrap used avoids the emission of 1.5 T CO2. End-of-the-life scrap availability in the world is estimated to reach 900 MT in 2050.

8. As per IEA estimates, production costs due to the switch over to hydrogen will be 10-50% higher than today and will exceed sales realisations. Since the switch will not be uniform across the world, those who make the switch first will have a disadvantage. Conventional steelmaking will have a carbon charge. CO2 price, which was around euros 25/t in 2019, is likely to go up to around euros 150/t by 2050. Green hydrogen price in 2020 was around 4-5 euros/Kg. It is expected to come down to about 2 euro/Kg by 2030 and to 1 euro/Kg by 2050 due to lower prices of wind and solar energy and falling cost of electrolysis due to the use of higher size and higher efficiency electrolysers. Up to 2030/2040, conventional steelmaking will have a cost advantage. New steel plants will consist of iron ore pellet plant, DRI plant based on hydrogen, EAF, the finishing facilities and other auxiliary facilities. Tie-up has to be made for hydrogen and renewable energy, and infrastructure has to be created for storage and transport. A higher grade of iron ore will be required. The process will be competitive at a hydrogen price of euros 1,200/t and an electricity price of 0.018 euros/KWh. The energy requirement for a 2 MT hydrogen-based steel plant is estimated at 8.8 TWh, while the hydrogen requirement is projected at 1,44,000 T. Water requirement for a hydrogen plant is projected at about 25 Kg/Kg while electricity is required at 90%. Electrolyser efficiency is estimated at 50-55 KWh/t. Electrolysers need high-quality water, which requires treatment (desalinisation). It has been estimated that for the world steel industry, hydrogen and electricity requirements in 2050 will be 11.8 MT and 722 TWh. It is easier to switch from a DRI/EAF production method, based on natural gas, to hydrogen. For the success of green hydrogen-based steelmaking, customer support, including the willingness to pay a higher price, is essential. Governments have to support the industry in respect of carbon border tax, CAPEX, and in terms of subsidies for the high cost of production.

9. In green steelmaking, EAF will be charged with DRI having zero carbon. This may result in the following problems in EAF operation:

a) Sufficient stirring in the bath may be difficult in the absence of carbon-generated CO

b) Since carbon is not available for foaming, alternative arrangements may have to be made for sufficient foaming

c) There could be yield loss due to higher FeO formation

d) There could be a loss of productivity through long melt down times and the formation of 'icebergs'

e) Energy consumption may be more due to higher temperature of melting

f) Refractory wear may increase due to higher temperature

g) Power-on-time may increase due to slow reaction

h) A deeper bath and higher slag volume may be required to bury the electrodes. This will require additional slag formers, and arrangements have to be made for the disposal of additional slag

j) Carbon and oxygen injection may be required to stir the bath and control FeO. Necessary corrective measures have to be found, after detailed research, to tackle these issues so that the cost of production does not shoot up

The Way Forward

- Actual CO_2 generation should be reported plant-wise by each company, big or small, in the annual report. A technical committee with representatives from MECON, NML and TERI should be formed to assist the units that may not be having the means to measure the CO_2 generation.
- Where necessary and possible, iron ore beneficiation plants should be modified to yield a higher grade of iron ore (preferable 65% Fe).
- Organised scrap recovery has started in India. Collection and recovery rates have to reach international standards. The quality of processed scrap is very important since it should be suitable for making higher grades of steel.
- Coal-based DRI production has to be discontinued gradually. In particular, units of 100 TPD or below should be closed down at the earliest. Their share in total coal-based sponge iron production is currently around 50%.
- In a stimulus package announced in May 2020 (during the first wave of COVID-19), the government of India has announced that coal gasification will be incentivised, and coal bed methane (CBM) production will be encouraged. These should be put into practice at the earliest to enable bigger coal-based sponge iron plants to switch over. If they make the switch to gas, it will be easier to switch over to hydrogen at the appropriate time. JSPL set up a coal gasification plant at Angul in January 2020, and they intend to set up two more, one each in Angul and Raigarh, by FY'25. Tata Steel initiated the trial for continuous injection of CBM gas in the 'E' blast furnace of Jamshedpur works in January 2022. CBM contains 98% methane.
- The government has plans to increase the share of natural gas in the overall energy mix to 15% by 2030 from the present

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around 6%. Storage facilities and pipelines are being built. Existing natural gas-based sponge iron plants should be supplied with their full requirements of natural gas. Once they stabilise their operations at an optimum level with natural gas, it will be easier to shift to hydrogen. Natural gas price is also an issue.

- Production capacity of DR grade pellets has to be suitably increased to meet the requirements in 2030, 2050 and 2070.
- Lower capacity blast furnaces (below 2,000 cu. m) should be permanently shut down when they next become due for relining/rebuilding. POSCO has permanently shut down Blast Furnace No. 1 at Pohang after a period of 48 years and six months since commissioning in 1973.
- Process intensification should be rigorously undertaken in other blast furnaces through measures like higher blast temperature, higher top pressure, oxygen injection up to 10%, higher use of higher grade pellets, PCI injection of minimum 200 Kg/THM, etc. PCI may be replaced by hydrogen when available. These furnaces have to be permanently shut down between 2050 and 2070. AM/NS India and JSW Steel, who have announced the setting up of greenfield plants in Odisha, and Adani group and POSCO in Gujarat, should choose gas-based DRI and EAF as the process route so that conversion to hydrogen will be easier.
- The companies using blast furnace hot metal in EAFs should set up gas-based DRI plants so that they can dispense with charging hot metal. Hot metal production and CO_2 generation will come down accordingly. The government is looking into electricity tariff issues.
- Smelting reduction technology processes like COREX (working in JSW and AM/NS), FINEX, HLSARNA HyREX, etc., should be tried during the interim in place of a blast furnace. ITmk3 could be also an option.
- All plants having blast furnaces of 2,000 cu. m or above should set up carbon capture and storage units to reduce emissions. Dialogue should be initiated with the chemical industry regarding its usage. Tata Steel has set up a 5 TPD CCUS plant at Jamshedpur to extract CO_2 from BF gas which will be reused to promote a circular carbon economy. Gas with depleted CO_2 gas with high CV will be sent back to the gas network.
- Present renewable energy capacity in India is 104 GW (30-11-2021), and the target is to reach 450 GW by 2030. By 2050, the plan is to meet 75% of energy requirements from renewable sources. The steel industry has to make a detailed study of the scenario and decide about setting up captive renewable energy plants. Such plants require a large area. Tata Steel has entered into PPA with Tata Power for setting up 21.97 MW and 19.22 MW solar PVs at Jamshedpur and Kalinganagar. They have a 3 MW plant at Noamundi iron ore mine. JSW Steel's group company JSW Energy is planning to set up a 2,600 MW renewable energy capacity by 2023. The company has commissioned 225 MW of 1 GW plant. AMNSIL will be drawing 20% of its requirements from a wind-solar mix plant (backed by a pumped hydro-storage project) being set up in Andhra Pradesh.
- Extensive research and development activities and techno-economic studies should be undertaken regarding Capex, water requirement, energy requirement, operating cost, etc., of different sizes of hydrogen plants as well as storage and transportation infrastructure. GAIL, Indian Oil, HPCL, BPCL and NTPC have decided to set up hydrogen plants. Reliance industries intends to set up a high-capacity plant in Gujarat and Solar Energy Corporation in Ladakh. Larsen & Toubro intends to set up a plant in Hazira and may also venture into the manufacture of electrolysers. National Hydrogen Mission, whose formation was announced on 15-08-2021, is supporting such activities. Rs. 800 Crores financial outlay has been made for the next three years. All these will give the steel industry a very good starting point.
- A detailed study has to be undertaken regarding the operation of electric arc furnaces with raw materials having zero carbon. Bath stirring, slag foaming, higher FeO formation, possible yield loss, increase in power consumption, and higher refractory wear, if any, could be some of the aspects needing detailed study. Requirement of additional slag formers, if any, need to be studied.

Conclusion

The path ahead for the Indian steel industry for decarbonisation is not quite smooth and requires dedicated and coordinated efforts from all concerned – the industry, the research institutions, the financial institutions, and the Government. Achieving carbon neutrality will save the earth and future generations from the ill effects of temperature rise. As per a California university study, even weather prediction may become difficult as the upper ocean becomes susceptible to uncertain temperature anomalies, which could get worse. The government is quite supportive and has come up with the National Hydrogen Mission and has also drawn out elaborate plans to increase renewable energy capacity.

As an immediate measure, the Indian steel industry has to take the required measures to improve the existing operations in order to reduce the emissions by 20% by 2030 and by 60% by 2050 (1.0 t/tcs) compared to 2020. The required measures include limiting the blast furnace coke rate to 350 Kg/THM (to 300 Kg/THM, if possible), increasing the availability of high-grade iron ore, increasing production of high-grade DR Pellets, increasing production of gas-based DRI (Coal Syn gas), discontinuing use of blast furnace hot metal in EAFs, use of smelting reduction technology processes, increasing the share of EAF production, increasing the proportion of scrap in EAFs, processing for higher grade scrap, use of renewable electricity, setting up of carbon capture, usage and storage facilities, etc. Switching over to hydrogen will hopefully commence by 2050, and the Indian steel industry will achieve net-zero emissions before 2070.

Considerable R&D effort has to go into for building the hydrogen plants and the required infrastructure for storage and transport. Capital expenditure, as well as the operating cost, will have a great bearing on the steel price. Even though the present cost of hydrogen is high, it is expected to come down to reasonable levels by 2050. Prices of wind and solar energy have already come down to below Rs. 3/unit in India.

The Indian steel industry has to act fast to reduce emissions. Otherwise, exports will become difficult as a penalty has to be paid for CO_2 emissions. CO_2 price, which was €25/T in 2019, is likely to increase to €100-150/T by 2050 in Europe.

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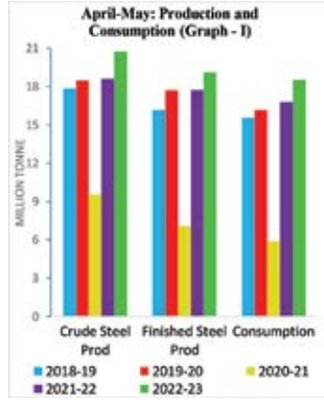
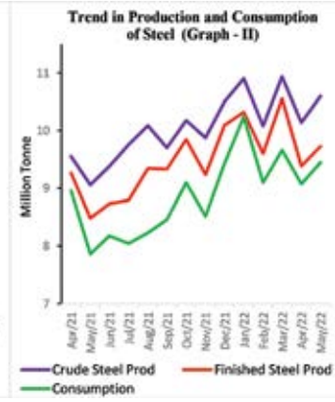
Iron & Steel Performance for May 2022

The important developments in the steel sector during the month of May 2022 are as follows:

- Globally, the iron & steel industry accounts for around 8% of total carbon dioxide (CO_2) emissions by the country vis-à-vis 12% by the iron & steel industry in India. Thus, the Indian steel industry needs to reduce its emissions substantially in view of the commitments made in the COP26. Taking cognisance of the above, the meeting of the Parliamentary Consultative Committee for the Ministry of Steel was convened on May 6, 2022, at Shimla under the Chairmanship of the Honourable Steel Minister (HSM) to brainstorm on the topic "Transition towards Green Steel". In this meeting, discussions were held on the present scenario, the way forward for promoting the transition towards green steel, various strategies & technologies that can be adopted by the steel industry to produce green steel, technology readiness levels, etc. The focus of the discussion was on the prospects of the use of green hydrogen in producing iron and the use of Carbon Capture Utilisation and Storage (CCUS) technologies for lowering emissions. Government interventions required to address the issues and constraints in the production of green steel were also discussed. The Chairman urged the stakeholders to develop a time-bound action plan and make concerted efforts to lower emissions from the steel industry in line with the commitments made by the government in COP26
- The Ministry has sought R&D project proposals in joint collaborative mode from reputed academic institutions, research laboratories and steel companies for the development of new alternate processes & technologies to address the issues faced by the iron & steel sector, such as climate change (green steel production, H2-based steel production, CCUS, etc.), waste utilisation, resource efficiency, etc., for providing financial assistance under the R&D scheme for the Financial Year 2022-23
- The application window for applying under the Production Linked Incentive (PLI) Scheme for speciality steel through an online process was opened on December 29, 2021, by Project Management Agency (PMA) initially for 90 days. The Ministry of Steel has proposed fresh modifications to the existing scheme to address concerns of the secondary steel sector, make it simpler and more participatory and include several other subcategories of speciality steel meant for the strategic sector. The proposal has been submitted for necessary approval. Accordingly, the last date of application has now been extended up to June 30, 2022
- The performance of the steel sector during April-May, FY'23, has been encouraging. The production and consumption over these two months of the last two years, i.e. FY'21 and FY'22, were affected adversely by the first and second wave of COVID-19, respectively. However, the cumulative production of Crude at 20.74 Million Tonnes (MT), Finished Steel at 19.11 MT and consumption of Finished Steel at 18.52 MT during April-May, FY'23, have exceeded their respective levels achieved over the corresponding period of not only the COVID-affected last two years but also pre-COVID years as well, as may be seen from the following graph on cumulative production and consumption for five years (Graph-I). The month-wise production and consumption indicate an overall increasing trend over the last fourteen months (Graph-II), with production and consumption of steel showing an improvement in May'22 over their respective levels in April'22





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- In sync with the overall performance of the sector during the month, all steel CPSEs, have registered an improvement in production performance M-o-M during May'22. When compared to production over the corresponding period last year (CPLY), all except KIOCL and RINL have shown an improvement. However, sales have shown some fluctuation across CPSEs, as may be seen below
  - During May'22, SAIL produced 16.15 Lakh Metric Tonnes (LMT) of Hot Metal, 14.89 LMT of Crude Steel and 14.04 LMT of Saleable Steel, recording an increase of 2.1%, 2.8% and 4.3% M-o-M and 16.9%, 20.4% and 13.0%, respectively, over CPLY. The cumulative production during April-May'22 for Hot Metal at 31.97 LMT, Crude Steel at 29.37 LMT and Saleable Steel at 27.50 LMT registered an improvement of 16.2%, 19.1% and 10.1%, respectively, over CPLY
  - Production of iron ore by NMDC at 32.0 LMT in May'22 registered an increase of 14.7% over CPLY and 1.6% M-o-M. The cumulative production of iron ore by NMDC during April-May'22 at 63.5 LMT registered an increase of 7.4% over CPLY. However, the sale of iron ore by NMDC at 26.5 LMT in May'22 was lower by 15.2% M-o-M and by 19.8% over CPLY. Also, during April-May'22, the sale of iron ore by NMDC at 57.7 LMT was lower by 9.8% over CPLY
  - During May'22, KIOCL produced 2.05 LMT and sold 0.54 LMT of Pellets, down by 9.7% and 79.6%, respectively, over CPLY. M-o-M, production of Pellets by KIOCL in May'22 increased by 5.7%, and sales declined by 67.3%. During April-May'22, the production and sales of Pellets by KIOCL stood at 3.99 LMT and 2.19 LMT, recording a decrease of 2.0% and 48.2%, respectively, over CPLY
  - During May'22, production of Manganese ore by MOIL at 1.07 LMT was 28.9% higher than CPLY and by 2.9% M-o-M. Its sales during May'22 at 0.89 LMT were 10.1% lower than CPLY but 58.9% higher M-o-M. During April-May'22, production of Manganese ore at 2.11 LMT was 34.4% higher than that in CPLY
  - In May'22, RINL achieved production of 3.80 LMT of Hot Metal and 3.59 LMT of Crude Steel, up by 8.6% and 24.7%, respectively, over its production in April'22, and 28.6% and 19.9% lower than CPLY, respectively. During April-May'22, production of Hot Metal by RINL at 7.30 LMT and Crude Steel at 6.48 LMT registered a decrease of 31.9% and 29.5%, respectively, over CPLY
- The Ministry of Steel has proactively taken up partially resolved and unresolved issues in projects of steel companies uploaded on PRAGATI and PMG portals with concerned central ministries/departments and state governments. Secretary (Steel) reviewed the progress of projects on the PRAGATI Portal related to the Ministry of Steel on May 30, 2022, and directed the concerned to resolve the pending issues expeditiously. Two more projects of steel CPSEs viz., Tokisud North Coal Mining project of NMDC and installation of 4th slab caster and new ladle furnace at Rourkela, SAIL, have been uploaded on PMG Portal
- Presently, there are eight ongoing projects of CPSEs, (SAIL-6, NMDC-2) uploaded on the OCMS portal of MoSPI. The total cost of these projects is Rs. 28,240 Crores, and an expenditure of Rs. 22,460 Crores (79%) has been incurred. Secretary (Steel) reviewed the progress of these projects with the heads of SAIL and NMDC on May 30, 2022, and directed the CPSEs to complete the project without any further delay
- Secretary (Steel) launched MSTC's new Bidding Platform for the import of coal, and events have already been hosted for the import of one LMT of coal on behalf of CESC Limited and Haldia Energy Limited
- Quality Control Order has been enforced on steel for high temperature bolting application (IS14331:1995) with effect from May 15, 2022, to ensure that only quality material as per the relevant standards are made available to the users. With the above enforcements, out of 145 notified Indian Standards, a total of 143 Indian Standards have been enforced
- CAPEX by steel CPSEs in May'22 at Rs. 556.5 Crores was 57.4% higher M-o-M and 63.8% higher than CAPEX in CPLY. The cumulative CAPEX by steel CPSEs for April-May, FY'23, at Rs. 909.9 Crores, was 26.0% higher than CAPEX during CPLY but 6.9% of the BE for the FY'23. The Ministry has directed all CPSEs to undertake regular milestone-based monitoring of capital expenditure for the provisioned outlay for FY'23 so that there are no slippages or delays in project completion. The steel CPSEs were also directed to front-load expenditure in the first two-quarters of FY'23 and ensure full utilisation of provisioned CAPEX during the FY'23
- The status of pending payments to MSMEs by CPSEs of the Ministry is being monitored on a weekly basis to ensure payments to them within the 45 days' time limit for such payments. Payment of Rs. 510.53 Crores was made by steel CPSEs to MSMEs during May'22, which was 37.1% higher than payments made during CPLY but 8.3% lower than M-o-M. During April-May'22, steel CPSEs made payments of Rs. 1,067.52 Crores to MSMEs
- A meeting of the Hindi Salahkar Samiti of the Ministry was held on May 13, 2022, at Gangtok under the chairmanship of HSM. HSM handed over Raj Bhasha Nishtha Samman to representatives of various PSUs. HSM advised greater use of Hindi in official works

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	Tm 38/3.0-120	Tm -63/3.5-150	Tm -76/4.0-150	Tm -90/4.5-120	Tm -127/5.4-100	Tm -193/7.0-70	Tm -219/9.0-50
OD (Min.-Max.)	12.7-38.1	15.88-63.0	19.05-76.1	21.3-88.9	33.4-127	76.1-193	88.9-219
Square (Min.-Max.)	10x10-30x30	15x15-50x50	16x16-60x60	19x19-75x75	25x25-100x100	60x60-150x150	70x70-175x175
Rectangular (Min.-Max.)	10x20-20x40	12x25-60x40	20x30-80x40	40x20-100x50	25x50-122x61	80x40-200x100	96x48-200x150
Coil Weight Max.	3 Ton	4 Ton	5 Ton	6 Ton	8 Ton	13 Ton	15 Ton
Line Speed Entry Line (Max. speed)	300 M/Min	350 M/Min	350 M/Min	250 M/Min	250 M/Min	200 M/Min	150 M/Min
Line Speed Weld Line(Max. speed)	120 M/Min	150 MMin	150 M/Min	120 M/Min	100 M/Min	70 M/Min	50 M/Min

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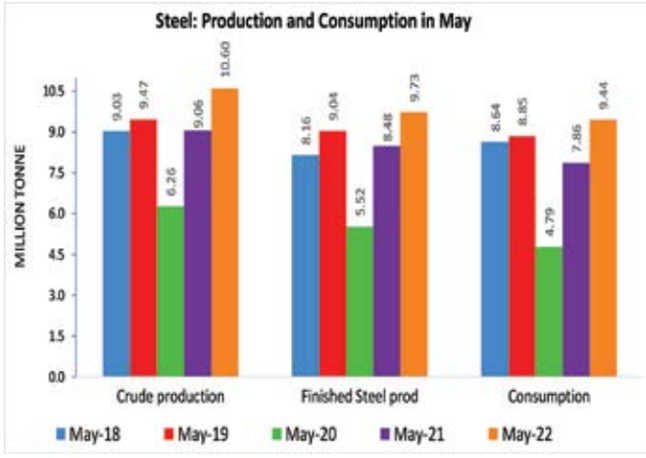
Production and Consumption Scenario

i. A comparison of production and consumption of steel during the month of May over five years indicates that production of Crude and Finished Steel, as well as consumption of Finished Steel during May'22, was the highest in five years, as may be seen from the following graph



ii. Production of Crude Steel in May'22 at 10.60 MT increased by 17.0% over CPLY and by 4.5% M-o-M

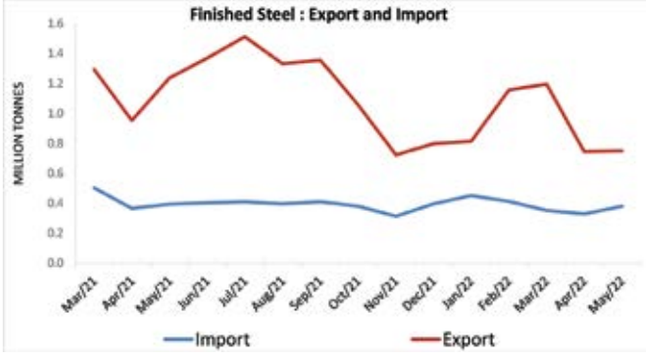
iii. Production of Finished Steel in May'22 at 9.73 MT increased by 14.7% over CPLY and by 3.7% M-o-M

iv. Consumption of Finished Steel in May'22 at 9.45 MT increased by 20.2% over CPLY and by 4.2% M-o-M

v. Inventories of Finished Steel with the steel producing companies at 7.89 MT at the end of May'22 was lower by 1.1% M-o-M and by 6.8% over CPLY

Export-Import Scenario

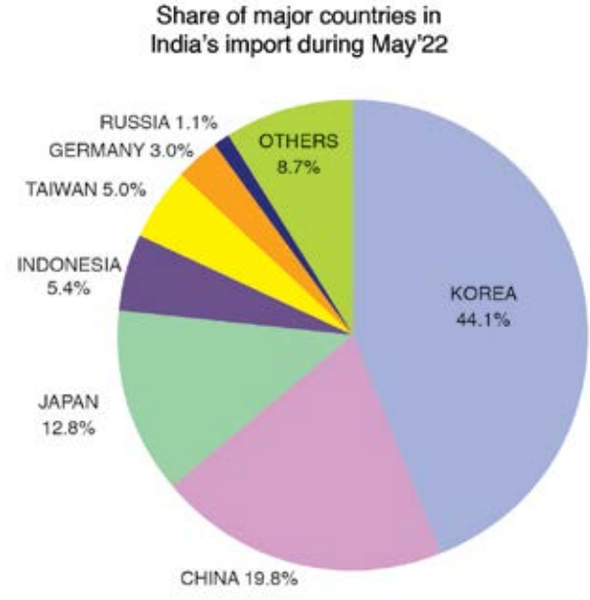
The month-wise trend in export and import of Finished Steel during recent months shows that India's export during a month has consistently exceeded import during that month. Also, the export of Finished Steel from India has shown more pronounced M-o-M variation, while imports have been relatively stable, as may be seen from the graph below.



i. Export of finished steel during May'22 at 7.49 LMT declined by 39.4%, while import at 3.79 LMT declined by 3.5% over CPLY. M-o-M, export and import of finished steel increased by 0.8% and 15.9%, respectively, in May'22 over April '22. During April-May, FY23 exports at 14.92 LMT and imports at 7.06 LMT have decreased by 31.8% and 6.7%, respectively, over the CPLY

ii. India was a net exporter of Finished Steel, recording a net trade surplus of 3.70 LMT in May'22

iii. Share of Korea, China and Taiwan increased in total steel import of India in May'22 as compared to May'21, while the share of Japan, Indonesia, Germany and Russia declined over this period, as may be seen from the following graph



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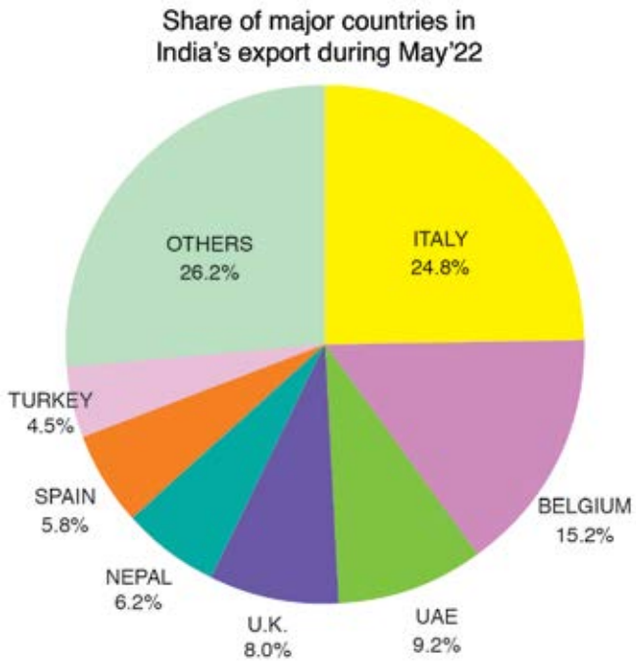
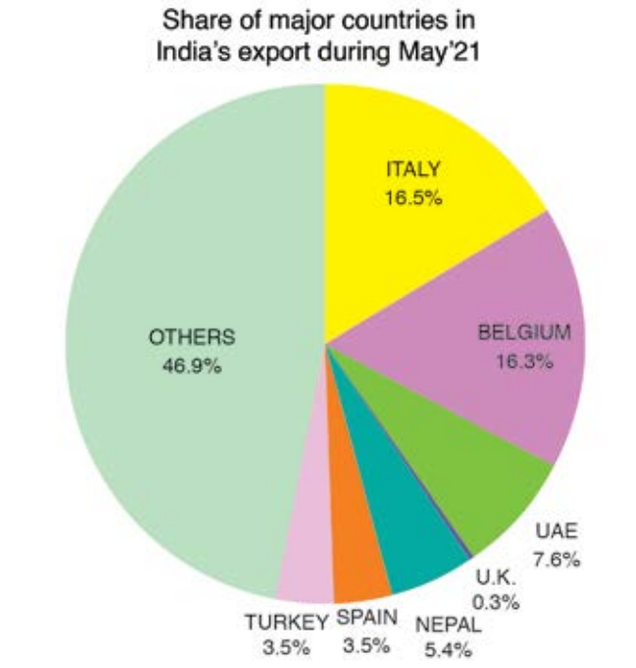
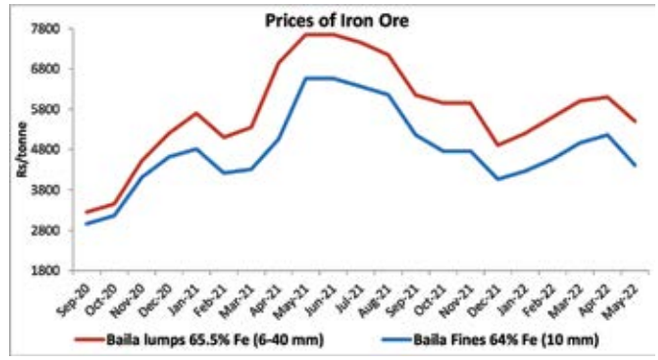
iv. Share of Italy, UAE, UK, Nepal, Spain and Turkey in total steel export from India was higher in May'22 as compared to May'21. However, the share of Belgium in India's total steel export declined over the same period as may be seen from the following graph





Price Scenario

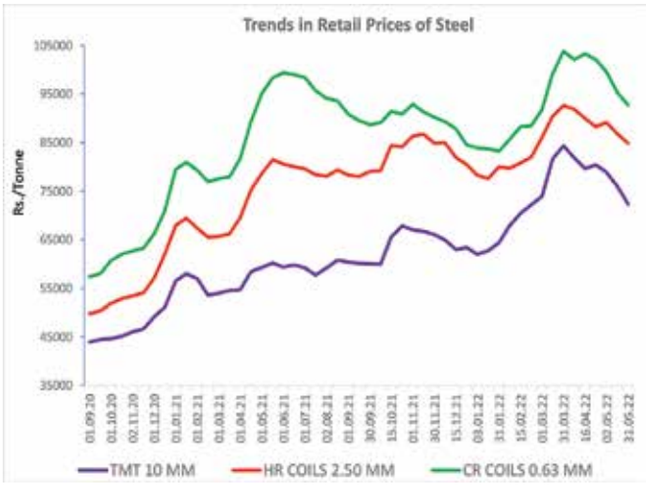
Prices of iron ore, after hitting a peak in May-June'21, followed a declining trend since July'21 till December'21 but started increasing again from January'22, and the uptrend continued till April'22. However, prices of iron ore decreased during May'22, as may be seen from the graph below.



i. During May'22, prices of iron ore lump decreased by 9.8% to Rs. 5,500/Tonne and that of fines by 14.5% to Rs. 4,410/ Tonne over their respective prices in April'22

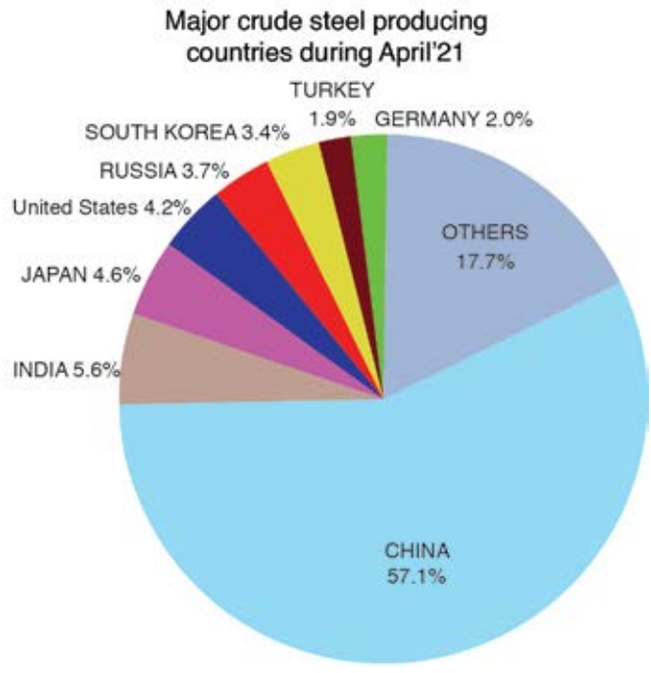
ii. NMDC achieved production of 32.0 LMT and sales of 26.5 LMT of iron ore in May'22. The production of iron ore during the month was higher by 14.7%, and sales of iron ore were 19.9% lower than that in the CPLY. M-o-M, production of iron ore by NMDC grew by 1.6%, and sales declined by 15.2% during May'22. During April-May'22, production of iron ore by NMDC at 63.5 LMT was higher by 7.4%, and its sales at 57.7 LMT were lower by 9.8% over CPLY. During the month, SAIL produced around 29.81 LMT of iron ore, up by 9.3% M-o-M and by 9.2% over CPLY, respectively. The cumulative production of iron ore by SAIL during April-May'22 stood at 57.09 LMT, an increase of about 4% over CPLY

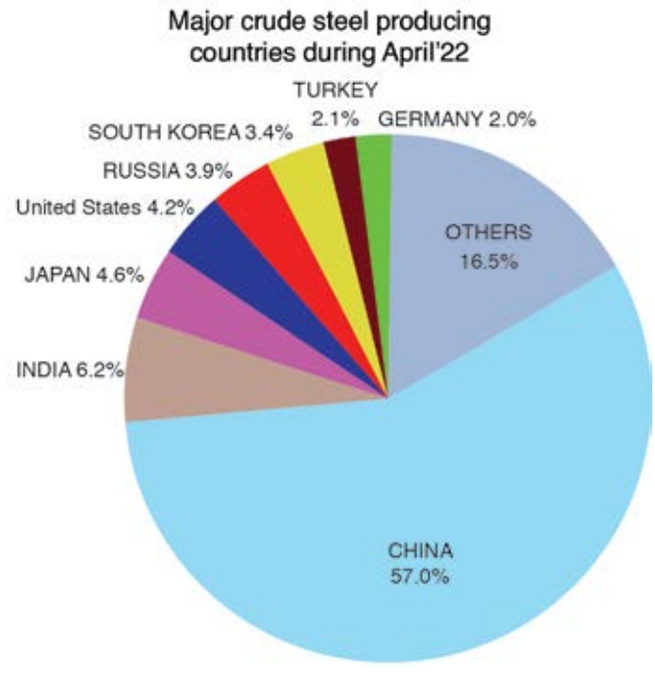
iii. The higher input cost and improved demand, both domestic and international, put pressure on the domestic prices of steel, keeping them at elevated levels. To ameliorate the situation, suitable modifications in tariff were made by the Ministry of Finance vide notification dated May 21, 2022, removing duty on import of raw materials like Anthracite/Pulverised Coal Injection (PCI) coal, coke and semi-coke and ferro-nickel and imposing/enhancing export duty on iron ores/concentrates, iron ore pellets, pig iron and certain steel products. These measures, along with other developments affecting the demand and supply of items impacting the steel sector, both domestic and international, have led to softening of prices of steel during May'22, as may be seen from the following graph depicting the trend in prices of steel product categories, viz. Rebar, HRC and CRC. The prices of CRC, HRC and Rebar, which showed signs of moderation during April'22, registered a steeper decline in May'22 M-o-M while still remaining at elevated levels



iv. The retail prices for Rebar (10 mm), HRC (2.50 mm) and CRC (0.63 mm) in Mumbai on May 31, 2022, at Rs. 72,350/ Tonne, Rs. 84,850/Tonne and Rs. 92,750/Tonne were 8.3%, 4.8% and 6.9% lower than their respective prices at the start of the month

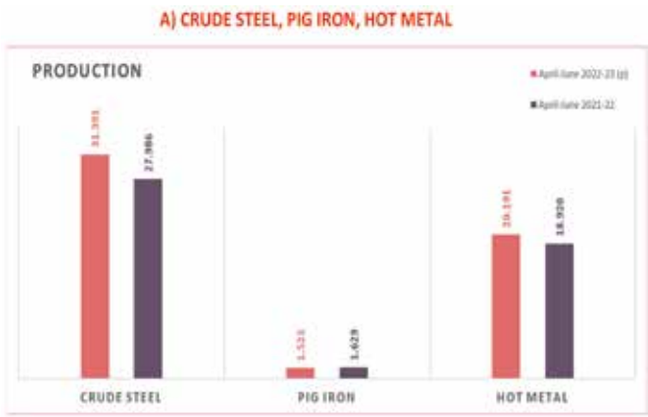
- The global production of Crude Steel decreased by 5.1% in April'22 over April'21, which is majorly due to a decline in production in China and Ukraine. In addition, few other major steel producing countries, viz. Iran, Japan, Spain, South Korea, USA, Brazil, France and Mexico also reported a decline in production during the month over CPLY. The major producing countries (with the production of 1 MT for the month) which contributed to the enhanced global production in April'22 over April'21 include India, Turkey, Italy and Russia. As regard the share of major producing countries in the global production of crude steel (Graph below), it is seen that due to the decline in production in China and uptick in production in some of the other major producing countries, the share of China declined while that of India, Turkey and Russia increased during this period





Performance of the Indian Steel Industry in April-June, 2022-23

- Summary Highlights



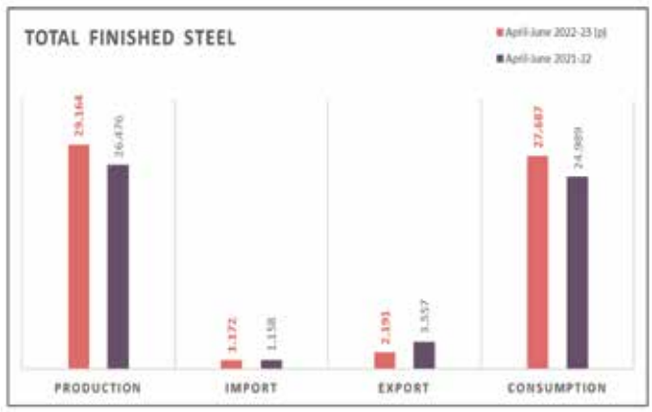
Item	April-June 2022-23 (p)	April-June 2021-22	% Change (p)
Crude Steel	31.391	27.986	12.2
Pig Iron	1.523	1.629	-6.5
Hot Metal	20.191	18.920	6.7

Source: JPC; Units in MT (Million Tonnes)

Major Highlights

- Production of Crude Steel was at 31.391 MT, a growth of 12.2%
- Production of Pig Iron was at 1.523 MT, a decline of 6.5%
- Production of Hot Metal was at 20.191 MT, up by 6.7%

B) TOTAL FINISHED STEEL



Total Finished Steel	April-June 2022-23 (p)	April-June 2021-22	% Change (p)
Production	29.164	26.476	10.2
Import	1.172	1.158	1.2
Export	2.191	3.557	-38.4
Consumption	27.687	24.989	10.8

Source: JPC; Units in MT

Major Highlights

- Total Finished Steel production was at 29.164 MT, a growth of 10.2%
- Import of Total Finished Steel stood at 1.172 MT, an increase of 1.2%
- Export of Total Finished Steel was at 2.191 MT, a decline of 38.4%
- Consumption of Total Finished Steel was at 27.687 MT, a up by 10.8%
- India was a net exporter of Total Finished Steel.

C) SHARE OF PSU/PRIVATE SECTOR

Item	April-June 2022-23 (p)	April-June 2021-22	% Change (p)
Crude Steel - PSU	5.340	5.131	4.1
Crude Steel - Private	26.051	22.855	14.0
Total Finished Steel - PSU	4.133	3.917	5.5
Total Finished Steel - Private	25.031	22.560	11.0

Source: JPC; Units in MT

Major Highlights

- **Crude Steel:** Private Sector (26.051 MT, up by 14.0%) accounted for 83%, the rest being the share of PSUs
- **Total Finished Steel:** Private Sector (25.031 MT, up by 11.0%) accounted for 86%, the rest being the share of the PSUs

D) SHARE OF OTHER PRODUCERS

Item	April-June 2022-23 (p)	April-June 2021-22	% Change (p)
Crude Steel - Other Producers	12.173	10.578	15.1
Crude Steel - SAIL, RINL, TSL Group, JSW, JSPL, AM/NS	19.218	17.408	10.4
Total Finished Steel - Other Producers	12.563	11.012	14.1
Total Finished Steel - SAIL, RINL, TSL Group, JSW, JSPL, AM/NS	16.601	15.464	7.4

Source: JPC; Units in MT

Major Highlights

- **Crude Steel:** SAIL, RINL, TSL GROUP, AM/NS, JSWL and JSPL (19.218 MT, up by 10.4%) accounted for 61%, the rest 39% being the share of the Other Producers (up by 15.1%)
- **Total Finished Steel:** SAIL, RINL, TSL GROUP, AM/NS, JSWL and JSPL (16.601 MT, up by 7.4%) accounted for 57%, the rest 43% being the share of the Other Producers (up by 14.1%)

Source: JPC ■

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SMS group Records the Highest Level of Order Intake in Ten Years

SMS group almost doubled its order intake by 86% to 3,507 Million Euros in 2021, thus recording the highest level in the past ten years. The reasons for this substantial rise are catch-up effects following the previous year's slump triggered by the COVID-19 pandemic and the growing demand for decarbonisation and recycling technologies.

SMS group experienced a significant increase in the order backlog, coming in at 3,944 Million Euros. Due to delays caused by the pandemic in the schedules for acceptance, the 2021 financial year closed with sales down by 6.8% from the previous year at 2,559 Million Euros.

Earnings before taxes (EBT) amounted to 87 Million Euros. With this result, SMS has returned to a post-pandemic situation of profitable growth. HR costs in Germany have been sustainably reduced by 75 Million Euros as a result of the extension of the future-oriented collective agreement and socially acceptable staff reductions. The free cash flow rose significantly to 145 Million Euros, while net liquidity climbed to 978 Million Euros. Investments were also higher than the year before, totaling 151 Million Euros.

Technology Partner for the Decarbonisation of the Steel Industry

With the acquisition of the remaining shares of Paul Wurth in April 2021, SMS has further strengthened its position as a technology partner and full-line supplier for the steel industry.

Burkhard Dahmen, Chairman of the Managing Board and CEO, SMS group

Burkhard Dahmen, Chairman of the Managing Board and CEO of SMS group, said, "Almost all industrialised countries have set themselves ambitious climate targets and resolved transformation strategies for their steel industries. Today, integrated steelworks produce around 1.3 Billion Tonnes of crude steel per year via the conventional BF-BOF route, accounting for 90% of all CO_2 emissions from the steel industry. In the decades to come, these production capacities will be subject to transformation. As a systems supplier, we are in a position to support our customers comprehensively in every situation."

Circular Economy – The New Growth Area

Under the hashtag "#turningmetalsgreen", SMS not only supplies solutions and systems to the steel industry but also develops technologies for the recovery and reuse of nearly all types of metals. In November 2021, a long-term, strategic partnership agreement was concluded with copper producer Aurubis, covering the development and construction of several modular recycling plants in Europe and North America. These modern multi-metal recycling plants will recover valuable metals, such as copper, nickel, tin, zinc, platinum and various precious metals, for reuse in the value creation cycle.

Environmental Technologies for Tomorrow's Mobility

The LIB (lithium-ion battery) recycling process from Primobius has secured its first commercial success. After the start of the commercial operation of the demonstration plant in Hilchenbach in spring 2022, Mercedes-Benz was one of the first customers to decide to use this process in its operations. Primobius will be building its first industrial-scale plant at the Mercedes-Benz location in Kuppenheim (Baden-Württemberg), Germany.

Increasing Use of Performance-Based Subscription Models in the Service Business

SMS is rigorously pursuing the expansion of its service business. The three focus areas of electrics/automation, digitalisation and technical service provide integrated solutions – to an increasing extent under performance-based subscription agreements.

Prof. Dr.-Ing Katja Windt, CDO of SMS group, said, "Many of our customers want to be able to focus more on their core processes and, therefore, have their maintenance services handled by service partners. Here, efficiency and sustainability are the primary performance indicators. We at SMS are positioned to support our customers during the entire lifecycle of their plants as a dependable single-source partner: during the design and commissioning of plants, and throughout their decades-long operation, including all upgrades and revamps."

Investment in KAEFER Isoliertechnik Completed

SMS has acquired a 50% stake in global industrial service provider KAEFER Isoliertechnik GmbH & Co. KG, together with private equity investor Altor. The closing of the transaction took place on May 24, 2022. SMS expects that the industrial services market will experience significant growth over the next few years. Together with KAEFER, SMS will explore new opportunities for cooperation in future-oriented areas, such as decarbonisation, the energy transition and LNG technology.

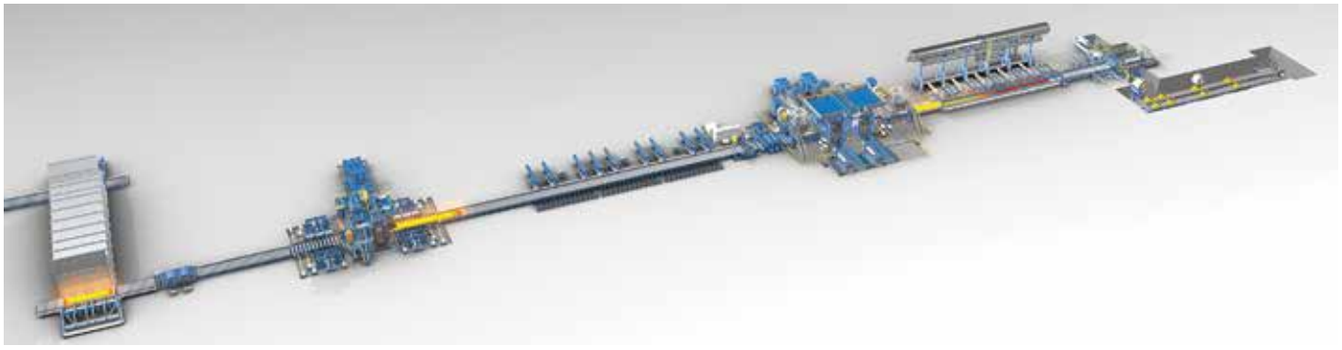
Positive Outlook

SMS expects a sustainable and perceptible increase in incoming orders and a marked improvement in results over the next few years. The order intake in 2022 is expected to level out at the previous year's figure, even in view of the Russia-Ukraine war.

■

Xinhai Industry Orders Twin-stand Steckel Mill from SMS group

Flexible "Twins"



Basic concept of a twin-stand Steckel mill from SMS group

Shandong Xinhai Industry Co. Ltd. has placed an order with the SMS group (www.sms-group.com) for the supply of a twin-stand Steckel mill for the Junan location in the Chinese province of Shandong. In China, Xinhai Industry is one of the largest producers of nickel-containing crude iron. The company is currently expanding its production facilities in the field of steel production, including the erection of the new twin-stand Steckel mill.

Mr. Wang Jiusheng, Chief Expert of Shandong Xinhai Technology, says: "A twin-stand Steckel mill from SMS group enables the economical production of hot strip through the combination of reversing Steckel technology and continuous rolling. The focus is on a wide range of products and very good quality for smaller quantities and smaller batch sizes. The so-called Steckel mills have also proved to be a very good solution when it comes to the production of stainless and acid-resistant steels. They offer a high degree of production flexibility."

With this plant configuration, Xinhai Industry will mainly roll hot strip made of stainless steels, duplex steels and heat-resistant steels up to a maximum annual capacity of 1.75 million tons. Incoming slabs can be processed with a maximum thickness of 230 millimeters, a maximum width of 2,100 millimeters and a maximum length of 12,000 millimeters. The maximum weight of a slab is 40 tons. At the same maximum width, the thickness range of the transfer bar is 25 to 40 millimeters. The width range of the finish-rolled hot strip is 1000 to 2100 millimeters, while the final strip thicknesses are achieved from a maximum of 16.0 millimeters to a minimum of 2.0 millimeters.

Already in 2023, Xinhai Industry will start production on the new twin-stand Steckel mill.

The SMS group supplies all essential units belonging to a twin-stand Steckel mill. These include a roughing mill descaler, a four-high reversing roughing stand with attached edger and a drum shear upstream of the Steckel stands. The centerpiece of the

rolling line is the two four-high stand with one Steckel furnace each in the entry and exit sections. To ensure an efficient rolling process and a stable rolling temperature, the rolled stock is wound up in one of the Steckel furnaces after each pass. The heat input in the furnaces ensures that the strip temperature is maintained at the required level during finish rolling. Looper between the Steckel furnaces and the Steckel stands enable, in particular, wider strips to be rolled at higher speeds. In addition, they enable more constant strip tension and thus an improved thickness tolerance. All three millstands, i.e. the roughing stand and the two Steckel stands, are equipped with hydraulic adjustment for precise thickness control. The Steckel stands also have proven CVC® plus technology (Continuously Variable Crown) for roll shifting. In conjunction with the negative work roll bending, the profile and flatness are precisely adjusted and product tolerances are achieved which correspond to those in modern hot strip mills. A laminar cooling section and a hot strip reel complete the scope of supply of the mechanical equipment. To simplify later stages of dismantling, the foundations, e.g. for a second hot strip reel, are already being prepared in the current construction phase. The entire mechanical components will be supplied by SMS group, in close cooperation with our regional set-up in China.

In addition to the mechanical equipment, the scope of supply also includes the X-Pact® electrical and automation systems for the entire production line.

The Level 1 automation system is designed completely based on the X-Pact® technology. The operating concept X-Pact® Vision is implemented according to ergonomic findings to enable the owner to operate it intuitively for optimal process control. The Level 2 process automation includes the technological process models from the pass schedule calculation PSC® (pass schedule calculation) via the profile and flatness model PFC (profile and flatness control) to the higher-level material tracking MTS (material tracking system). Before delivery, the X-Pact® electrical and automation system is prepared for efficient commissioning by means of the Plug and Work integration test developed by the SMS group.

An internationally set-up team under regional management ensures order handling and the timely and successful commissioning of the plant. The team is also available to the owner for the units to be supplied by the owner at all times in an advisory manner due to the high plant know-how´s the owner.

The centerpiece of a twin-stand Steckel mill is the millstands with the entry and exit-side Steckel furnaces in which the strip is heated between the reversing roll passes. The photo is the reference example of a comparable SMS plant

■

The Digitalisation of EOT Cranes: Big Data and Crane Life Monitoring

The digitisation of steel plants and in particular of EOT cranes is an essential aspect in the construction of an efficient and safe plant, where product and process quality pass through the status and efficiency of individual components

Edited by Francesco Rapolla
Automation Engineer, Danieli Centro Cranes

In steel-related applications, the absence of human intervention is becoming the new normal. Danieli Centro Cranes had – and continues to have – an important role in this transition. Indeed, in the last several years, it has built many automatic warehouses governed by optimised algorithms in which the human workers cannot enter.

An automated plant requires several sensors: whether there are process deviations, a collision event happens, or the target position is not precisely reached, a sensor can fire an alarm, and the wrong behaviour can be corrected. Each component shall be continuously monitored to ensure fast replacement in case of failure. Also, it allows component failure prediction, replacing the equipment before it either stops or slows the process.

During their lifespan, all machines – semiautomatic, automatic and remotely guided – produce many valuable data. Those are acquired via several sensors installed for the machine's normal operation, which means it is possible to obtain all information from the field, with additional measurements being provided through ad hoc sensors.

Therefore, the real issue doesn't lie in data collection (i.e. the "logging" stage) but their analysis and use. A machine provides so much data that the main task is to filter, categorise and understand them.

A crane needs a lot of sensors to be safely used. Without limit switches on the bridge, trolley and hoist, the crane cannot be

used because it's unsafe and dangerous to both people and the crane itself. The information coming from on-field sensors like pt100, drives and the motor can be used to provide an accurate analysis of the machine state. For example, it is possible to find the actual torque, speed, machine status (if it's moving or not), a component's temperature and others from the drives.

Thanks to its experience in the crane field, Danieli Centro Cranes can process all of those data with algorithms and extract the most important information: data are merged, grouped and filtered to provide indices to help maintenance.

Several components (e.g. brakes, contactors) have a defined number of cycles they can perform before requiring changing. Through data acquisition, it's possible to trace the number of times the component is being used, and change it before it warns of using the basic concept of predictive maintenance.

Other data can be used to define the machine's remaining life based on the number of cycles it completed, and thanks to the related load spectrum, it's possible to define a usage index to better understand when the machine needs maintenance or if a certain part needs substitution.

A final set of data provides information about the time in which the machine is idle, the time needed for the maintenance operations and the actual operation time. All these indices are very important to track the crane usage, to have objective data to use in case of an inspection or as a reference for future operations.

Crane Life Monitoring System

Danieli Centro Cranes' Crane Life Monitoring system, CLM for short, is a tool to convert data coming from the crane into understandable information to reduce plant downtime and develop a long-term predictive maintenance strategy.

- The CLM provides information based on the sensors already installed on the machine, so the initial investment does not require additional hardware
- The CLM is based on a fine optimised software to acquire and analyse data, providing easily readable reports with all the main information required to track the machine life and its components
- The information gathered from the sensors feeds an accurate model to predict the machine's life

Sometimes, however, it's required to add sensors to have a more accurate outlook on the state of a component. For example, in the case of a bearing, the information about revolutions completed during the crane's working time is usually not accurate enough to predict its remaining life. For these reasons, ad hoc sensors (i.e. vibration sensors) need to be mounted on the shell to provide more accurate results. Combining the installed sensors with the new, ad hoc ones, it's possible to increase the quality and accuracy of the prediction about the current and remaining life of the crane and its components.

The collected data can be used to define a long-term predictive maintenance strategy to reduce the plant shutdown time. Based on reports, the maintenance personnel can decide whether a component required substitution or it could be kept in use until it breaks completely, due to an economic-utility trade-off. The report can also show indices about the current crane usage, the fired alarms and the maintenance time.

Thanks to the crane life monitoring system, Danieli Centro Cranes can provide customers with a great tool to ensure the status of their equipment down to the single component, taking quick action to prevent issues from happening.

Courtesy: DaNews ■

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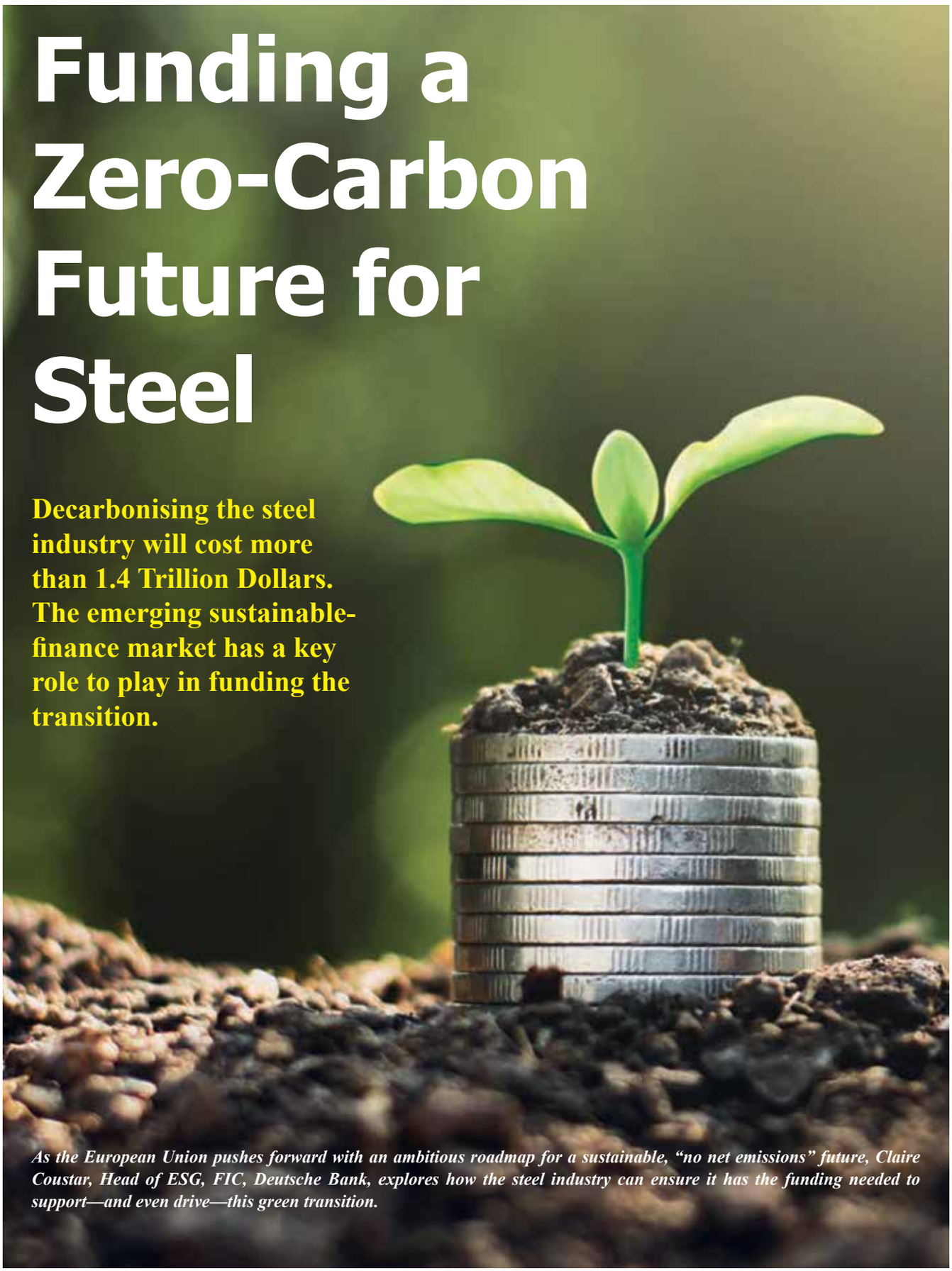
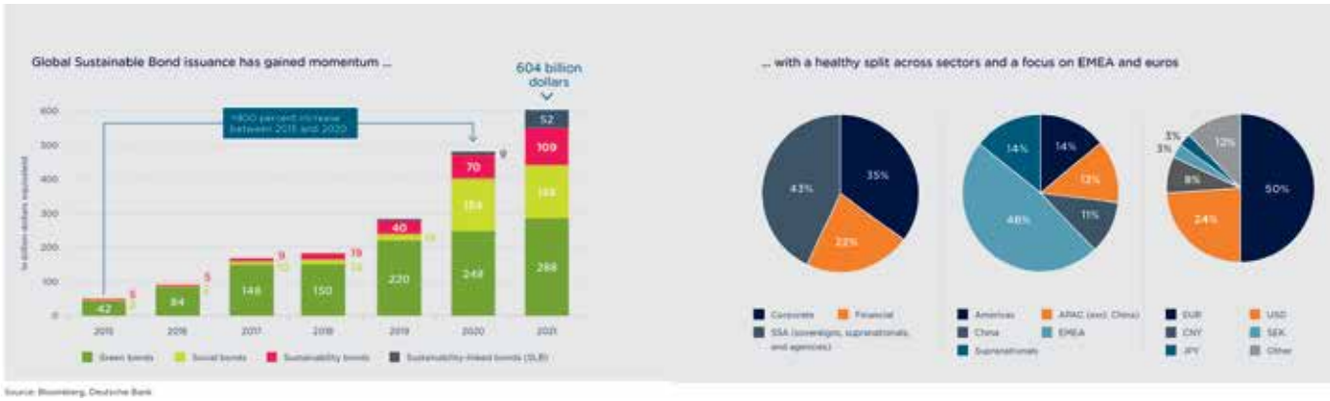
REFRATECHNIK

Funding a Zero-Carbon Future for Steel

Decarbonising the steel industry will cost more than 1.4 Trillion Dollars. The emerging sustainable-finance market has a key role to play in funding the transition.



As the European Union pushes forward with an ambitious roadmap for a sustainable, "no net emissions" future, Claire Coustar, Head of ESG, FIC, Deutsche Bank, explores how the steel industry can ensure it has the funding needed to support—and even drive—this green transition.



The world is stepping up its efforts on a momentous project—the fight to limit the damage from climate change. Pre-eminent among the battle objectives is the call to reduce CO_2 emissions for energy-intensive industries in order to meet climate targets. Nowhere is this more apparent than in the steel sector, which, according to the World Steel Association, accounts for nearly 9% of all direct fossil-fuel emissions globally.

The European Union has traditionally been at the front line. As the bloc follows a path toward net zero emissions by 2050 – the primary goal of the European Green Deal, whose latest proposals were announced in July 2021 – the process of "greening" the steel industry has gained more urgency. Other major steel-producing economies are following suit: Japan and Korea have both announced net-zero targets, and China has set a zero-carbon target. But with the industry still feeling the effects of faltering demand and disrupted supply chains, how can it secure the significant funding needed to make this vision a reality? The emerging sustainable-finance market has a key role to play.

Greening the Industry

A concerted, global effort to decarbonise the economy is underway—one that aims to shift the energy mix away from fossil fuels in order to move toward a renewable future. As part of this journey, several ambitious targets have been laid out by governments and corporations alike. The biggest of these is the Paris Agreement, a legally binding international treaty on climate change. Adopted by 196 parties, the agreement aims to limit global warming to well below 2°C—preferably to 1.5°C—compared to pre-industrial levels.

To ensure sustainability efforts stay on track, Europe has laid out a comprehensive roadmap to prepare the continent for a net-zero future. In December 2019, the European Commission announced the "European Green Deal"—the bloc's most ambitious attempt to date to counter climate change and environmental degradation. In line with the Paris Agreement, the initiative targets zero net emissions of greenhouse gases by 2050 and is underpinned by a series of interconnected goals covering almost every element of the economy, including energy, construction, agriculture, and transport.

Meeting the aims of the Green Deal involves a massive funding injection for every part of the economy, in every industry and across every sector. At least 1 trillion euros in funding is needed for the coming decade, and while a large share of this will come from the EU budget and national governments, a contribution worth 279 billion euros is required from the private sector. Looking only at the steel sector (but taking a global view), the IEA has projected a cumulative need for investment of around 1.4 Trillion Dollars until 2050.

This presents a huge challenge for banks, but also a huge opportunity. Capital will need to be allocated, and banks—those best positioned to support sustainability—can be there to provide it. But how exactly will the funding be achieved?

Integrating ESG into Finance

The shift toward sustainable financing – with tools linked to "ESG" criteria: environment, social, and governance – has already begun. It is best illustrated by the recent, exponential growth of the green-bond market. Ten years ago, it had yet to develop. Fast-forward to today, and total market capitalization recently surpassed 1 Trillion Dollars. In the past decade, the market for both green bonds and green financial instruments in general has expanded significantly. For example, social bonds have seen a significant surge, especially since the onset of COVID-19, while the market for sustainability-linked instruments (which tie the cost of the financing to performance on ESG metrics) has also grown substantially.

In part, this growth is down to the increasing awareness among corporates of the urgent need to tackle climate change, but it is also being driven by governmental and regulatory policies. For instance, in June 2020 the European Union published its Taxonomy Regulation – a classification system for green investments that, it is hoped, will be instrumental to the EU's scaling up sustainable investment and implementing the European Green Deal. Under the taxonomy, activities are considered to be "green" if they substantially support one (or more) of six objectives: climate change mitigation; climate change adaptation; sustainable use and protection of water and marine resources; circular economy; pollution prevention and control; and biodiversity. By providing a common language, issuers will be able to more easily demonstrate how their efforts align with the Paris Agreement and goals of the European Green Deal, while investors should more easily avoid the reputational risks of associating with activities that undermine environmental objectives.

Challenges for the Steel Industry

Among the largest contributors to carbon emissions is the steel industry. And even Europe, with all its modern assets and infrastructure, has much remedial work to do. Recent statistics from industry group Eurofer show only around 40% of the 160 Million Tonnes of crude steel produced in the EU comes from electric furnaces – both arc and induction. The rest involves traditional blast furnaces—a good indication as to why carbon emissions run so high in this industry.

Indeed, after the power-generation sector, iron and steel are the largest industrial producers of CO_2 emissions in Europe, with the industry currently generating 221 megatons of greenhouse-gas emissions annually, representing 5.7% of total EU emissions. Reducing CO_2 levels for this energy-intensive industry will, therefore, be central to meeting the EU's climate objectives.

Working toward this goal, over the past year, major mining and steel companies have put a significant focus on climate-change disclosure—with many corporates having now adopted the major voluntary reporting guidelines, including the Global Reporting Initiative and the Financial Stability Board's Task Force on Climate-Related Financial Disclosures (TCFD).

At the same time, individual companies are stepping up to the plate. In September 2020, ArcelorMittal, the world's largest steelmaker, became the first to pledge net-zero emissions by 2050, with plans to combine small amounts of hydrogen with coal in a blast furnace, as well as substitute wood biomass for coal in processes. Unfortunately, these efforts will prove costly. The company estimates that decarbonizing its facilities in Europe alone – in line with the EU's Green Deal – will require between 15 billion and 40 billion euros and won't be profitable before the 2030s. And the price is estimated to be just as eye watering for others in the industry, with a July 2021 Deutsche Bank Research paper, titled "Can Mining & Steel Sustain in a Low Carbon World?," reporting that the capex bill for European carbon steel over the next 10 years could reach 20 billion dollars for the already capital-constrained sector.

European steel has been struggling in recent years, hit by the trio of stagnating demand, international-trade distortions, and the impact of COVID-19 on supply chains. At the same time, the industry is expected to turn its attention to a complete rethink of its existing processes to facilitate substantial reductions in emissions—something it has to do quickly and at great expense. As explained in the European Commission's report "Towards Competitive and Clean European Steel," these headwinds, combined with the cost and urgency of upgrades, "make for an exceptionally challenging business environment and illustrate many of the challenges that E.U. industry at large faces." So how exactly can the struggling industry meet these capex demands? One potential route is through the sustainable-financing market.

Integrating ESG into Steel

As noted, financial products that meet ESG criteria have enjoyed increasing demand for several years—not least within the steel industry. Given the high levels of emissions produced by its members, the prospect of reconciling the desire for returns with personal or institutional values is particularly resonant. Interest in the markets has been building rapidly in recent times. For example, U.S. Steel launched its inaugural 60-Million Dollars green-bond issuance in December of 2020 to finance a new electric arc furnace. In early 2021, Hyundai Steel received 1.9 billion dollars in orders for its green bond issue. And Indian steel company JSW recently raised 1 billion dollars with sustainability-linked bonds (SLB), becoming the first company in the steel sector to issue an SLB in hard currency.

It's not just the bond market that is making an impact. In November 2020, Deutsche Bank and Primetals Technologies agreed to the world's first hedging concept that links currency hedges to sustainability goals. The framework enables the supplier of plants, equipment, and services to hedge its currency risk with FX derivatives over a 4-year period, with the product offered on the basis of the company's wider ESG performance based on pre-agreed metrics. These metrics are in line with the new Sustainable Finance Framework published by Deutsche Bank in July 2020. This sets out the classification of ESG financing and other financial products, which is aligned on a best-effort basis to the EU Taxonomy Regulation.

The targets were developed in consultation with the external independent consultancy, Environmental Resources Management, which will be monitoring Primetals Technologies' ambitious targets with a remit to annually assess whether the targets have been met. Among the goals are the percentage of projects sold in total sales that lead to a reduction in greenhouse-gas emissions for the customer; the ratio of sales to expenditure on research and development for product The targets were developed in consultation with the external independent consultancy, Environmental Resources Management, which will be monitoring Primetals Technologies' ambitious targets with a remit to annually assess whether the targets have been met. Among the goals are the percentage of projects sold in total sales that lead to a reduction in greenhouse-gas emissions for the customer; the ratio of sales to expenditure on research and development for product solutions that lead to improved resource efficiency; and the promotion of a safe and healthy work environment for all Primetals Technologies employees. If the company fails to meet these agreed sustainability targets, it pays a predefined sum to a contractually defined non-government organisation.

Source: Metals Magazine ■

The Green Pulse of Ironmaking

The newly developed Sequence Impulse Process (SIP) takes blast furnace ironmaking one step closer to carbon neutrality and shifts the coal-coke ratio toward more coal

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Fig. 1: Image showing a blast furnace with SIP installed. The proprietary SIP boxes can be seen in the upper part of the picture (silver/blue)

The Sequence Impulse Process enhances blast furnace-based ironmaking and lowers the associated carbon footprint. The technology superimposes periodic bursts of oxygen on the steady flow of oxygen to the furnace, thereby optimising the conversion behaviour of coal and coke particles.

The global challenge faced by all steelmakers to eliminate greenhouse gas (GHG) emissions and reduce raw material and energy consumption in pursuit of carbon neutrality is well documented. The route to achieving this is less clear and will be different for each producer. With around 7-10% of industrial GHG emissions attributed to the steel industry and 70% of the total global steel production reliant on thermal reduction via the integrated steelmaking route, replacement of carbon-based fuels will be necessary.

Improvements in the circular economy of steel to increase the availability of high-quality scrap and to support the transition to electric steelmaking as the primary production route are also underway. Hydrogen-powered ironmaking is seen as the natural successor to the blast furnace, with ferrous units being generated in the form of direct-reduced iron. Alternatively, complimentary processes such as carbon capture and storage or utilisation could lower the amount of CO_2 emitted to the atmosphere. The final picture will likely be a complex combination of these options for

many steelmakers as this transformation evolves.

Whilst there appears to be a general acceptance of the global imperative and requirement by steel producers to change, the technologies and especially the infrastructure to do so are not yet fully realised. Availability and utilisation of higher proportions of hydrogen, plentiful supplies of cheap "green" energy, high-quality scrap and mass capture and utilisation of emissions remain frustratingly distant technical and economically viable options for producers. In each of the routes, there are substantial hurdles – both technologically and commercially – to facilitating a change at pace. This is in addition to what could be considered an overwhelming financial investment.

It is probable that significant undertakings by governments, businesses, and consumers will be required on a global scale to provide both the legislative and commercial drivers to ensure the shift can happen to meet the ambitious, international goals set out. This will take lengthy and protracted negotiation, resulting in extended timescales, to realise the necessary outcomes. What can be concluded from these facts is that the movement to new steelmaking routes is coming, but not today or tomorrow and possibly not within the next decade.

A Major Transition

Clearly then, the challenge for blast furnace operators to accelerate this transition is immense – but they must continue to produce competitively in the interim. Even though the task seems daunting, it also presents opportunities where significant gains can be made. The blast furnace is the single greatest contributor to the production of GHGs in the process route. As carbon-trading markets continue to develop rapidly, operators are facing increasing cost pressure based on their existing footprint. Many have already declared their own ambitious plans but must act now. The reality remains that there is a desperate need for effective technologies to support the roadmap toward carbon neutrality. Implementing technology that can have a significant impact in the blast furnace, therefore, represents a major stepping-stone for operators globally.

Whilst the fundamental characteristics of the blast furnace have changed little over the last 100 years or so, designers and operators have implemented incremental developments for the main vessel and process equipment. This has continued to push productivity to ever-higher levels; at the same time, it has been possible to reduce the cost of the hot metal produced. Lower fuel and energy requirements combined with optimisation of raw-material quality have become paramount.

In the current environment, the costs for carbon emissions, growing awareness of climate targets and sensitivity to climate-centred topics are increasingly influencing markets and consumers to the extent that every marginal gain allows steel producers to run their plants more competitively. What if that gain could be achieved whilst also complementing and making a significant contribution toward carbon neutral production?

A Powerful Pulse

In a mature process such as blast furnace ironmaking, technology step changes come rarely and are often decades apart. Sequence Impulse Process (or SIP for short), a new technology available from Primetals Technologies, is such a step change.

As the name suggests, SIP technology involves the pulsing of a medium into the blast furnace. That medium is oxygen. The overall equipment required consists of a pressure-reducing station with ring-distribution lines for nitrogen and oxygen, proprietary SIP boxes (the heart of the pulse generation), pulse lines from the SIP boxes to the tuyeres and a bespoke plant-control system.

The pulse lines, coming from the SIP boxes, each lead to a dedicated lance, which is inserted into the blowpipe next to the existing coal lance. For cooling, the lance is supplied with a continuous flow of oxygen, the so-called basic load. As it leaves the dedicated lance, the oxygen first meets the carbon stream emerging from the coal lance and is ignited. The pulsed oxygen initially ensures a mixing effect as well as a certain optimisation of the conversion behaviour of the injected coal.

Periodically, a pulse is generated by the SIP boxes (seen in Fig. 1) and then superimposed on the basic oxygen-flow quantity at a pre-determined frequency. A proprietary valve opens and closes very quickly to ensure that a high-energy shock wave reaches the raceway zone of the blast furnace at supersonic speed (Figs. 2 and 3). This wave front provides a massive increase in turbulence and, thus, has a positive effect on the conversion behaviour of coal and coke particles, including the uncombusted char that builds up in the lower part of the furnace, forming the "dead-man".

Fig. 2: In regular BF operation, coal injection results in char deposits accumulating, which restricts penetration of the "dead-man" and limits the gas flow into the furnace centre

Fig. 3: With SIP implemented, the shock waves from the high-pressure oxygen penetrate deep into the raceway, combusting the fine char and improving coke permeability

The control of the system with regard to pulse frequency and the admission of individual tuyeres is freely selectable and depends on how the furnace is operated, which is why it will be matched to the respective furnace during the initial setup. The expectation is that this initial setup will be adapted through the day-to-day life of the furnace, as is the case with controlling the various other input parameters.

Economically, the use of SIP technology at the blast furnace is expected to allow for more cheap injection coal to be used instead of the more expensive coke. In addition, the reduction of less thermally converted coal particles can be expected to improve throughput and drainage, which ultimately leads to increased production.

Greener Ironmaking

SIP was developed by thyssenkrupp AT.PRO tec and has seen success in foundry cupola furnace applications. Following significant research and development, the first full installation has been operational since December 2020 on blast furnace No. 1 at thyssenkrupp's Schwelgern steel plant in Duisburg, Germany. SIP delivered a significant shift in raw-material consumption. The improved gas utilisation was demonstrated as expected and resulted in a lower overall fuel rate with a consequential reduction in CO_2 emissions.

As such, SIP offers blast furnace operators a proven and effective tool in support of the journey to carbon neutrality, bringing essential "green" credentials. Not only does the process enhance the overall OPEX, but it also makes furnace operation smoother (see next page).

The OPEX benefits lead to a short amortisation time, typically within 12-18 months when considering the fuel rate only. This is dependent on production levels as well as internal utility and relative material costs. When also considering the added benefit of reducing the charges related to carbon emissions, the payback time shrinks further – to less than a year, depending upon the carbon levy applied. Primetals Technologies can provide an indicative payback figure to producers based on their specific operational conditions and associated material-utility and carbon costs.

A Future-Oriented Step in the Right Direction

Dr. Dirk Gotthelf, Head of thyssenkrupp Steel's Schwelgern blast-furnace plant, talks about his experience with the Sequence Impulse Process.

What motivated you to consider and then implement the Sequence Impulse Process?

Dr. Dirk Gotthelf: The availability of high-quality raw materials is now severely limited. Compromises between quality and cost have become absolutely necessary to ensure that the production process remains economical. This sometimes poses problems that are difficult to overcome with the conventional process-control strategy at the blast furnace. New approaches are inevitable. Helping the blast furnace right at its heart with regular "oxygen injections" is a fantastic idea.

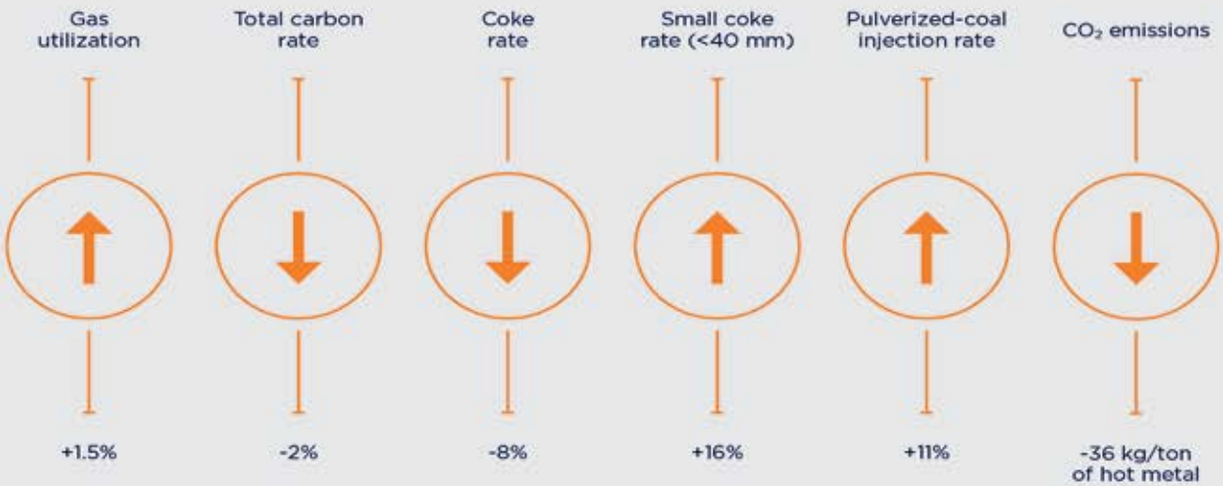
What are the biggest benefits you have seen with the Sequence Impulse Process solution?

Gotthelf: The task of every blast furnace operator is to produce pig iron at low cost and high throughput. Due to the more stable furnace behaviour and the cost savings on reducing agents, the SIP plant makes a significant contribution to reaching these goals.

Has the technology met or even surpassed your expectations?

Gotthelf: Since the SIP technology was tested for the first time worldwide on a large blast furnace, I was curious to see what the results would be in terms of operation and cost benefits. The evaluation of the test phase showed great potential for production at lower costs, which for me, as the responsible Production Manager, means an important and future-oriented step in the right direction.

OPERATIONAL RESULTS WITH THE SEQUENCE IMPULSE PROCESS



All figures were obtained at thyssenkrupp Steel's Schwelgern plant in Duisburg; further improvements are expected once the system is fully optimized.

DESIGNED TO ADDRESS REAL-WORLD PROBLEMS

IDEAL OPERATING CONDITIONS	REALITY	WITH SEQUENCE IMPULSE PROCESS TECHNOLOGY
Consistent, high-quality raw materials	High cost; lower availability of high-quality raw materials	Higher rates of pulverized-coal injection achievable with typically available raw materials
Minimal energy and reducing agent consumption	Raw materials of variable quality reduce permeability, increasing total fuel rate	Improved gas flow and utilization reduces total fuel rate and CO_2 emissions
Maximum use of low-cost fuels to replace expensive coke	Inability to achieve high pulverized-coal injection rates	Higher pulverized-coal injection rates and lower coke rates result in lower OPEX
Good "dead-man" permeability enabling gases to penetrate the furnace	Char deposits in the "dead-man" reducing the permeability of the furnace	Cleans the "dead-man" so gas can pass effectively into the furnace
Continuous and unvarying operation	Tuyere-to-tuyere differences can cause asymmetry of gas flow in the furnace	Stable operation with fewer burden-related "hanging" events and tuyere changes

Benefits of the Sequence Impulse Process

- Improved across-furnace gas distribution and drainage, enhancing production potential
- Improved gas flow into the furnace increases gas utilisation, reducing both the total fuel rate and the total CO_2 emissions
- SIP offers a rapid return on investment of under two years for most plants and less than one year for some
- Substituting coke with higher rates of injected coal results in lower OPEX
- Reduced carbon-related costs
- The oxygen previously injected via the stoves or oxy-coal injection is repurposed. The total oxygen requirement will be determined by the final pulverised-coal-injection demand
- More stable furnace operation, compared to conventional coal injection operations. These effects are observed during pulsing:
  - Fewer burden-related "hanging" events
  - Fewer tuyere changes
  - Reduced heat loads, particularly in the lower stack of the furnace
  - Higher central-gas temperatures and lower wall-gas temperatures
- Improved furnace permeability and an increase in the small-coke proportion are possible without impacting productivity

Source: Metals Magazine

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JSW to Serve the Packaging Industry with New, Flexible Tinplate Cold Complex in India

The 200,000-tpy plant enables the customer to create products with excellent corrosion resistance and appearance for the food industry

Edited by Elisa Grosso
Project Manager, Danieli Wean United
Dmitriy Voitekhovskii
Tech Team, Cold Products, Danieli Wean United

In February 2022, Danieli and JSW signed the Final Acceptance Certificate for the flexible tinplate cold-rolling complex in Tarapur, India.

The new plant is designed with a double, cold-reversing mill (DCR), a coil preparation line, an electrolytic tinning line (ETL), and two cut-to-length lines. Products from the complex are used in the packaging industry, thanks to their excellent corrosion protection, appearance, strength, light weight, formability, and resistance to corrosion by organic substances, dilute acids, bases, and salts. It is a reliable alternative to the use of plastic for food packaging, especially thanks to JSW Platina®, a sustainable material produced by JSW through Danieli's electrolytic tinning line.

The Double Cold-Reversing Mill

The DCR is capable of processing different steel grades – such as T1 and T5 – in single-reduction mode, and DR480, DR8, DR9 and DR10 in double-reduction mode. The strip thicknesses range from 0.14-0.60 mm (0.38 mm max. for DR), while the width will range from 650 to 1,250 mm. The DCR mill is sized to produce 160,000 tpy of tempered products and 40,000 tpy of double cold-reduction products, for a maximum 3% strip elongation in temper mode, and thickness reduction of up to 35% in DCR mode. The mill can operate in either dry or wet temper modes, with the use of anti-oxide lubricants. Meanwhile, the fast-responding HAGC cylinders located on top of the mill housing ensure proper tolerances and final product quality. A separate, direct oil-application and a roll-cooling system are used on stand 1: the emulsion systems allow high reduction, up to 35%; instead, by using direct application, it is possible to achieve a rapid change in

lubricant concentration, for quick adaptation to different rolling conditions.

Electrolytic Tinning Line

This line is designed to operate at 400 mpm and can produce 200,000 tpy of tinplated products, with a coating weight from 0.56 to 16.8 g/m^2 per side for tinplate strip, and 7 to 140 mg/m^2 per side for tin-free steel (TFS).

Prior to the tinplating section, the line features a cleaning section, an electrolytic pickling section and a tension leveller to make the strip shape perfect for downstream processes. The Ferrostan process is applied in tinplating, with soluble anodes and vertical tanks: the ionic tin is converted to metallic tin by the plating bath, and deposited on the strip surface through an electrochemical process, involving simultaneous cathodic and anodic reactions in the vertical plating cell. Danieli's ETL process also offers a cast-tin soluble anodes technology: the different possible configurations offer the best cost/benefit results.

Cut-to-Length Lines

The cut-to-length lines are used for thickness measuring, levelling and cutting the coils into sheets, which are stacked and weighed. The inspection area is equipped with mirrors for operators' strip top- and bottom-surface inspection; the inspection is performed prior to the thickness gauge, which detects strip thickness by a non-contact isotope. Afterwards, the strip is fed by a roll into the cut-to-length shear that cuts the coil in the sheet into certain lengths; the drum shear is able to cut at a maximum speed of 180 m/min for sheets between 400 and 1,300 mm. Then, the sheets are transferred by belt and intermediate conveyors, which can be adjusted according to the line speed, and used to transfer the sheets into different stackers. The sheets can be sorted to different stackers according to the feedback from the thickness gauge and pinhole detector.

To conclude, Danieli Automation developed the whole cold complex software packages and their integrated functionalities: the process control is performed by the HiPAC, a powerful and advanced platform, based on an IPC solution and EtherCAT field-bus technology that incorporates a full series of dedicated technological packages, such as mass-flow control, automatic thickness and elongation control, roll eccentricity and friction compensation and mill threading setup.

DANIELI STRIP PROCESSING STRENGTHS

133 COLD ROLLING MILLS
119 PICKLING LINES
156 HOT-DIP GALVANISING LINES
114 ELECTROLYTIC TINNING LINES
146 CUT-TO-LENGTH LINES

JSW'S ELECTROLYTIC TINNING LINE HIGHLIGHTS

STRIP THICKNESS UP TO
0.14 mm
SPEED RUNNING AT
400 mpm
COATINGS RANGING FROM
0.56 to 16.8 g/m²
PER SIDE

Courtesy: DaNews ■

Precise Argon Purging System through Mono Block Stopper to Avoid Alumina Clogging and Inclusion Flotation in Tundish

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The demand for cleaner steel production increases every year. In addition to lowering non-metallic inclusions, different application practices during continuous casting improve inclusion flotation. Isostatic products, such as Mono Block Stopper (MBS), play a very important role in avoiding phenomena like alumina clogging. Precise argon purging through MBS helps to avoid deposition in SEN/TN mouth. Controlling argon flow through MBS can be achieved by reducing the size of the argon hole/maintaining constant back pressure to ensure precise argon flow. A typical injection rate followed is 10 litres/minute. The present article discusses different designs and features of MBS to control the argon flow into the steel stream, thereby improving inclusion flotation and simultaneously decreasing clogging in nozzles.

Introduction

Clogging in nozzles is the build-up of material during continuous casting. The consequences of clogging include decreased productivity, increased cost and decreased quality of casted steel. In addition to clogging, non-metallic inclusions or NMIs have a major impact on clean steel production. Both above-mentioned factors, i.e. clogging and NMIs, affect the quality of steel casted[1, 2]. Hence, to avoid or minimise such issues, argon injection is found to be a suitable solution. Argon is injected through refractories into the steel stream during casting, mainly through flow control refractories, such as stoppers and nozzles. Though the preliminary function of a tundish stopper is precise control of the steel flow from tundish to mould, apart from that, argon gas is also purged through the stoppers during continuous casting to avoid clogging in nozzles. In practice, argon gas is injected through the stopper-rod system, which finally goes out through the stopper tip. The uninterrupted argon flow has been achieved by various methods with modifications in the internal design of the stopper tip.

Influence of Inclusions on Castability and Tundish Nozzle Clogging

One of the key challenges steelmakers face is the clogging of tundish nozzle or SEN due to deposition of non-metallic inclusion on it during continuous casting of aluminium killed steel. Initial deposition leads to a castability problem which is generally manifested by the movement of the stopper rod. Nozzle clogging has a significant and detrimental effect on caster productivity and product cleanliness/surface quality. Refractory 'nozzles' (made from a mixture of carbon, alumina and zirconia-based refractory) are used to transport liquid steel from a ladle to a tundish and from tundish to a mould since they reduce re-oxidation and allow greater control of flow[3]. However, it has long been recognised that these nozzles may become progressively blocked or 'clogged' by the build-up of solid masses on the inner walls of the nozzles. Subsequent solutions involved devices to replace clogged nozzles. Thus, while 'changeable' nozzles have been widely adopted as a limited counter measure to clogging, increasing customer demand and quality expectations are forcing steelmakers to eliminate the nozzle clogging phenomenon altogether.

Removal of Inclusions from Steel Melt

Inclusions beyond a certain tolerable size limit are detrimental and, hence, their removal is always a matter of concern. Removal of inclusions products from melt and the associated rate of removal have a considerable bearing on the quality of the final


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product. Removal is facilitated by various mechanisms and include:

- Stokes flotation
- Wall adhesion
- Agglomeration

Non-metallic inclusions are lighter than steel, therefore, tend to float naturally. A first-hand estimate of the rise velocity and rising time for a spherical-shaped inclusion can be obtained from the Stokes law 1:

$$V_t = gdp^2\Delta\rho/18\mu$$

Where: v_t is the constant rise velocity (commonly termed as the terminal rise velocity), d_p is the diameter of the inclusion, and $\Delta\rho$ is the density differential. As seen from Stokes law, bigger inclusions float out readily. We must, therefore, create conditions such that: (i) formation of bigger size inclusions is facilitated and (ii) smaller size inclusions are also eliminated (through reasonable holding time, gas injection into the tundish, etc.).

Estimates based on Stokes law indicate that inclusions having a diameter greater than 100 μm shall readily float, and elimination of such large size inclusions is practically complete within a reasonable processing time[4, 5]. Floating the smaller size inclusions holds the key to successfully producing clean steel.

Removal of Inclusions by Argon Bubbles

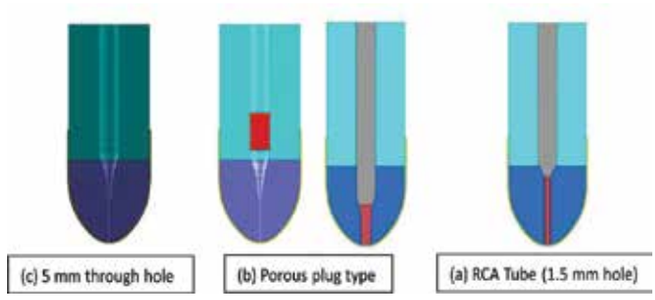
Inclusions are removed from steel melts via bubbles, particularly during gas injection operations through refractories. The adhesion of inclusion to bubble surfaces is governed by various forces such as capillary, buoyancy and pressure forces. Contact angle and interfacial tensions are also important, and thus, the specific nature of the inclusion surface plays an important role in their attachment to the bubble surface[6]. Inclusion can adhere to a bubble surface as a single particle or clusters/layers depending on the relative magnitude of inter-particle cohesive forces and adhesive forces between inclusion and bubble surface.

Inert gas injection into the tundish reduces the content of non-metallic inclusions by 70% for the >50 μm class and by 40% for the 25-50 μm class. Removal of non-metallic inclusions is most effective when the bubble diameter is 1.0-3.25 mm and the gas flow rate is 10-12 L/min[6].

Different Stopper Designs for Ultimate Argon Injection and Bubble Size Calculation

There are two different ways to blow argon into the nozzle, i.e. sonic or low pressure. The main difference between the operations is the pressure kept inside the stopper system, positive in sonic operation, and normally negative in low-pressure operation. Hence, the argon channel in the stopper is designed accordingly to cater to both situations mentioned here. There are various designs of argon channels, such as:

- 5 mm hole in Tip piercing type
- Porous plug in the argon channel (positioned in bore/at Tip)
- Recrystallised alumina tube with hole dia 1.5 mm to 2.5 mm



Among all, the 5 mm hole type is commonly used. However, controlled argon flow is not possible because maintaining back pressure with such a big hole is difficult. Flushing of the clogged material in the nozzle is achieved by pushing a large volume of argon. However, increasing the flow rate above the critical value reduces the refining effect because of the turbulent mixing of the metal and slag at the argon bubbles. Thus, putting control on argon flow is necessary. It has been achieved by putting a porous plug inside the stopper bore. The porosity of the plug ranges between 27-35% and acts as a positive pressure creator. The bubble size also gets reduced drastically, which further enhances the inclusion flotation.

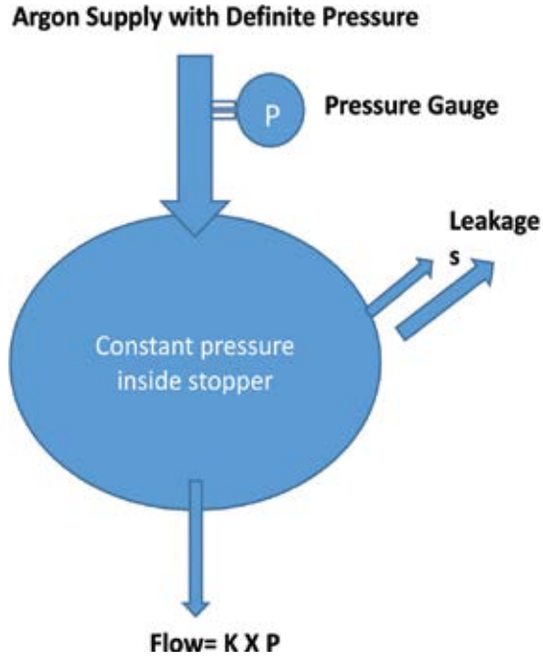
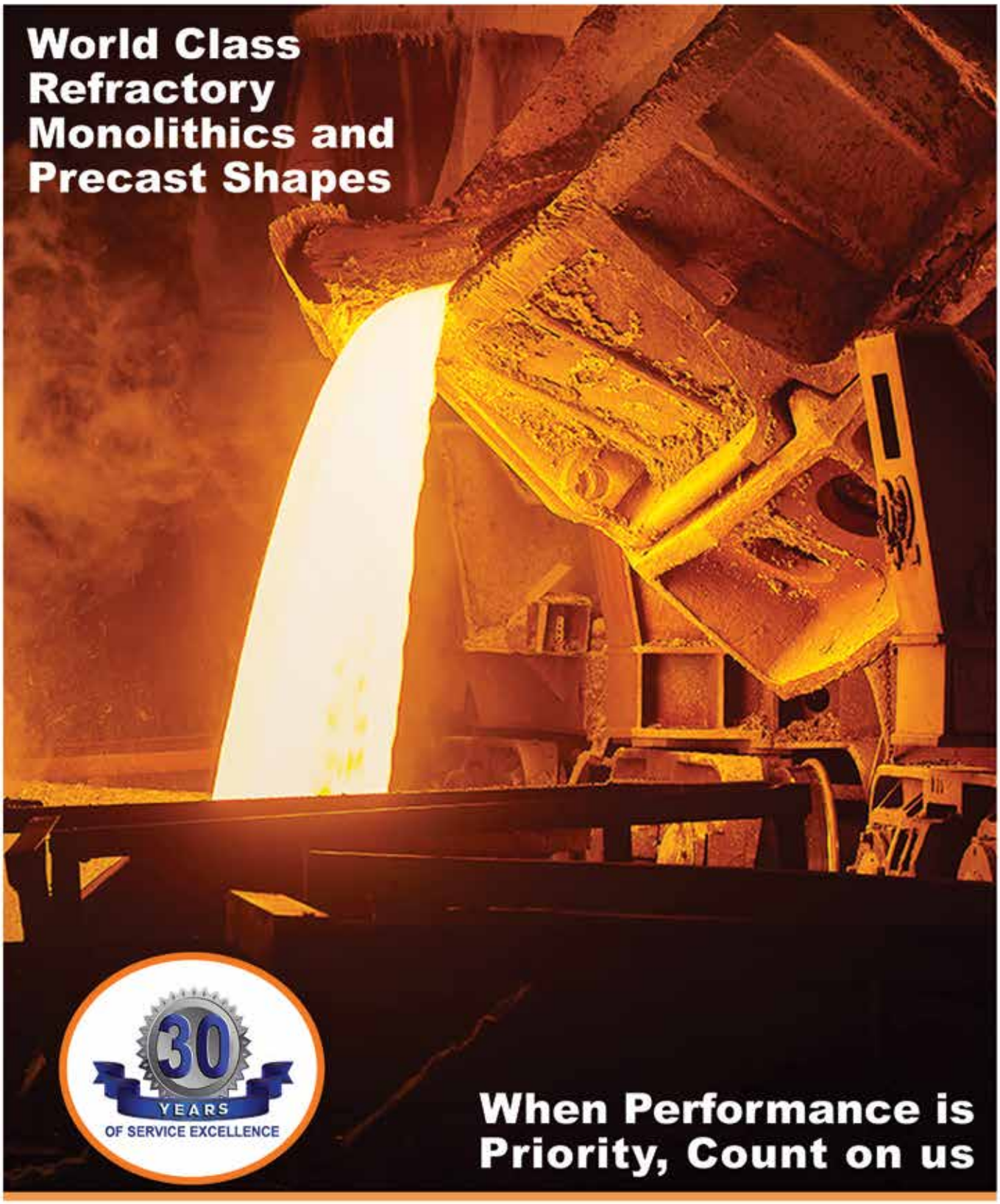


Fig. 1: Argon injection system through stopper with RCA tube



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Another way of controlling the argon flow, especially in sonic operation, is assured through the use of a recrystallised alumina tube on the stopper head, replacing a simple hole or a permeable plug. The hole diameter can be varied from 1.5 mm to 2.5 mm as per the requirement of the application. Fig. 1 explains how pressure builds up inside the stopper to control the flow.

The initial size of the bubble ($d_{b.in}$) generated through stopper tip perforation can be calculated based on the following formula[6]:

$$d_{b.in} = \sqrt[3]{\frac{6\sigma_{st} D_n Q_g}{g\rho_{st}}},$$

Where: D_n is the diameter of the injection aperture, g is the acceleration due to gravity (ms^{-2}), and p_{st} is the density of the molten steel kg m^{-3}. The bubble begins to grow as it floats up by coalescence. Its size may be calculated on the basis that, at the moment of a breakaway from the pore/hole, the uplift force on the bubble is equal to the restraining force due to the surface tension of the melt over the bubble perimeter. The gas density may be neglected here. Correspondingly, at the instant of breakaway from the injection nozzle, the bubble diameter $d_{b.br}$ is:

$$d_{b.br} = \sqrt[3]{\frac{3\sigma_{st} d_{b.in}}{2g\rho_{st}}}.$$

The most important factors in the effective removal of the inclusions are the flow rate of the injected gas and the bubble diameter. On the basis of the calculations, we may recommend argon bubbles of diameter $d_b \approx 3.0$-3.25 mm and gas flow rates Q_g = 10-12 L min^{-1} for the flotation of non-metallic inclusions in the tundish.

Conclusions

Production of clean steel is market-driven, and customers are demanding improved cleanliness on an ever-increasing scale. Stoppers of various designs equipped with argon injection capability help to improve inclusion flotation by limiting the initial bubble size. The useful refining process can be effective when the flow rate is 10-12 L min^{-1}, and the bubble diameter at breakaway from the pore is 1.75 mm. Argon bubble size increases with increasing gas flow rate and decreasing steel flow rate. At high gas flow rates above a threshold limit, a gas film may form to help prevent 6 nozzle clogging but create annular flow. Argon bubbles collect inclusions and greatly enhance their removal.

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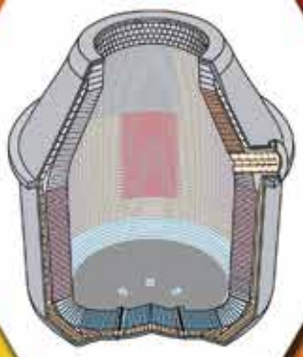
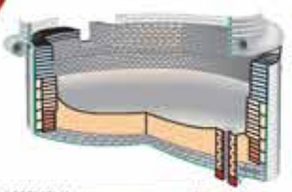
BOF

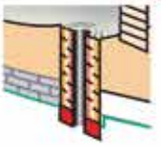


LADLE

EAF

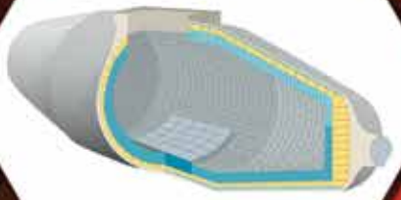


EBT ASSEMBLY



OUR PRODUCT RANGE

TORPEDO



OVERVIEW

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New Generation Refractories for Iron and Steelmaking

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India is the world's 2nd largest steel-producing country, with an annual production of over 110 million tonnes of crude steel and a production capacity of over 150 million tonnes of steel. The Make in India drive and the new Steel Policy of the Govt. of India is to ensure high-quality steel production and also enhance domestic steel consumption. This creates an opportunity for the technologically advanced and globally competitive steel industry. The Ministry of Steel-India, projection is that by 2030 India's crude steel annual production capacity will reach 300 million tonnes, with annual production expected to reach 255 million tonnes and per capita steel consumption to reach a level of 160 Kg, from presently around 70 kg.

Refractory products play an important role in the daily operations of many industries like Iron & Steel, Non-Ferrous, Glass, Cement, and others. However, Iron & Steel Industries are the largest consumers of refractory and, hence, refractories have become an integral part of iron and steel making. For a long time, the refractory industry has undergone many vital changes in terms of technological developments from various manufacturing processes and raw material combinations. On the other hand, the industry has always evolved with superior products to cope with the requirements of advanced steel-making practices.

This paper emphasizes the developments of some of the technologically advanced refractory products to meet the high-quality refractory needs of steel-making vessels like Steel Ladles, EAF, BOF, Torpedo & Hot Metal Ladle Linings, and BF Zone.

Introduction

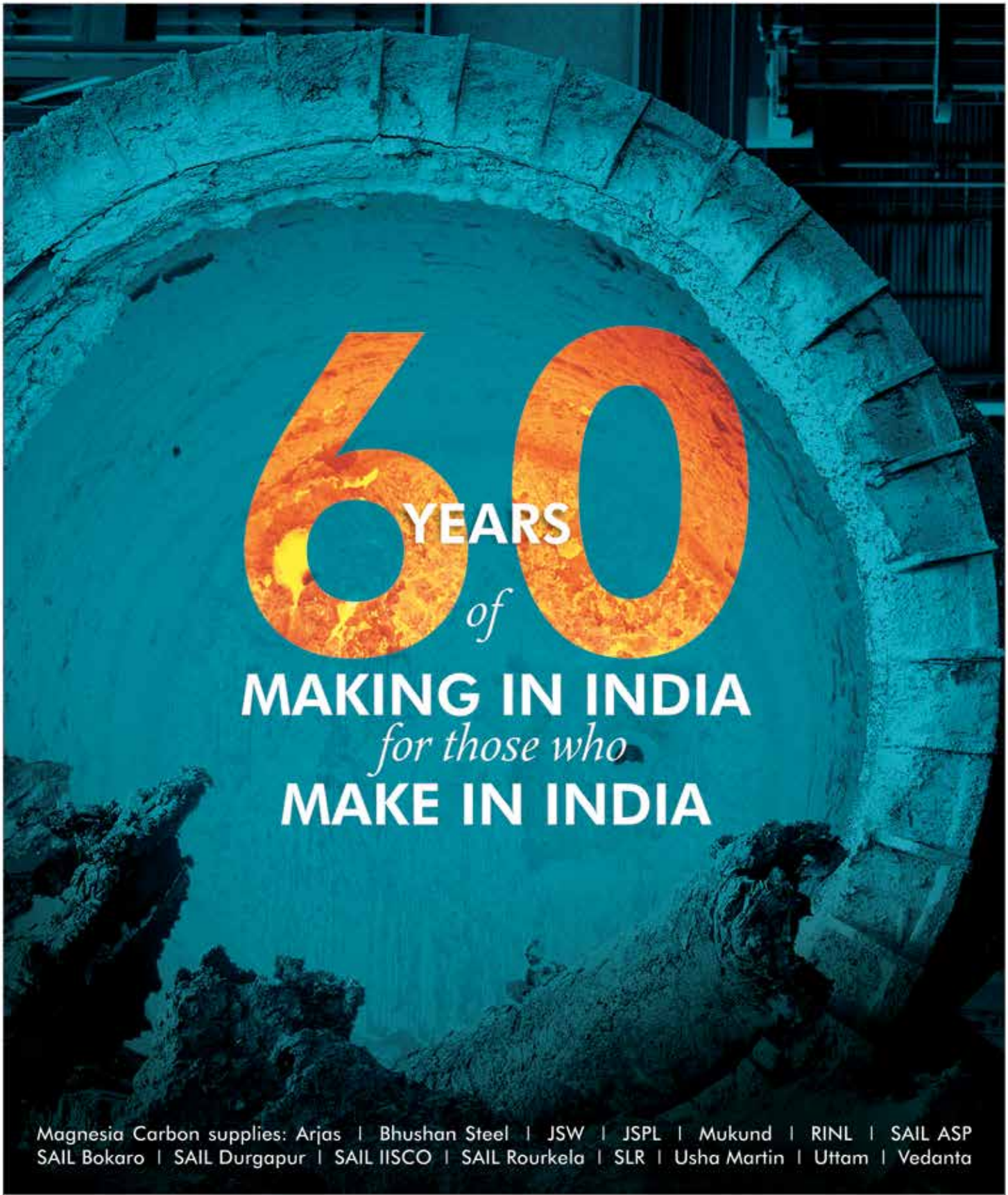
Refractories undergo very high thermal and mechanical erosion as well as chemical corrosion, due to molten steel & slag reactions with refractory linings. Hence, refractories are one of the major consumables in the steel industry. The global refractories market size is projected to reach USD 42.30 billion by 2027, exhibiting a CAGR of 3.6% during the forecast period [2020-2027] in the Market Research Report published in July 2020 by Fortune Business Insights.

Figure 1: India's Expected Strong Growth [2020-2027]

Since the promulgation of the "Atmanirbhar Bharat" initiative by the Government of India, refractory industries in India have revived adequately and are growing at a rapid pace. The steel industries of India are also supporting Indian refractory industries under the aegis of the Make in India drive. Further, the "Atmanirbhar Bharat" initiative by the Government of India is an inspiration and the driving force for the Indian refractory industry for manufacturing and development of next-generation refractory products in India.

The Jharkhand government is conducive to refractory manufacturing in the state. Refractory manufacturing units located in Jharkhand have the unique advantage of being in close proximity to steel plants, sea ports, and a number of quality raw materials. More than 40 million tonnes of steel manufacturing capacity are located in and around Jharkhand state. Energy and Water are also adequately available for these industries.

The refractory industry has to face the challenge of developing new generations of refractory products for technologically advanced steel-making processes. New steelmaking processes have emerged over the past few decades, considering the market requirements for cleaner steel. Steelmaking refractories need to withstand very high temperatures and show resistance to erosion and corrosion for longer process times at high temperatures. Simultaneously, there is a demand for high productivity, stringent process parameters, and cost economization.



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New generation refractory products have emerged globally and evolved over the years to prolong the campaign life of refractory lined vessels, ease of application, and reduce the overall cost of steel making. Some of the new generation refractory products are Spinel bricks for steel teeming ladles, superior qualities of MgO-C Bricks for Steel Ladles; EAF's & BOF linings; and Al_2O_3-SiC-C (ASC) Bricks for Torpedo, Hot Metal Transfer & Hot Metal pre-treatment ladle linings. In iron making, multiple tube (19 holes) Checker Bricks for BF Stoves need special mention as they have improved the efficiency of stoves and, in turn, the productivity of Blast Furnaces.

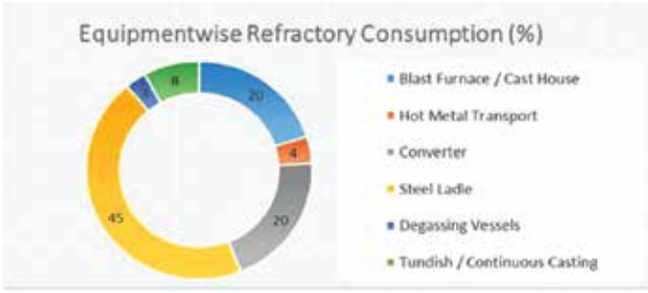

Fig.2: Equipment-Wise Refractory Consumption

In spite of the constraint of indigenous superior quality refractory raw materials, "Atmanirbhar Bharat" has given the thrust for the development of new generation refractories for Iron & Steel making and enriched Indian refractory product portfolio with products as below:

- MgO-C Bricks for Steel Ladles, EAF & BOF Linings
- Spinel Bricks for Steel Ladle Linings
- Al_2O3-SiC-C (ASC) Bricks for Torpedo, Hot Metal Treatment Ladles
- Multiple Tubes Chequer Bricks for BF Stoves etc.

Carbon-containing basic refractories evolved with improved slag corrosion resistance. Until the 1990s, steel ladle refractories were majorly comprised of fired high alumina bricks. Steel ladle lining performance was low, and hence, the specific consumption of bricks was high. Refractory consumption of steel melt shops in the 90's was in the range of 12–15 kg/TLS and now it has been reduced to the range of 4–7 kg/TLS. Manufacturing of clean steel started following basic slag practice, which required higher grade refractories with greater corrosion resistance than basic slag. Also developed Al_2O_3-MgO-C (AMC) Bricks with high abrasion resistance for impact areas like the bottom and side walls of Steel Ladles.

Further, in view of IF grade or ultra-low or no carbon steel and electrical grade steel manufacturing, the Indian refractory industry has successfully developed Al_2O_3-MgO Spinel Bricks for Ladle Bottom and Metal Zone.

Iron zone also observed changes in the practice of desiliconization, dephosphorization & desulphurization of hot metal. Hence, new generation refractories with improved slag corrosion resistance in their Torpedo Ladles, KR Ladlesand Transfer Ladles which led to the evolution of Al_2O_3-SiC-C (ASC) refractories. Also demand for higher productivity has strong intent for multiple tubes (holes) in chequer bricks for BF Stoves.

New Generation MgO-C Refractories in India

To meet the production of good quality MgO-C Bricks, the technical challenge to the Indian refractory industry is to develop new raw materials, improved formulations, and additives. There is also a need to install high-precision presses and high-intensity mixers to achieve consistent properties of MgO-C refractories.

The main ingredients for superior quality Mg0-C bricks are high purity graphite, DBM, and FM. Indian manufacturers were solely dependent on China for those ingredients. After the 2017 China crisis for steel plant refractories and refractory raw materials, the Indian refractory industry strongly ventured into the manufacturing of new generation refractories in India. Initially, they were mostly dependent on Chinese raw materials. However, as of today, more than 50% of raw materials sources developed are outside of China, and the journey is on to further reduce China's raw materials dependence.

Table1: Raw Material Source Dependence

Raw Material or Ingredient	Quality	Source China %	Source Non-China %
Magnesite raw materials	DBM 97	20	80 (Japan, Turkey, Australia)
	FM 97	60	40 (Japan, Turkey, Australia)
	FM 97.5	60	40 (Japan, Turkey, Australia)
	FM 97.8 LC	60	40 (Japan, Turkey, Australia)
Flake Graphite	>1= 96% F.C.	0	100
Pitch Powder	Carbores	0	100
Resin	Phenolic	0	India
Antioxidant additives	Al or Si Metal Powders	0	India
Alumina raw materials	Tabular Alumina	10	90 (India - Shortly)
	Alumina-Mag Spinel	50	50
	WFA	40	60

Ladle and EAF Bricks are developed according to individual steel plant operating conditions. Also, there has been development of various raw material combinations suitable for respective operating parameters.

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Table 2: MgO-C Bricks Product Specifications

Properties	Steel Ladle		EAF	
Chemical Properties	**MZ & Bottom**	**Slag Zone**	**Slag Line**	**Hot Spot**
MgO (%)	97.0	97.5	97.5	97.8
CaO (%)	1.60	1.40	1.40	1.20
SiO_2 (%)	0.80	0.60	0.60	0.50
Al_2O_3 (%)	0.15	0.10	0.10	0.10
Fe_2O_3 (%)	0.45	0.40	0.40	0.40
C (%)	10.0	14.0	15.0	15.0
Physical Properties				
A.P. (%)	5	4	4	4
B.D. (g/cc)	3.08	3.05	3.05	3.05
CCS (kg/cm')	400	400	400	400
Other Properties				
CMOR at room temp (kg/cm^2)	125	115	115	115
HMOR at 1400°C (kg/cm^2)	100	90	90	90

Make in India, new generation MgO-C bricks' performances are at par with imported products and have achieved more than guarantee performance in 90% of steel ladles with varied capacity from 35 to 250 tonnes capacity steel ladles. Also, indigenously developed MgO-C EAF bricks performed up to 500heats in 100T capacity EAF with 100% coal base DRI charging.

Table 3: MgO-C Brick Performances

Steel Ladle Set Performance in India (As on 31st March 2022)

S. No.	Capacity	Quantity Evaluated	Guaranteed Life	Achieved Life
I.	150	35	130	140.80
2.	66	21	70	76.04
3.	60	18	27	35.25
4.	130	5	70	72.50
5.	130	2	80	111.00
6.	130	99	70	78.19
7.	180	85	40	42.19
8.	210	9	100	97.40
9.	160	10	105	97.70
10.	135	5	210	203.56
11.	180	5	170	162.10
12.	210	5	135	128.00
13.	65	5	125	127.00
14.	150	137	95	96.76
15.	150	67	70	71.40
16.	40	11	90	87.30
17.	70	5	90	90.40
18.	100	7	90	111.00
19.	75	7	50	56.00
20.	250	11	115	124.00
21.	100	92 1	30	138.00
22.	60	16	110	112.00
23.	60	85	150	152.50
24.	50	65	110	114.00
25.	35	24	110	117.00
26.	35	8	100	110.00

Alumina-Silicon Carbide-Carbon (ASC) Bricks for Torpedo Ladle Car Linings

Presently, 45% of steel production in India is through an integrated route (BF-BOF-LRF-RH) and is expected to increase to 60% in coming years. ASC bricks are mainly used for refractory linings of Torpedo Car Ladles, Iron Transfer Ladles, Hot Metal pre-treatment (KR) ladles, and Hot Metal Mixers in integrated steel plants. This paper presents the development and application of ASC Bricks in Torpedo ladle linings. Aiming to present as a success story on ASC bricks performances in Torpedo Car Ladle Linings.

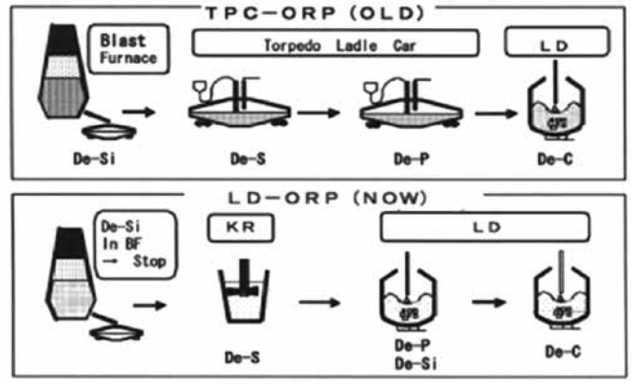

Fig.3: Process Flow For Hot Metal Handling

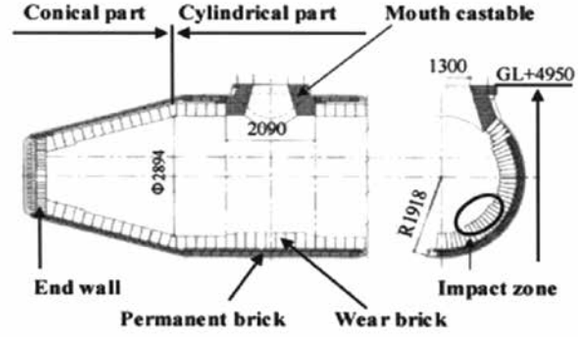

Fig. 4: General Layout For Torpedo Linings

ASC Bricks - Product Information

Table 4: Typical Properties of ASC Brick

Properties	Typical Value
Chemical Properties	
Al_2O_3 (%)	78.9
SiC (%)	10.3
F.C. (%)	10.7
Physical Properties	
A.P. (%)	5.2
B.D. (g/cc)	3.1
CCS (kg/cm^2)	545
Other Properties	
CMOR	98
PLC at 1500°C/ 3hrs (%)	+ 0.13

Table 5: Torpedo Ladle Refractories Performance

Description	Mix Lining (Al_2O_3+ASC Impact) Life in no. of heat cycles		ASC working Lining (Wall + Impact) Life in no. of heat cycles
Torpedo Capacity - 300 MT	1st Set	2nd Set	3rd Set
Performance (No of Tap Cycles)	1132	1286	1443
Specific Refractory Consumption (kg/TLS)	0.55	0.45	0.40

Spinel (Alumina-Magnesia) Bricks for Steel Ladle Linings:

We evaluated our journey on the development and application of Spinel bricks in Steel Ladles used for secondary refining of liquid steel in steel melt shops. Technological advancements in steel making, like Ultra-Low Carbon Steels (like IF grade steel) manufacturing, create an extraordinary demand for the requirement of Low/No Carbon Refractories for secondary refining vessels like Steel Ladles. Also, it is today's demand on possibilities for alternate solutions to environmentally harmful chrome containing refractories. It is anticipated that the importance of Spinel bricks will continue to grow in coming years to meet the challenging requirements of steel making processes.

The need for clean steel is known to all of us. For any grade of steel with minimum or very low impurities, common trace elements like Phosphorous and Sulphur and gas elements like Nitrogen, Oxygen, and Hydrogen etc. However, 20 to 30 ppm of carbon content in the case of IF grade (Interstitial free) steels, or max 50 ppm of each Sulphur and carbon in Electric grade steels, demands more stringent secondary refining requirements like RH degassing or Vacuum degassing etc.

The Advantages of Spinel Ladle Bricks over Conventional Carbon-Containing Refractories:

- Ease of secondary refining of ultra-low Carbon Steel (IF grade steel) and no Carbon pick up in steel from refractory lining.
- To enhance MZ (Metal Zone) and bottom lining life of ladles to increase ladle life and, in succession, ladle turn-around.
- Reduced specific consumption of ladle refractories, resulting in a cost reduction. Also, indirect savings like reductions in preheating & manpower expenses.
- Spinel Linings are more reliable in terms of safety as compared to conventional unfired products because any imperfection will be surfaced during high temperature firing.
- Environmentally friendly refractories. Push for an eco-friendly environment.
- Increase reliance on indigenous raw materials for refractories and reduce reliance on imported magnesia raw materials, primarily from China.
- Reduction in inventory and improved inventory management by having local sources and also optimization of working capital and other financial benefits. Spinel bricks' material is recyclable by simple and hassle-free processes.
- Energy saving because of less heat loss due to heat radiation through the ladle lining and shell. This is due to the lower thermal conductivity of Spinel Bricks (3 W/m.K) as compared to MgO-C bricks (10 W/m.K).

Alumina-Magnesia Spinel brick is the most widely accepted and most prominent option to meet stringent secondary refining parameters.

Alumina-Magnesia Spinel bricks are developed with special characteristics such as volume stability during application, better spalling resistance, less slag penetration, and improved slag corrosion resistance. A-M spinel bricks were installed in 130 and 180 MT capacity ladles in one of the largest integrated steel plants in India. Performances are encouraging, as per below.

Spinel Product Information

We developed alumina spinel bricks with the desired chemical and physical properties as mentioned in Table 6.

Table 6: Typical Properties of Spinel Brick

Properties	Typical Value
Chemical Properties	
Al_2O_3 (%)	94.36
Fe_2O_3 (%)	0.21
SiO_2 (%)	0.32
TiO_2 (%)	0.02
MgO (%)	4.78
Na_2O+K_2O (%)	0.31
Physical Properties	
A. P. (%)	15.9
B.D. (g/cc)	3.16
CCS (kg/cm^2)	1112
Other Properties	
Thermal Shock at 1350°C (no of WQ cooling Cycles)	7
HMOR at 1400°C (kg/cm^2)	95.8
PLC at 1600°C/ 5hrs (%)	+ 0.06
RUL (ta°C)	1720 (ND)

Application and Case Study

Alumina Spinel Bricks are used in 05 Ladles, each with a capacity of 130 MT and 180 MT, respectively. The lining pattern is followed as per the existing practise in the steel plant.

Table 7: Spinel Bricks performance compared with MgO-C Bricks

Description	Ladle Capacity - 130 MT		Ladle Capacity - 180 MT	
	MgO-C Bricks	Spinel Bricks	MgO-C Bricks	Spinel Bricks
Ladle Metal Zone (MZ) & Bottom Life (Heats)	140	195	145	165
Specific Consumption MZ+B (kg/TLS)	0.95	0.60	0.85	0.75
Carbon Pickup from working lining (ppm)	NA	02-05 ppm	NA	02-05 ppm

Conclusions

Make in India "New Generation Refractories" enabled Indian refractory producers to enhance the product range with superior quality new generation refractory products. India is heading towards reducing its dependence on China for FM & DBM based refractories. Made in India, MgO-C & AMC products are performing up to bench mark levels in steel ladles up to 250 T capacity and improving further. Also, superior quality EAF MgO-C bricks have achieved satisfactory results in 100 T capacity EAF's. The Al_2O_3-SiC-C (ASC) bricks developed in India have performed above satisfactory levels. Alumina Spinel Bricks have been successfully developed to achieve higher performance and minimum or no carbon pick up from the working lining in steel ladles. Indigenously developed Spinel-bricks will be the cost effective solution for Steel Ladles, Metal Zones and Bottom Linings with reduced specific consumption of refractories.

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Dawn of New Drives and Automation Systems by Japanese Technology

Innovating Technology from Japan known as the Land of Rising Sun. Fuji Electric (Est. 1923) becomes 99 years old company along with Japanese industry and 50% plus share in the Automation Systems for the steel long product proven by its advanced technology.

Edited by Yoshifumi TOKIWA
General Manager, Project Engineering, Fuji Gemco Pvt. Ltd, India

Fuji Electric have shown its presence in Japanese domestic steel industrial market by its advanced technology, and started a JV company "Fuji Gemco Pvt. Ltd" Faridabad in India since 2016 for contributing of the growth of Indian Industry. Its Japanese Technology and Quality have been already available in Indian Steel Industry as proven by some records like "Individual Block Mill System (MICREXdrive WRM)", "8 MTCs and 9 Loops Bar Rolling Mill System (MICREXdrive BRM / HDS)" and so on.

Introduction

Indian history of Iron and Steel has existed since the "Iron Pillar of Delhi" was constructed, back in 415 AD. Furthermore, nowadays India has the second largest crude steel production with high growth of 17.8% in 2021 (as reported by The World Steel Association, WSA). These facts indicate that India is the hub of Iron & Steel and has potential of further growth. However, this industry has a huge impact on the environment due to carbon emissions.

This paper indicates the dawn of new era by cost effective solutions provided by rich experience and expertise of Fuji Gemco in Indian industry based on Japanese technology from Fuji Electric.

Our Missions

As a company, which has been selected as a component of "Dow Jones Sustainability Indices (DJSI)" of the world's sustainability-driven companies for the 17th consecutive year (2021), Fuji Electric strictly follows the environmental guidelines enforced in India by the government.

Fuji Gemco as a member of Fuji Electric group delivers state-of-the-art controls and drives & automation systems to contribute to the rise in the Indian industry.

Innovative Technologies from JAPAN

Famously known by the word "KAIZEN", Japanese industries are determined for continuous innovation to improve the process and quality. Besides, Fuji Electric became a leader of drives & automation systems provider in Japan. Some of the latest innovations from Fuji Electric include:

Fig.1: Fuji Electric Group (Japan, India)

Process Model Driven Control built in our Key Components

Fuji Electric has developed the unique control theories and methods which are based on the process model. These technologies are built into our drives and PLC as follows.

- "Fuji Observer Theory" can estimate the load torque and compensate differences between nominal model and actual. This method is applied in drives and controllers as "Fuji Tuning Less Control (TLS)", "Fuji Observer theory Speed Compensation control (FOSC)", "Fuji Observer theory based Minimum Tension Control (F-MTC)" and so on.
- PID parameters can be calculated and suggested on SCADA system automatically based on the process model. As mentioned above, each parameter and control value can be given as per the process nominal model, hence it will achieve high response and robustness, despite variable and tough environment like in a rolling mill process.

Fuji High Speed PDA System: f(s) NISDAS

f(s) NISDAS is a Process Data Acquisition (PDA) system which is developed by Fuji Electric, and support stabilized production and easy trouble shooting by following features.

- High Speed: Sampling time is minimum i.e.~ 1ms
- Long-term Storage: 4 months or more
- Flexibility & Usability: Multi window, 32k Tags

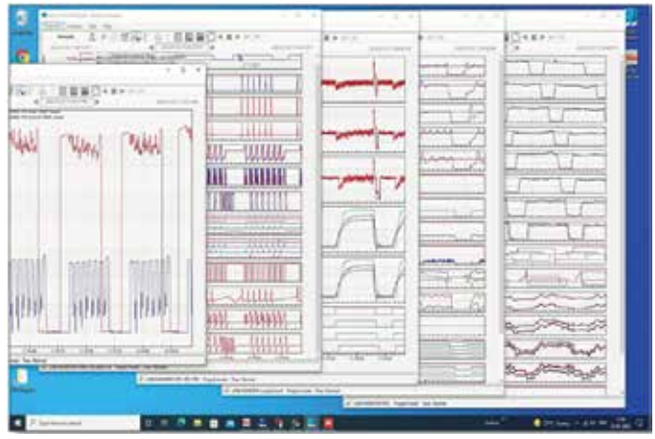

Fig.3: NISDAS Analyzer Multi Monitor Viewing

Fuji Rolling Mill System Package: MICREXdrive

To achieve the highest performance, Fuji Electric and Fuji Gemco launched the optimized system package for each rolling mill system in India. Japanese/Indian specialists provide full support during and post installation.

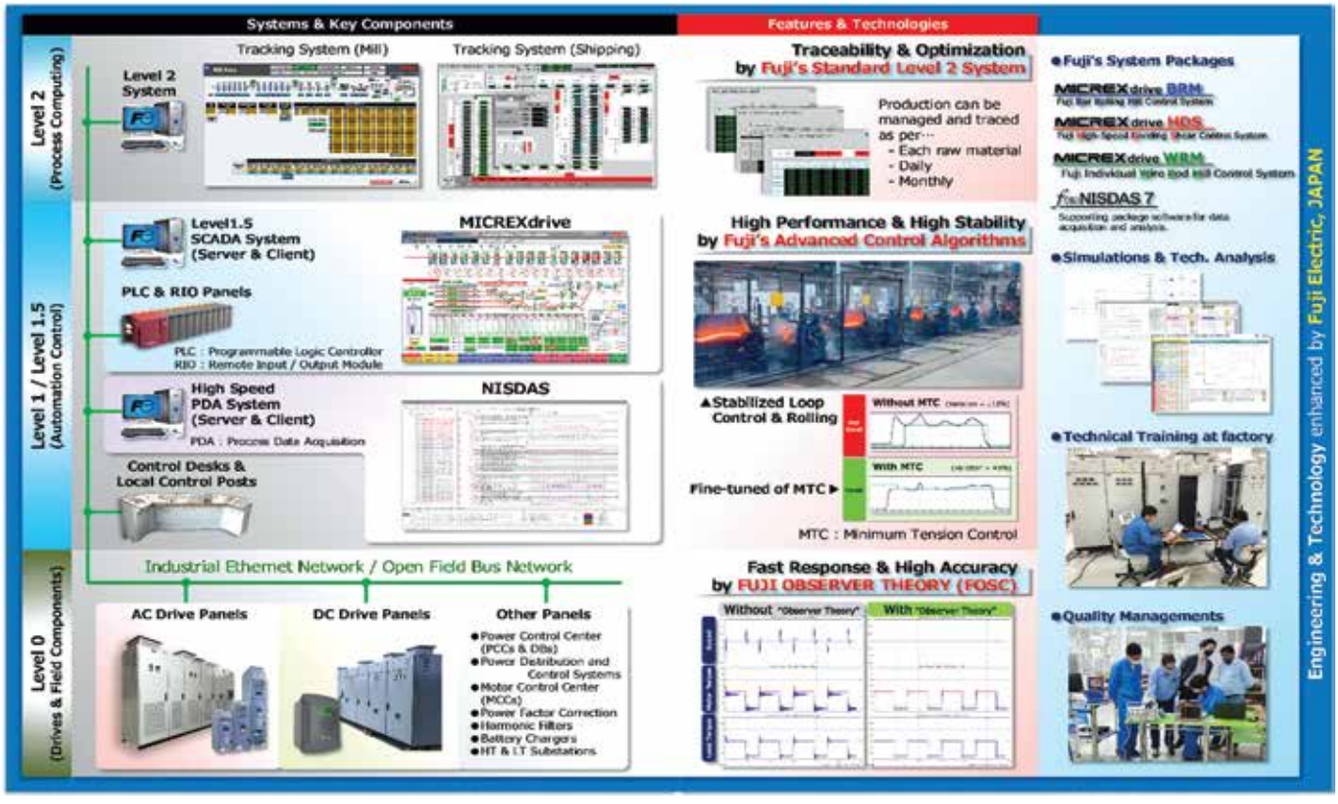

Fig.2: Engineering & Technology enhanced by Fuji Electric, Japan

Fuji Bar Rolling Mill System: MICREXdrive BRM

MICREXdrive BRM give advantages for production shape, stabilized rolling and easy operation. All mill stands are synchronized smoothly and keep correct tension as specified by observer based technologies.

Table.1: Feature & Benefits of MICREXdrive BRM

MICREXdrive BRM Fuji Bar Rolling Mill Control System	Benefits
Fuji Minimum Tension Control (F-MTC)	Improve Production Shape
Fuji Loop Regulation Control (F-LRC)	Stabilize Rolling Process
Fuji Bite Compensation Control (F-IMP)	Reduce Operation Error
Auto Calculation Logic of PID parameter	Easy Tuning & Maintenance

In the last year, multiple MICREXdrive BRM and HDS have been installed successfully in India. One of these plants has 8 minimum tension controls and 9 loop regulations against 18 stands single slitting mill (0.4 Mton/year, 21 m/s at 8 mm). Currently, 3 projects are under construction with MICREXdrive BRM / HDS, and coming soon in 2022 and 2023.

Fig.4: Roughing Mill Train with F-MTC

Fig.4: Roughing Mill Train with F-MTC

Fuji High-Speed Shear System: MICREXdrive HDS

MICREXdrive HDS contribute for high accuracy cutting and stable production by high-speed control cycle 1 ms. Furthermore, this system is available for each braking system like tail braking pinch roll, twin channel, rotary drum and braking apron.

Fig.6: Cut Accuracy

Table.2: Feature & Benefits of MICREXdrive HDS

MICREXdrive HDS Fuji High-Speed Dividing Shear Control System	Benefits
High Speed Control Cycle (1ms)	High Accuracy of Cutting
Fuji First Cut Compensation Control	High Speed Rolling
Cut by Cut Length Tuning Function	Easy Maintenance by reducing Absolute Encoder
Fuji Cycle Pulse Detection Logic (CYPL)	

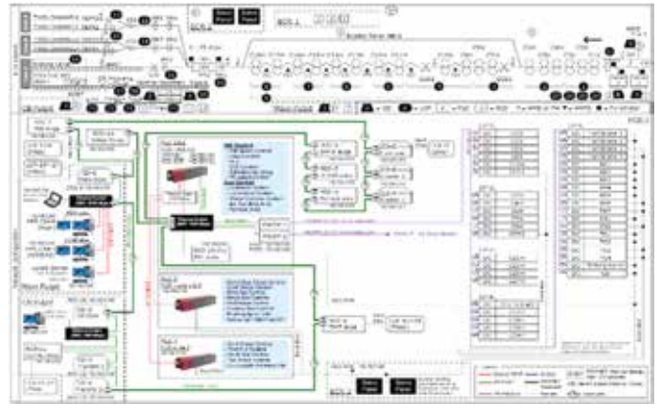

Fig.7: System Configuration of MICREXdrive BRM/HDS

Fuji Individual Wire Rod Mill System: MICREXdrive WRM

The first successful Individual Block Mill system in India was done using MICREXdrive WRM in 2020 in Hyderabad. This innovating technology changed the current trend and brought the chance to expand the wire rod mill industries.

Table.3: Feature & Benefits of MICREXdrive WRM

MICREXdrive WRM Fuji Individual Wire Rod Mill Control System	Benefits
High Speed PLC "MICREX-SX"	Easy Maintenance
- Individual Speed Synchronization	Energy & Cost Saving
- High Speed Control Cycle (1ms)	Easy Installation
High Performance AC Drive "FRENIC-VG"	Flexible Rolling Operation
- Inbuilt Bite Compensation Logic	Roll Long Campaigning
- Fuji Tuning Less Control (TLS)	Improve Production Shape
	Stabilize Rolling Process

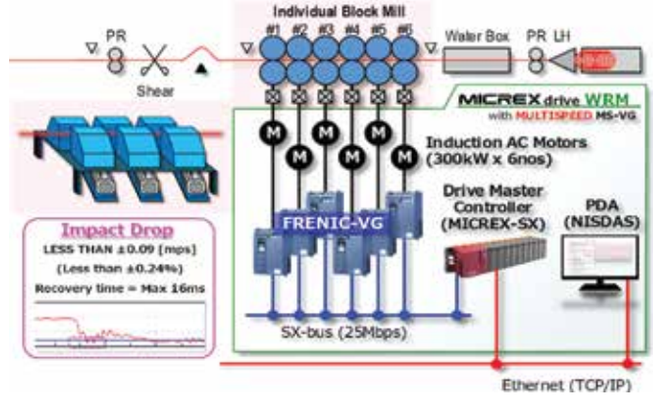

Fig.8: System Configuration of MICREXdrive WRM

Conclusion

Drives & Automation systems is the one of the important factor in rolling mill plant having large consumption of energy as well as resources. Fuji Gemco and Fuji Electric will keep providing world class automation solutions and will continue to contribute to the Indian Iron and Steel Industry by delivering advanced technologies and products. ■

GEMCO

Innovating Energy Technology

Dawn of New Drives and Automation Systems **by Japanese Technology**

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DC Drive System
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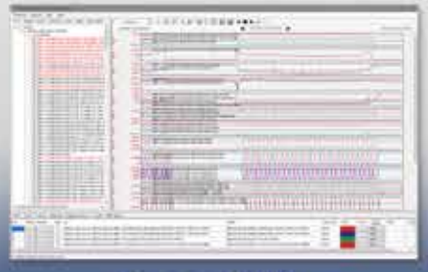

Traceability

MICREX drive BRM
Fuji Bar Rolling Mill Control System

High Performance

Fuji's Simulations & Analysis Tech.

Reliability

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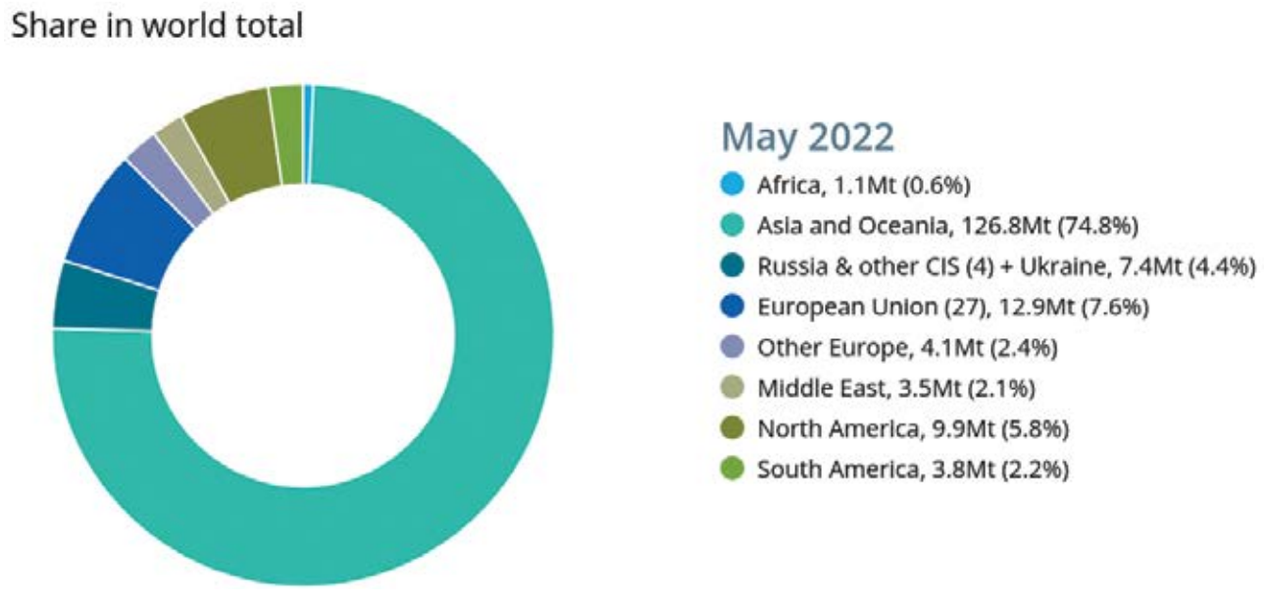
World Crude Steel Production

May - 2022



Contd...

Crude Steel Production by Region				
Regions	**May 2022 (MT)**	**% Change May 22/21**	**Jan-May 2022 (MT)**	**% Change Jan-May 22/21**
Africa	1.1	-18.9	6.1	-7.0
Asia and Oceania	126.8	-1.7	582.0	-6.5
EU (27)	12.9	-6.8	62.3	-4.3
Europe, Other	4.1	-1.7	20.2	-3.5
Middle East	3.5	-10.0	17.0	-6.1
North America	9.9	-4.0	47.5	-2.3
Russia & other CIS + Ukraine	7.4	-19.1	38.4	-13.1
South America	3.8	-2.8	18.1	-2.4
Total 64 countries	**169.5**	**-3.5**	**791.8**	**-6.3**

The 64 countries included in this table accounted for approximately 98% of total world crude steel production in 2021
MT – Million Tonnes

Top 10 Steel-Producing Countries				
Countries	**May 2022 (MT)**	**% Change May 22/21**	**Jan-May 2022 (MT)**	**% Change Jan-May 22/21**
China	96.6	-3.5	435.0	-8.7
India	10.6	17.3	53.2	6.5
Japan	8.1	-4.2	38.5	-3.5
United States	7.2	-2.6	34.3	-1.6
Russia	6.4 e	-1.4	31.0	-2.3
South Korea	5.8	-1.4	28.2	-3.4
Germany	3.2	-11.5	16.4	-4.8
Turkey	3.2	-1.4	16.0	-2.8
Brazil	3.0	-4.9	14.5	-2.2
Iran	2.3 e	-17.6	11.4	-10.8

e – estimated. Ranking of top 10 producing countries is based on year-to-date aggregate
MT – Million Tonnes

Courtesy: worldsteel.org

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DOMESTIC

Performance of the Indian Steel Industry in April-June, 2022-23

Share of PSU/Private Sector

Item	April-June, 2022-23 (p)	April-June, 2021-22	% Change (p)
Crude Steel - PSU	5.340	5.131	4.1
Crude Steel - Private	26.051	22.855	14.0
Total Finished Steel - PSU	4.133	3.917	5.5
Total Finished Steel - Private	25.031	22.560	11.0

Source: JPC; Units in MT

Major highlights:

- **Crude Steel:** Private Sector (26.051 mt, up by 14.0%) accounted for 83%, the rest being the share of PSUs
- **Total Finished Steel:** Private Sector (25.031 mt, up by 11.0%) accounted for 86%, the rest being the share of the PSUs

Share of Other Producers

Item	April-June, 2022-23 (p)	April-June, 2021-22	% Change (p)
Crude Steel - Other Producers	12.173	10.578	15.1
Crude Steel - SAIL, RINL, TSL Group, JSW, JSPL, AM/NS	19.218	17.408	10.4
Total Finished Steel - Other Producers	12.563	11.012	14.1
Total Finished Steel - SAIL, RINL, TSL Group, JSW, JSPL, AM/NS	16.601	15.464	7.4

Source: JPC; Units in MT

Major highlights:

- **Crude Steel:** SAIL, RINL, TSL GROUP, AM/NS, JSWL, JSPL (19.218 mt, up by 10.4%) accounted for 61%, the rest 39% being the share of the Other Producers (up by 15.1%)
- **Total Finished Steel:** SAIL, RINL, TSL GROUP, AM/NS, JSWL, JSPL (16.601 mt, up by 7.4%) accounted for 57%, the rest 43% being the share of the Other Producers (up by 14.1%)

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Crude Steel Production

April-June, 2022-23 (Provisional)

(In '000 Tonnes)

Producers	June			June Vis-A-Vis May			April-June		
	2022-23 (Prov.)	2021-22 (Final)	% Variation	June (Prov.)	May (Prov.)	% Variation	2022-23 (Prov.)	2021-22 (Final)	% Variation
A. SAIL	1395	1303	7.1	1395	1489	-6.3	4332	3770	14.9
B. TSL GROUP	1722	1516	13.6	1722	1649	4.4	5116	4626	10.6
C. RINL (VSP)	360	441	-18.3	360	359	0.4	1008	1360	-25.9
D. AM/NS (ESSAR) + JSWL + JSPL	2921	2527	15.6	2921	3079	-5.2	8762	7652	14.5
E. OTHERS	4058	3590	13.0	4058	4048	0.2	12173	10578	15.1
PRODUCTION	**10455**	**9377**	**11.5**	**10455**	**10624**	**-1.6**	**31391**	**27986**	**12.2**
Total PSU Production	**1755**	**1744**	**0.6**	**1755**	**1848**	**-5.0**	**5340**	**5131**	**4.1**
% Share of PSU	**16.8**	**18.6**		**16.8**	**17.4**		**17.0**	**18.3**	

Note: 1. The production figures of SAIL, RINL & TSL are as reported. 2. The production figures of AM/NS, JSWL & JSPL are estimated as per the production trend of previous months from April 2022.
3. The production of Other Producers are estimated as per the receipt status and the production trend of previous months from April 2022.

Hot Metal Production

April-June, 2022-23 (Provisional)

(In '000 Tonnes)

Producers	June			June Vis-A-Vis May			April-June		
	2022-23 (Prov.)	2021-22 (Final)	% Variation	June (Prov.)	May (Prov.)	% Variation	2022-23 (Prov.)	2021-22 (Final)	% Variation
A. SAIL	1497	1383	8.3	1497	1615	-7.3	4694	4135	13.5
B. TSL GROUP	1651	1626	1.5	1651	1645	0.4	4914	4847	1.4
C. RINL (VSP)	383	471	-18.6	383	380	0.8	1113	1542	-27.8
D. AM / NS (ESSAR) + JSWL + JSPL	2500	2070	20.8	2500	2577	-3.0	7501	6340	18.3
E. OTHERS	657	708	-7.2	657	641	2.5	1970	2055	-4.2
PRODUCTION	**6687**	**6256**	**6.9**	**6687**	**6857**	**-2.5**	**20191**	**18920**	**6.7**
Total PSU Production	**1880**	**1853**	**1.5**	**1880**	**1995**	**-5.8**	**5807**	**5677**	**2.3**
% Share of PSU	**28.1**	**29.6**		**28.1**	**29.1**		**28.8**	**30.0**	

Note: 1. The production figures of SAIL, RINL & TSL are as reported. 2. The production figures of AM/NS, JSWL & JSPL are estimated as per the production trend of previous months from April 2022.
3. The production of Other Producers are estimated as per the receipt status and the production trend of previous months from April 2022.

Finished Steel Production

April-June, 2022-23 (Provisional)

(In '000 Tonnes)

Producers	June			June Vis-A-Vis May			April-June		
	2022-23 (Prov.)	2021-22 (Final)	% Variation	June (Prov.)	May (Prov.)	% Variation	2022-23 (Prov.)	2021-22 (Final)	% Variation
A. SAIL	1121	1002	11.9	1121	1199	-6.5	3497	3028	15.5
B. TSL GROUP	1582	1506	5.0	1582	1611	-1.8	4737	4570	3.7
C. RINL (VSP)	285	288	-0.9	285	207	37.8	636	889	-28.5
D. AM / NS (ESSAR) + JSWL + JSPL	2557	2259	13.2	2557	2716	-5.9	7731	6977	10.8
E. OTHERS	4164	3674	13.3	4164	4195	-0.7	12563	11012	14.1
PRODUCTION	**9710**	**8730**	**11.2**	**9710**	**9927**	**-2.2**	**29164**	**26476**	**10.2**
Total PSU Production	**1406**	**1290**	**9.0**	**1406**	**1406**	**0.1**	**4133**	**3917**	**5.5**
% Share of PSU	**14.5**	**14.8**		**14.5**	**14.2**		**14.2**	**14.8**	

Note: 1. The production figures of SAIL, RINL & TSL are as reported. 2. The production figures of AM/NS, JSWL & JSPL are estimated as per the production trend of previous months from April 2022.
3. The production of Other Producers are estimated as per the receipt status and the production trend of previous months from April 2022.

Finished Steel - Production, Imports, Exports, Availability & Consumption

April-June, 2022-23 (Provisional)

(In '000 Tonnes)

Producers	Finished Steel								
	Non-Alloy Steel			Alloy & Stainless Steel			Total		
	2022-23 (Prov.)	2021-22 (Final)	% Variation	2022-23 (Prov.)	2021-22 (Final)	% Variation	2022-23 (Prov.)	2021-22 (Final)	% Variation
a) Production									
SAIL	3476	2973	16.9	22	54	-60.3	3497	3028	15.5
TSL GROUP	4609	4477	2.9	129	94	37.5	4737	4570	3.7
RINL	636	889	-28.5	0	0		636	889	-28.5
AM/NS (ESSAR) + JSWL + JSPL	7503	6792	10.5	228	185	22.8	7731	6977	10.8
OTHERS	11153	9690	15.1	1410	1322	6.7	12563	11012	14.1
Total Production	**27376**	**24821**	**10.3**	**1788**	**1655**	**8.0**	**29164**	**26476**	**10.2**
b) Imports	618	773	-20.1	555	385	43.9	1172	1158	1.2
c) Exports	1885	3325	-43.3	306	232	31.9	2191	3557	-38.4
d) Availability (a + b - c)	**26108**	**22268**	**17.2**	**2037**	**1809**	**12.6**	**28146**	**24077**	**16.9**
Opening Stock	7809	8843		178	124		7987	8967	-10.9
Closing Stock	8249	7878		197	177		8446	8055	
e) Variation in Stock	**440**	**-965**		**19**	**53**		**459**	**-912**	
f) ASU (Consumption)	**25668**	**23234**	**10.5**	**2019**	**1756**	**15.0**	**27687**	**24989**	**10.8**

Note : 1. The production figures of SAIL, RINL & TSL Group are as reported.
2. The production figures of AM/NS, JSWL & JSPL are estimated as per the production trend of previous months from April 2022.
3. The production of Other Producers are estimated as per the receipt status and the production trend of previous months from April 2022.

Finished Steel - Production, Imports, Exports, Availability & Consumption

June 2022 Vis-A-Vis May 2022 (Provisional)

(In '000 Tonnes)

Producers	Finished Steel								
	Non-Alloy Steel			Alloy & Stainless Steel			Total		
	June (Prov.)	May (Prov.)	% Variation	June (Prov.)	May (Prov.)	% Variation	June (Prov.)	May (Prov.)	% Variation
a) Production									
SAIL	1109	1190	-6.8	12	8	42.9	1121	1199	-6.5
TSL	1539	1566	-1.7	43	45	-4.8	1582	1611	-1.8
RINL	285	207	37.8	0	0		285	207	37.8
AM/NS (ESSAR) + JSWL + JSPL	2481	2629	-5.6	76	87	-12.9	2557	2716	-5.9
OTHERS	3708	3718	-0.3	456	477	-4.4	4164	4195	-0.7
Total Production	**9123**	**9310-**	**2.0**	**587**	**618**	**-5.0**	**9710**	**9927**	**-2.2**
b) Imports	211	205	2.7	239	184	30.2	450	389	15.7
c) Exports	470	723	-35.0	168	69	145.7	638	792	-19.4
d) Availability (a + b - c)	**8864**	**8792**	**0.8**	**658**	**733**	**-10.3**	**9521**	**9525**	**0.0**
Opening Stock	7991	7800		192	176		8183	7976	
Closing Stock	8249	7991		197	192		8446	8183	
e) Variation in Stock	**258**	**191**		**5**	**16**		**263**	**207**	
f) ASU (Consumption)	**8605**	**8601**	**0.0**	**653**	**717**	**-8.8**	**9258**	**9318**	**-0.6**

Note : 1. The production figures of SAIL, RINL & TSL Group are as reported.
2. The production figures of AM/NS, JSWL & JSPL are estimated as per the production trend of previous months from April 2022.
3. The production of Other Producers are estimated as per the receipt status and the production trend of previous months from April 2022.

JPC Market Price Retail for 15th June, 2022

(Rs/Tonnes)

Sl. No.	ITEM	Kolkata	Delhi	Mumbai	Chennai
1.	PIG IRON	53660	59950	73160	56640
2.	BILLETS 100 MM	59340	57230	59000	65040
3.	BLOOMS 150X150 MM	61840	NA	58760	NA
4.	PENCIL INGOTS	54640	56880	55050	56050
5.	WIRE RODS 6 MM	62950	NA	NA	75170
6.	WIRE RODS 8 MM	61650	NA	NA	74700
7.	ROUNDS 12 MM	62450	63720	73380	69920
8.	ROUNDS 16 MM	61780	65790	73380	69920
9.	ROUNDS 25 MM	60750	66380	73380	69920
10.	TMT 10 MM	67140	71170	69880	71100
11.	TMT 12 MM	66760	69480	66920	70510
12.	TMT 25 MM	67220	69620	66380	70510
13.	ANGLES 50X50X6 MM	65210	69270	69170	67460
14.	ANGLES 75X75X6 MM	65220	69330	68560	67460
15.	JOISTS 125X70 MM	63040	69620	69900	68900
16.	JOISTS 200X100 MM	65640	69260	70110	68800
17.	CHANNELS 75X40 MM	66300	69740	70610	67460
18.	CHANNELS 150X75 MM	64660	69660	71950	68800
19.	PLATES 6 MM	70250	71980	75130	76320
20.	PLATES 10 MM	70870	71980	74930	76320
21.	PLATES 12 MM	71820	73870	75930	76320
22.	PLATES 25 MM	72190	75760	76980	79260
23.	H. R. COILS 2.00 MM	74590	74180	75640	80640
24.	H. R. COILS 2.50 MM	73220	73000	74080	76350
25.	H. R. COILS 3.15 MM	72490	72830	74080	76350
26.	C. R. COILS 0.63 MM	85250	81420	83790	88800
27.	C. R. COILS 1.00 MM	83000	80830	83270	87620
28.	G. P. SHEETS 0.40 MM	96630	93450	89730	100600
29.	G. P. SHEETS 0.63 MM	94130	90800	85940	99780
30.	G. C. SHEETS 0.40 MM	96500	93630	92460	101140
31.	G. C. SHEETS 0.63 MM	95250	91980	89150	99760
32.	MELTING SCRAP H M S - I	44500	45260	44450	45080
33.	MELTING SCRAP H M S - II	44810	45020	47200	43070
34.	SPONGE IRON (COAL BASED)	35650	42250	42780	39420

Note: 1) JPC will not be responsible for the outcome of any work done by any party/user of this report based on the data featured in this report.
2) Prices are indicative.
3) Prices are inclusive of GST.
4) All prices are in Rs./Tonne and has been compiled on the basis of average of Main & Others producers' price.
5) All prices are as on the 17th of May, 2022.
6) Prices have been rounded up to the nearest ten.
7) For Blooms 150X150 mm, prices were not available in Delhi & Chennai.
8) Wire Rod 6 mm and 8 mm prices were not available in Delhi.

Courtesy: JPC ■

ENGINEERING SERVICES | COMPLETE BENEFICIATION PLANT | GRINDING CIRCUIT | MAGNETIC SEPARATOR CIRCUIT | FILTRATION CIRCUIT | OPERATION & MAINTENANCE SERVICE | PLANT AUDITS

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Speciality Plating of Continuous Casting Mould Plates for Steel Plants

Mipalloy Nomura Plating Company LLP (MNPCO) is an Indian-Japanese Joint Venture between Mipalloy (India) & Nomura Plating Company Limited (Japan).

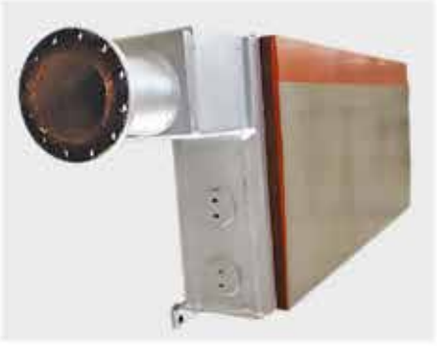
We offer refurbishment of used/ old Continuous Casting Mould Plates with Nickel & Nomura Plating's Patented TAP-2 coating technologies.

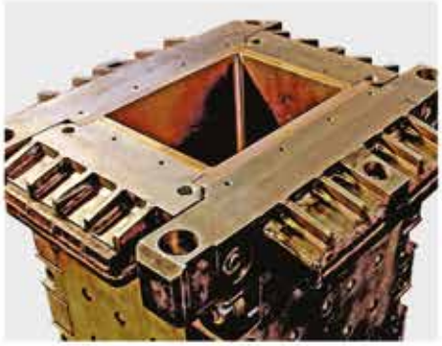
MNPCO's TAP-2 coating offers maximum mould life in comparison with other coating technologies available contemporarily. Also our TAP-2 coating ensures best surface quality of cast Steel Slabs & Blooms due to its inherent technology features.

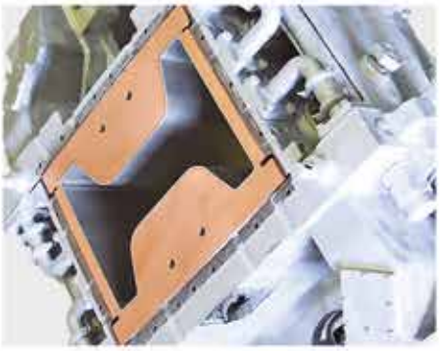
MNPCO offers the following coatings for Continuous Casting Mould Plates used in Steel Industry.

1) TAP-2 Production Plus Plating 2) TAP-2 Plating 3) Nickel Plating 4) Chromium Plating.

New Continuous Casting Mould Plates can be supplied with MNPCO's coatings by Mipalloy.







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