IIM Metallurgy Materials Engineering

MET-INFO

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Jawahar Dhatu Bhawan
39, Tughlakabad Institutional Area
M. B. Road, New Delhi-110 062

Dr. Mukesh Kumar
Chairman
IIM Delhi Chapter

S C Suri
Editor-in-Chief
IIM DC Newsletter

Tel: 011-29955084, 21820057
E-mail: iim.delhi@gmail.com
Website: www.iim-delhi.com

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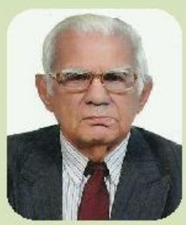

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NAME	DESIGNATION	CONTACT NO.	E-MAIL
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Shri Manoranjan Ram	Vice Chairman	9910014989 9999303008	manoranjanram@yahoo.com m.ram@danieli.com
Dr. Ramen Datta	Secretary	9958084110	dattaramen@gmail.com
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Shri S C Suri	Member	9650936736 46584279/26949167	scsuri.iimdc@gmail.com
Shri K L Mehrotra	Member	9810203544	klmehrotra48@gmail.com klm91048@gmail.com
Shri K K Mehrotra	Member	9868112514 9968653355	kishorekmehrotra@gmail.com
Shri G I S Chauhan	Member	9717302437 7048993116	gisc.delhi@gmail.com
Shri R K Vijayavergia	Member	9650155544	rkv.sail@gmail.com
Shri N K Kakkar	Member	9871008505	nirmalkakkar@gmail.com
Shri Deepak Jain	Member	9868640986 8368622619	deepakjain7177@gmail.com
Shri K R Krishnakumar	Member	9818277840	kuduvak059@gmail.com
Shri M P Sharma	Member	9212202084 9818508300	aluminiumconsultant@yahoo.com aflmps@rediffmail.com
Prof. Jayant Jain	Member	9582513867	jayantj@iitd.ac.in
Dr. Lakshmi Narayan R	Member	26591494	rlnarayan@iitd.ac.in

Welcome to Delhi Metro Rail Corporation

Delhi Metro Rail Corporation (DMRC) has become Donor Member of IIM and is affiliated to Delhi Chapter.

The Executive Committee of Delhi Chapter welcomes DMRC's affiliation with our Chapter.

Renewables could Overtake Coal as World's Largest Power Source by 2025

The global energy crisis is driving a sharp acceleration in installations of renewable power, with total capacity growth worldwide set to almost double in the next five years, overtaking coal as the largest source of electricity generation along the way and helping keep alive the possibility of limiting global warming to 1.5 °C.

Energy security concerns caused by Russia's invasion of Ukraine have motivated countries to increasingly turn to renewables such as solar and wind to reduce reliance on imported fossil fuels, whose prices have spiked dramatically. Global renewable power capacity is now expected to grow by 2 400 gigawatts (GW) over the 2022-2027 period, an amount equal to the entire power capacity of China today,

This massive expected increase is 30% higher than the amount of growth that was forecast just a year ago, highlighting how quickly governments have thrown additional policy weight behind renewables. Renewables are set to account for over 90% of global electricity expansion over the next five years, overtaking coal to become the largest source of global electricity by early 2025.

Renewables were already expanding quickly, but the global energy crisis has kicked them into an extraordinary new phase of even faster growth as countries seek to capitalise on their energy security benefits. The world is set to add as much renewable power in the next 5 years as it did in the previous 20 years. This is a clear example of how the current energy crisis can be a historic turning point towards a cleaner and more secure energy system. Renewables' continued acceleration is critical to help keep the door open to limiting global warming to 1.5 °C."

The war in Ukraine is a decisive moment for renewables in Europe where governments and businesses are looking to rapidly replace Russian gas with alternatives. The amount of renewable power capacity added in Europe in the 2022-27 period is forecast to be twice as high as in the previous five-year period, driven by a combination of energy security concerns and climate ambitions. An even faster deployment of wind and solar

PV could be achieved if EU member states were to rapidly implement a number of policies, including streamlining and reducing permitting timelines, improving auction designs and providing better visibility on auction schedules, as well as improving incentive schemes to support rooftop solar.

Beyond Europe, the upward revision in renewable power growth for the next five years is also driven by China, the United States and India, which are all implementing policies and introducing regulatory and market reforms more quickly than previously planned to combat the energy crisis. As a result of its recent 14th Five-Year Plan, China is expected to account for almost half of new global renewable power capacity additions over the 2022-2027 period. Meanwhile, the US Inflation Reduction Act has provided new support and long-term visibility for the expansion of renewables in the United States.

Utility-scale solar PV and onshore wind are the cheapest options for new electricity generation in a significant majority of countries worldwide. Global solar PV capacity is set to almost triple over the 2022-2027 period, surpassing coal and becoming the largest source of power capacity in the world. An acceleration of installations of solar panels on residential and commercial rooftops, will help consumers reduce energy bills. Global wind capacity almost doubles in the forecast period, with offshore projects accounting for one-fifth of the growth. Together, wind and solar will account for over 90% of the renewable power capacity that is added over the next five years.

There are emerging signs of diversification in global PV supply chains, with new policies in the United States and India expected to boost investment in solar manufacturing by as much as USD 25 billion over the 2022-2027 period. While China remains the dominant player, its share in global manufacturing capacity could decrease from 90% today to 75% by 2027.

Total global biofuel demand is set to expand by 22% over the 2022-2027 period. The United States, Canada, Brazil, Indonesia and India make up 80% of the expected global expansion in biofuel use, with all five countries having comprehensive policies to support growth.

For an accelerated case in which renewable power capacity grows a further 25% on top of the main forecast, in advanced economies, this faster growth would require various regulatory and permitting challenges to be tackled and a more rapid penetration of renewable electricity in the heating and transport sectors. In emerging and developing economies, it would mean addressing policy and regulatory uncertainties, weak grid infrastructure and a lack of access to affordable financing that are hampering new projects.

Worldwide, the accelerated case requires efforts to resolve supply chain issues, expand grids and deploy more flexibility resources to securely manage larger shares of variable renewables. The accelerated case’s faster renewables growth would move the world closer to a pathway consistent with reaching net zero emissions by 2050, which offers an even chance of limiting global warming to 1.5 °C.

Source : Renewables 2022, IEA

DRI Smelting Furnace - Technology for Decarbonizing Steel Production

Iron and steel industry produce around 7% of global CO_2 emissions causing climate warming. Replacing coal and blast furnaces with hydrogen and direct reduction plants is the current megatrend in iron and steel industry, and with this new solution, the sector's CO_2 emissions can be reduced up to 80%.

The hydrogen-based direct reduction process combined with an electric arc furnace (EAF) is a known solution for the industry, but this combination is not going to solve the decarbonization challenge. The reason for this is the demand of high-quality iron ore. EAF cannot tolerate the high slag volumes that are generated in the processing of DRI from blast furnace grade iron ore. It has been estimated that currently only 4% of global iron ore supply meets the requirements of the H_2-DRI +EAF steel making route. Therefore, demand and price of high-quality iron ore will increase dramatically in the future.

Metso Outotec DRI Smelting Furnace

DRI Smelting Furnace

The Metso Outotec DRI Smelting Furnace can handle large slag volumes without excess iron losses, thereby allowing the use of blast furnace grade iron ore. It is a continuously operating process securing high production volumes in the steel plant. By combining direct reduction plant with DRI Smelting Furnace and feeding DRI hot from a direct reduction plant directly into a smelting furnace, the energy efficiency of the process route can be further improved.

Metso Outotec's rectangular DRI Smelting Furnace can meet high capacity and availability demands of blast furnaces. The "six electrodes in line" furnace can produce more than 1.2 Mt/y of hot metal. Several DRI Smelting Furnaces can be combined using joint facilities and utility areas.

The main products of the DRI Smelting Furnace process are hot iron metal with required carbon content, excellent quality slag and furnace off-gas with high chemical energy content. Hot metal carbon content is adjustable to meet the requirements of the next process step but also depended on carbon content of the DRI used as a raw material.

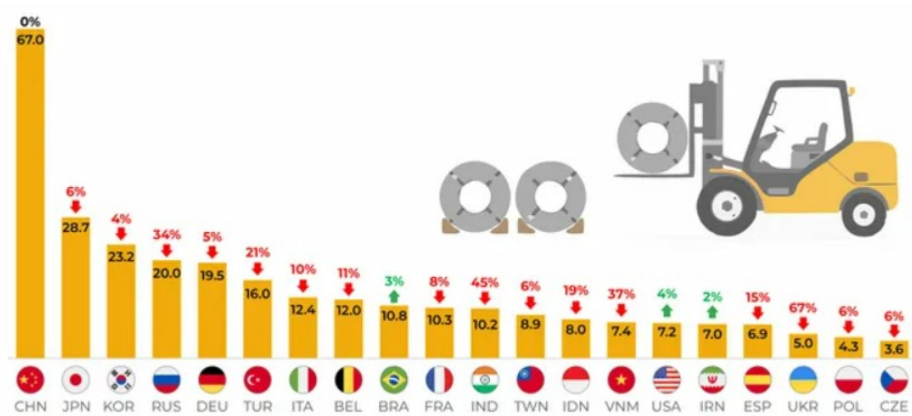
Metso Outotec DRI Smelting Furnace can be erected in the vicinity of existing blast furnace and direct reduction plant and ramped up while blast furnace is operating. After successful ramp-up, blast furnace can be demolished. This kind of project arrangement allows stable production to the steel plant without unnecessary production stoppages. The DRI Smelting Furnace product can also be tuned to meet requirements of the downstream process by carbon and silica level in hot metal, and also by volume and interval of tapped metal tons.

DRI Smelting Furnace can also be erected close to an iron ore mine site together with direct reduction plant. In such case, hot metal produced can be cast or granulated to suit to be used as a raw material.

Source : Metso Outotec Smelting Newsletter 2022.

India at 11th Place Among Global Steel Exporters in CY22

Steel exports by India dropped by around 45% y-o-y to 10.19 million tonnes in 2022 from over 18 million tonnes in 2021. Thus, India slipped to the 11th spot among major steel-exporting countries this year from the 7th position last year. This is attributed mainly to the 15% duty slapped on steel exports in May this year.



Steel Exports from Various Countries (2022e)

Source: Steelmint

Air Liquide Completes Hydrogen Pipeline to thyssenkrupp Steel in Duisburg

- Four-kilometer section completed after a six-month construction period.
- First pipeline to supply Germany's largest steel mill with hydrogen from renewable energies.
- Air Liquide is currently building a 20(+10) MW electrolysis plant in Oberhausen. Green hydrogen can be produced from the fall of 2023 onwards.
- Funding of the pipeline by the German Federal Ministry for Economic Affairs and Climate Protection as part of the real laboratory of the energy turnaround.

Steel production of the future will depend on having large quantities of hydrogen. As part of the H2Stahl real laboratory sponsored by the German Federal Ministry for Economic Affairs and Climate Protection (BMWK), the industrial gases company Air Liquide has now completed a pipeline to thyssenkrupp Steel in Duisburg. The approximately four-kilometer-long pipeline connects the Duisburg steel mill site with Air Liquide's hydrogen network in the Ruhr district.

Europe's largest steel site in Duisburg is taking on a pioneering role in the decarbonization of steel production. As early as 2019, it injected hydrogen into a blast furnace for the first time on a test basis to reduce CO_2 emissions from conventional steel production. The state government of North Rhine-Westphalia supported the project at the time as a pioneering pilot project.

Linking the Air Liquide hydrogen pipeline to thyssenkrupp Steel shall create the conditions for climate-friendly steel production, moving forward step-by-step on the path to transformation. It will enable climate-friendly hydrogen to be delivered to from 2024 onward. It will utilized for research and simulation purposes and then, to power the direct reduction plant.

Hydrogen has not yet been used on a large industrial scale for steel production. Starting in 2019, thyssenkrupp Steel has successfully completed a series of initial tests for hydrogen injection into an existing blast furnace. Although an expansion of these tests is currently suspended due to high natural gas and energy prices, plans to build a direct reduction test facility are continuing unabated, in which the technological leap to hydrogen-based, carbon-neutral hot iron production will be tried out. The technological milestone will be when the first large-scale industrial direct reduction plant with melting units is constructed.

thyssenkrupp Steel Europe AG is Germany's biggest steel manufacturer. The Duisburg-based company with around 26,000 employees is one of the world's leading suppliers of high-quality steel products for innovative and demanding applications, as well as for providing steel-related services. Steel production at thyssenkrupp Steel Europe is planned to be completely climate-neutral by 2045 at the latest. The decisive step in this direction will be the construction of hydrogen-based direct reduction plants in conjunction with innovative melting units. The first plant is scheduled to go on stream in Duisburg in 2026. Production of five million metric tons of low-CO_2 steel is already planned for 2030.

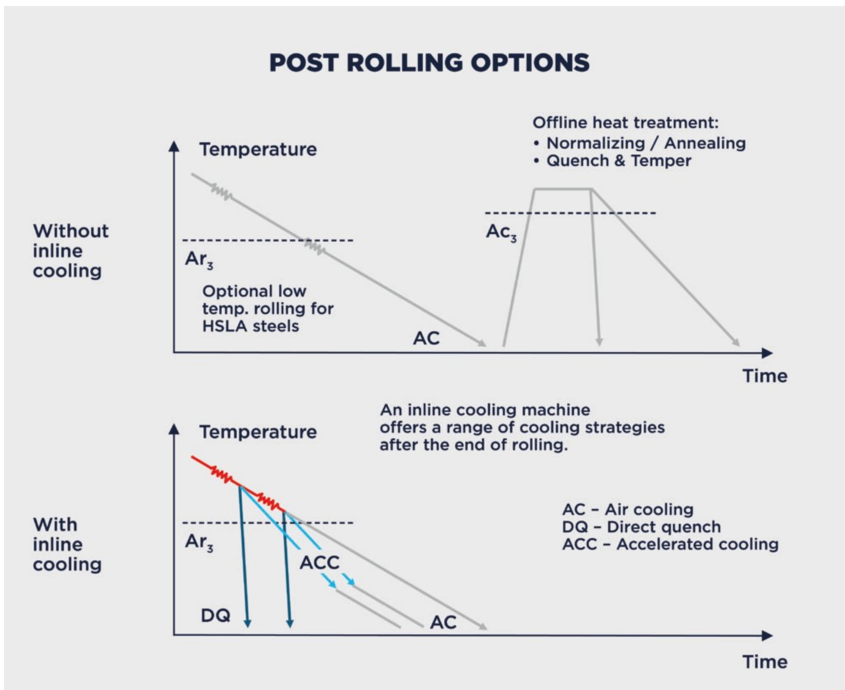
Inline Plate Cooling

As the steel industry focuses on its environmental impact and producers search for ways of simultaneously improving efficiency and product quality, digitalization and process optimization are the keys to a sustainable future for steel. Analog and digital solutions provide steel producers with a means of cooling plates in an eco-friendlier and more efficient manner, all the while reducing production costs.

Industry-wide the use of inline plate cooling technologies has proven to be essential to producing high-strength steel grades. Producers have been focussing on decreasing their environmental impact and lowering operational costs by reducing post-processing requirements and carefully monitoring and managing water consumption.

Accelerated cooling of hot-rolled sheets emerged in the 1980s. Today, “alloying with water” is standard practice in the steel industry, where micro-alloyed steel plates are cooled directly after rolling, achieving the desired strength, flatness, and toughness. The value of accelerated cooling extends beyond the ability to achieve the desired microstructure and product quality as it also allows for the elimination of expensive reheating practices, efficient water utilization, improved yield and an accelerated production time.

Previously, cooling the hot-rolled plates to room temperature before low-temperature rolling and processing was the standard practice for high-strength low alloy steel grades (HSLA). Examples of processing included normalizing and annealing or quenching and temper processing. Before inline plate cooling, steel producers used these steps to tailor the air-cooled plate microstructure for final applications, for example, abrasion-resistant plates. However, with the application of inline cooling, steel producers can achieve target microstructures with temperature control for accelerated cooling and direct quenching.



Schematic diagram illustrating post-rolling options with and without inline cooling technology

Moreover, inline cooling offers various cooling strategies following rolling for different steel grades.

The impact of accelerated cooling on plate production is immediately visible regarding reduced manufacturing time. For example, direct quenched (DQ) or abrasion-resistant steel plates require specific processing that traditionally utilizes reheating, quenching, and tempering to reach the necessary hardness, toughness, work-hardening, and ductility required. Producers of high-strength steel focus on these characteristics because abrasion-resistant steel is essential in mining, lifting, and excavation industries.

Inline cooling technology is a viable solution for steel producers to achieve greater efficiency by applying direct quenching that bypasses the reheating step. Abrasion-resistant steel requires temperature control and flatness to achieve the correct microstructure. Cooling conditions can vary during rolling and result in non-uniform temperature profiles of the plate.

When applying plate cooling technology, the benefits for steel producers are abundant, including improved cost efficiency, reduced environmental impact, increased product versatility, i.e., from structural grades to abrasion-resistant steel, leaner manufacturing, and enhanced quality and productivity. Previous accelerated cooling technologies were without recent developments in automation and digitalization, which now take each of these improvements one step further.

Flatness and yield are two key performance indicators that contribute significantly to the overall efficiency of the production of steel plates. Rectifying flatness defects requires post-processing, such as cold levelling, so the ability to control and optimize flatness during cooling is an essential feature of the technology. Improving yield from a plate means that less steel is needed to produce the equivalent final product, saving energy and emissions. During cooling, the final temperature uniformity, which influences mechanical property distribution in longitudinal and transverse directions, significantly impacts yield.

Ensuring that the cooling equipment is always available when required is essential to avoid unnecessary stoppages or compromises to the quality of end products. A condition monitoring system can read and evaluates plant feedback information from sensors and actuators to increase availability. Signal processing techniques compress this amount of measured data to help determine when maintenance is due for individual parts of the equipment, preventing unnecessary and unplanned machine downtime.

Monitoring and optimizing water usage during cooling is another means of minimizing environmental impact during production. The precise control of the water flow rates to the cooling machine is key to ensuring minimum water consumption during cooling.

Green Steel Plant with an Integrated Hydrogen Production Facility in Finland

Finland Norwegian company *Blastr Green Steel (Blastr)* is planning to establish a green steel plant with an integrated hydrogen production facility in *Inkoo*, Finland. Blastr has entered into a Letter of Intent with Nordic Energy Company *Fortum* that provides Blastr exclusive rights to utilize an existing industrial site located in Inkoo. The four-billion-euro investment is expected to create up to 1,200 direct jobs in the operations phase. The production is planned to start by end of 2026.

Green steel is a key enabler for the green transition, as it will be a critical raw material for developing renewable energy infrastructure, such as wind turbines, as well as in segments such as construction, the automotive industry, and consumer goods. In Europe alone, the demand for decarbonized steel is expected to reach 50 million tons by 2030, nearly one-third of the current European steel demand. Finland has an ambitious low-carbon target, supportive and predictable operating conditions for the green industry, fossil-free energy, and a highly qualified workforce. Inkoo was selected as location due to its high-quality infrastructure and access to clean power. In addition, the ice-free deep-sea harbor enables efficient, low carbon logistics all year round and close access to the European market. Finland is an excellent place for carbon-neutral industry and production of decarbonized steel. It has a strong and reliable electricity grid, good conditions for producing emission-free energy and efficient logistics. The project will contribute greatly to the climate and carbon neutrality goals of both Finland and the EU. It is significant also for the entire European industry as an enabler of the green transition.

Blastr aims to cut the CO_2 emissions of its end products by 95 percent. The steel industry produces about eight percent of the world's CO emissions due to the high amount of fossil fuels used to manufacture steel through conventional methods. Currently, one ton of steel produced creates on the average about 1.9 tonnes of CO_2. Blastr will replace coke and coal with hydrogen in the chemical reduction phase, as well as reduce the CO_2 footprint along the entire value chain, with the aim of achieving 95 percent lower CO_2 emissions, compared to the conventional manufacturing process. The steel plant is planned to produce two and a half million tons of high-quality hot and cold-rolled green steel annually.

Blastr Green Steel is dedicated to decarbonizing the steel value chain through developing local, sustainable and scalable value chains for steel production. By utilizing local raw materials and fossil-free energy and applying circular economy thinking throughout the value chain, Blastr aims to cut the CO_2 emissions of its end products by 95% compared to conventional methods. The company will establish a pelletizing plant in Norway.

Source : www.investinfinland.fi; Business Finland Press Release, 3 January 2023

Price Change in Metals in 2022

	Unit	March 31, 2022	Jan. 13, 2023	% Change
Zinc*	$/tonne	5174	4273	-17.4
Lead*	$/tonne	4260	3302	-22.5
Nickel*	$/tonne	33400	27175	-9.0
Aluminium*	$/tonne	3503	2511	-28.3
Copper*	$/tonne	10337	9107	-11.9
Tin*	$/tonne	44200	28530	-35.5
HR Steel, Average, China	CNY/tonne	5267	4198	-20.3
**LME Index;* *CNY: Chinese Yuan*				

Expanding Data Collection and Analysis Capabilities in Blast Furnace

Steel makers are constantly reviewing, developing, and implementing technology-based solutions in order to improve the processes to advance manufacturing in the steel industry.

Researchers from Mohawk College's Sensor Systems and Internet of Things (IoT) Lab will work with *Stelco* to prototype a customized vision and communication system that will be installed in the company's blast furnace.

The goal of the Mohawk-created system is to collect and analyze real-time image and sensor data and automatically communicate it to the Operations and Process Engineering Teams during the furnace's operation. The project has a unique design challenge since the prototype will have to withstand the high temperatures and vibrations that are present within the blast furnace environment.

By incorporating the industrial internet of things (IIoT) system into one of the primary stages of making steel, information gathered can also be incorporated into decision-making at the subsequent processes. This ability will lead to increased operational efficiencies and will optimize the use of resources both at, and outside of, the blast furnace.

IIoT Applications will include machine vision and image processing, instrumentation and data analysis, sensors, advanced manufacturing, and process automation. Research teams will work to employ machine vision and complex data analytics to enhance the current blast furnace process monitoring and provide a superior way to monitor key performance factors.

The two-year project has received $300,000 in funding from the National Sciences and Research Council of Canada (NSERC) through an Applied Research and Development Grant. Stelco will also be investing in the project as part of its larger investment in its blast furnace upgrade.

Source: Press Release, Mohawk College, Hamilton, January 11, 2023