AIIFA SUSTAINABLE STEEL MANUFACTURERS ASSOCIATION

(FORMERLY KNOWN AS ALL INDIA INDUCTION FURNACES ASSOCIATION)

(Promoting Sustainability in Steel for Greener Future)

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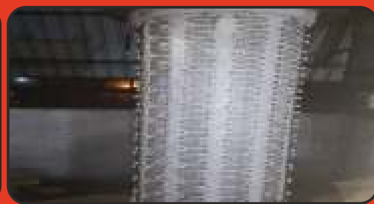

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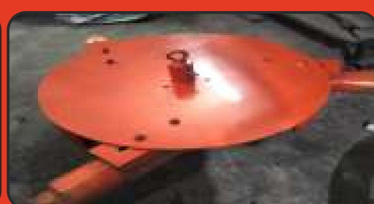

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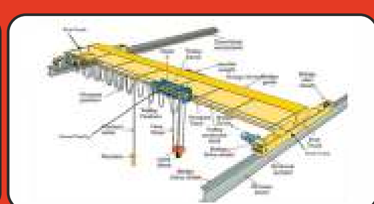

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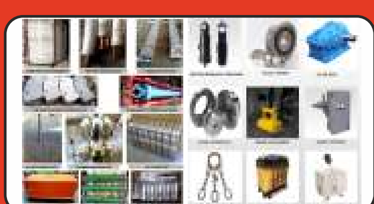
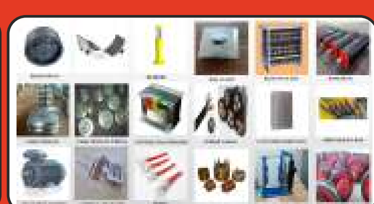

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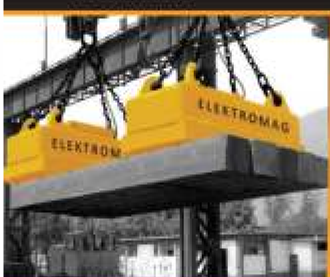

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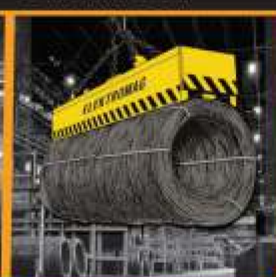

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Liquid Steel Casting for Good Quality Ingot

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Ex ASP/SAIL, AIIFA Consultant
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Sr. Executive Director, AIIFA

Synopsis:

To achieve high-quality steel ingots in a competitive market, focus must be placed on three key areas within the steelmaking process: sourcing high-quality recycled ferrous scrap, refining melting practices, and optimizing pit-side operations. Improving production efficiency and reducing product costs while maintaining superior quality are essential. Pit-side operations, in particular, involve critical processes such as argon purging of liquid steel, secondary refining techniques, and precise control during liquid steel pouring into molds. The electric induction furnace operates on a batch melting process, where each cycle, known as a "heat," involves a tap-to-tap sequence encompassing several key operations. To consistently produce high-quality ingots for further processing, it is crucial to strictly adhere to standard operating procedures and ensure close supervision across all stages of the production cycle.

Introduction:

In the process of casting liquid steel into ingots, the pit-side practice of teeming—pouring molten steel into molds—plays a critical role in producing high-quality ingots. In the secondary steelmaking route, ferrous scrap and scrap substitutes are melted in electric induction or electric arc furnaces, particularly in Indian mini steel plants. After refining, the molten steel is poured into molds. Traditionally, the top-pouring method was used for this, but it often led to metal splashing and adhering to the mold walls, resulting in surface defects on the ingot that required further surface conditioning.

For producing high-quality steel, the top-pouring method is less suitable. Instead, bottom-pouring is preferred, as it allows the metal to solidify more uniformly, leading to ingots with smoother, defect-free surfaces.

A common practice involves teeming molten steel from a ladle into multiple molds, either sequentially or simultaneously. However, simultaneous filling often encounters challenges due to uneven metal flow between molds. To avoid irregularities, the preferred method is to fill each mold separately, using a valve-controlled nozzle to regulate the flow of molten metal under high hydraulic pressure, ensuring a controlled and consistent teeming process.

Liquid Steel Teeming in Ingot Mold:

Teeming liquid steel into ingot molds can be performed either by top pouring or bottom pouring methods, each with distinct advantages. The top-pouring method offers benefits such as reduced labor requirements, lower consumption of refractory materials, and minimized steel loss due to the solidification in the gating systems. However, top pouring presents challenges in maintaining the quality of the ingot surface.

In the top-pouring method, the stream of molten steel strikes the bottom of the mold chamber, often causing damage. Throughout the teeming process, the steel splashes violently, interacting with air and forcefully hitting the mold's side walls. This can result in cutting or welding of the molten metal to the mold walls, which interferes with the proper shrinkage of the ingot, making it difficult to strip the ingot from the mold and potentially causing surface defects, such as tears or imperfections.

The bottom-pouring method, by contrast, uses a "pouring set," commonly known as a bottom-pouring set, which consists of hollow runner bricks designed to facilitate the flow of molten metal.

These hollow shapes are typically made from plastic fire clays or, in some cases, non-plastic clay, ensuring ease of metal flow during the process.

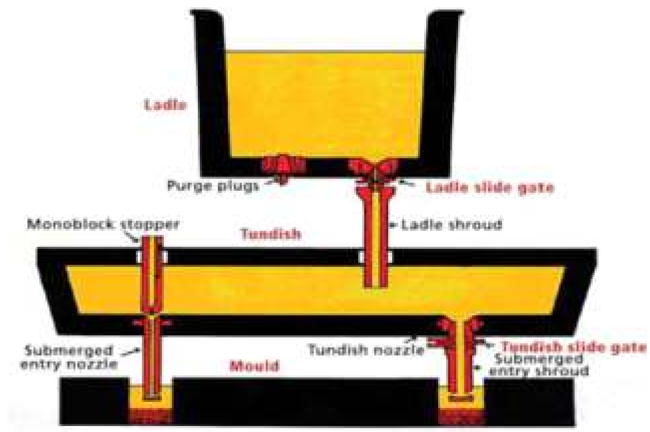
During top pouring, as the molten metal enters the mold, it can be deflected and driven with significant force against the mold walls, leading to the formation of a thin, mushy skin on the walls above the more settled metal in the mold. This skin is often disrupted or broken during pouring, leading to irregularities and defects in the final ingot. Bottom pouring mitigates these issues by providing a more controlled and uniform flow of molten steel, reducing the likelihood of surface defects and improving overall ingot quality.

Steel Bottom Pouring in Set of Molds

Liquid Steel Top Pouring in mold Liquid

Slide Gate Fixing in Ladle:

Slide gates are essential components fixed to ladles, exposed to extreme thermal stress and physical abrasion from molten metal and slag. These conditions require the slide gate's refractory plates to possess high resistance to heat, corrosion, and mechanical wear, making them crucial for both ingot teeming and continuous casting processes. However, for smaller capacity ladles, slide gate installation is often impractical due to design limitations.



Slide Gate Plate (Above), Slide Gate Fitted in Continuous Casting Ladle (Bottom)

The tundish plates used in the slide gate system must withstand thermal shock and corrosion. The material composition of the slide gate plate refractories significantly impacts both the production capacity and cost of steel. These plates are typically manufactured from alumina/graphite or magnesia/graphite, selected based on the specific steel grade requirements. Recently, alumina/carbon refractories have gained popularity for their durability and ability to eliminate fuming caused by pitch, which was traditionally used in plate construction. However, alumina/graphite plates are prone to rapid erosion when exposed to calcium-treated steel and high oxygen levels.

Basic refractory materials, like magnesia, offer superior corrosion resistance compared to neutral metals, making them more suitable for certain steel grades. However, these materials may have a higher thermal expansion coefficient, leading to reduced resistance to thermal spalling. When molten steel flows through the nozzle of a slide gate plate, the significant temperature differential between the inner and outer parts of the plate can induce thermal shock. To address this, gate plate devices are constructed from refractory materials with high thermal shock resistance, even if they have relatively lower fineness.

In summary, the structure and composition of slide gate plate refractories are critical to optimizing steel production efficiency and cost, balancing durability against corrosion and thermal challenges depending on the specific production conditions and steel grade.

Importance of Bottom Pouring Set:

The bottom pouring set, composed of refractory materials, plays a critical role in the casting process by controlling the flow of liquid steel into molds. These sets must withstand the abrasive forces during the steel flow, as well as the high temperatures of molten steel, to prevent erosion. Manufacturers typically offer bottom pouring sets in grades such as 30% alumina and 40% alumina, with high alumina variants available for enhanced durability. The primary advantage of using these sets is their ability to produce high-quality steel ingots, thanks to the reduced turbulence in the mold. This flow control results in a calm meniscus and superior ingot surface quality, with minimal or no splashing of molten steel droplets.

Key Action Areas in Teeming:

1. **Temperature Selection for Steel Grades:** The pouring temperature should be carefully chosen based on the specific steel grade, typically 40-80°C higher than the melting point of the steel. This ensures proper fluidity and reduces the risk of defects in the final casting.
2. **Control of Pouring Speed:** The pouring speed must be adjusted depending on the casting type. For thin-walled or complex castings, rapid pouring is recommended to avoid defects such as cold shuts or incomplete filling. Additionally, for molds with a large upper plane, fast pouring helps prevent sand inclusions caused by prolonged exposure of the mold surface to high temperatures, which can lead to peeling and defects.
3. **Alignment of Steel Grades and Sandboxes:** To ensure efficiency and prevent errors during teeming, steel grades should be aligned in sequence, with sandboxes arranged systematically. Gates should be positioned in a straight line to facilitate crane operations and ensure smooth pouring.
4. **Placement of Molds:** Medium and small molds, or those requiring shorter pouring times, should be placed closer to the furnace. Larger molds, which need longer pouring times, should be positioned further away. This arrangement optimizes workflow and ensures an efficient teeming process.
5. **Safety Precautions:** The pouring channel should always be clear of obstructions. Ensure there is no water or moisture on the ground, and check for flammable or explosive materials. Emergency evacuation routes should be identified and kept clear in case of accidents.
6. **Pit Molding Precautions:** The parting surface of the pit molding should not exceed the upper plane of the pit. If it does, remedial measures must be taken to correct it. This ensures the mold is properly aligned and reduces the risk of casting defects.
7. **Control of Rising Speed:** The rising speed of molten steel in the mold is crucial for producing high-quality steel castings. A moderate, controlled speed allows the steel to fill the mold cavity evenly and avoid defects such as cold shuts, sand inclusions, cracks, or slag. If the rising speed is too slow, the casting may fail or develop defects. Conversely, if it is too fast, issues such as choking, air holes, and slag inclusions may occur. The optimal rising speed can be adjusted depending on the size of the

steel castings, with specific reference data used for large and medium castings.

By addressing these key areas in the teeming process, it is possible to enhance casting quality, reduce defects, and improve the overall efficiency and safety of steel production.

In every melt shop, controlling the pouring speed of steel castings is crucial, and it is largely influenced by the skill of the operators and the diameter of the casting mouth. The flow velocity of molten steel at the opening of the steel ladle is proportional to the square root of the diameter of the opening and the height of the liquid steel level in the ladle. As the liquid steel level decreases, the flow velocity reduces. To maintain an optimal pouring speed, it is essential to equip the ladle with a casting brick of suitable diameter. In certain cases, a double casting port mold may be required to facilitate controlled pouring or to accommodate a specific piece being cast.

For safety reasons, there should be no water seepage in the casting area to prevent accidents and preserve the quality of the ingots. Half an hour before pouring, a spot check of the mold cavity and runner should be conducted to ensure that the gates meet the requirements. For molds that require preheating, verify that the preheating has been completed. Additionally, check that the pressing iron and box clamps are secure to prevent leaks or other issues during pouring. Necessary tools and materials such as crowbars, sample spoons, heating agents, and heat preservation agents should be prepared in advance to ensure a smooth operation.

A designated person should supervise the entire pouring process. This supervisor must be well-versed in the material in the furnace, the amount of molten steel to be poured, the gross weight of the liquid steel, the riser height, and the number and quality of molds. All safety measures should be meticulously observed by the team, as the pouring area is highly sensitive and critical for protection.

Depending on the position of the sand mold, the condition of the sprue, and the placement of the steel ladle, an appropriate pouring platform should be set up. If the platform exceeds a height of 1.5 meters, a ladder must be provided for safe access. The route to and from the platform should be clear, allowing workers to evacuate quickly in case of an emergency. Pouring personnel should also have protective gear and necessary materials such as back sand and covering agents on hand.

Before pouring begins, the temperature of the molten steel must be measured. Higher initial pouring temperatures are ideal for complex or thin-walled castings, while lower temperatures are better suited for simple, thick-walled castings. During pouring, the ladle's pouring port must be aligned with the mold's pouring cup to prevent molten steel from spilling. The distance between the pouring port and the sprue cup should be minimized to reduce secondary oxidation.

The initial flow of molten steel should be slow to achieve a trickle-like pouring. This helps minimize the erosion of the mold and prevents splashing. Once the flow is established, it can be gradually increased, ensuring that it remains continuous and smooth without interruptions during mold filling. Generally, small or thin-walled castings are poured first, followed by larger or thick-walled castings. If the ladle is not sufficiently preheated, a larger casting should be poured first to account for the lower steel temperature at the bottom of the ladle.

When the molten steel reaches the riser, it should be poured slowly to the desired height. This prevents the steel from overflowing and reduces the risk of lifting the mold box. Slow pouring at the riser also allows for proper compensation for volume shrinkage during the transition from liquid to solid steel. After filling the mold, spot casting can be performed 1-3 times at the gate. Once pouring is complete, a thermal insulation covering agent should be added 1-2 times to ensure the riser does not show signs of overheating.

Hot Tops and Hot Topping Compounds:

Hot tops create an insulating effect by preventing heat loss through the risers and assisting in the formation of piping within the risers to feed castings effectively. Hot topping compounds can be exothermic, insulating, or a combination of both. These compounds generate heat, which aids in feeding the casting. After the exothermic reaction, the resulting crust provides an insulating barrier that helps improve the quality of the ingot.

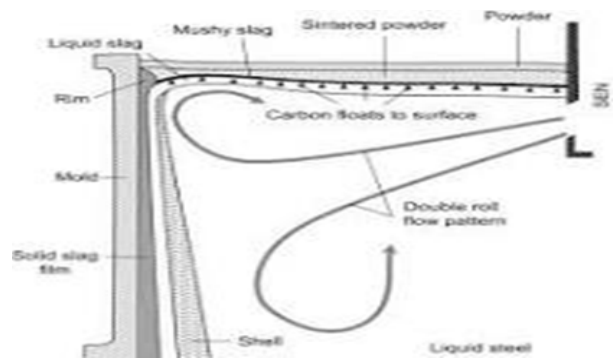
Exothermic powders, used as hot topping compounds, are applied to the top of open feeder sleeves. They prolong the cooling time at the top of the open feeders by preventing the interaction of the molten metal with air, thereby reducing the formation of a crust during cooling. This enhances feeding efficiency by using the feeder sleeve more effectively. The amount of exothermic powder can be adjusted based on the size of the feeder, and these powders are formulated to produce minimal gas while generating high energy.

Exothermic topping materials create a highly exothermic reaction, preventing the formation of a metal skin on the casting and allowing atmospheric pressure to act on the solidifying casting. Once the exothermic reaction subsides, these materials provide excellent insulation, maintaining consistent thermal conditions throughout the casting's solidification. This ensures uniform metallurgical quality, low carbon content, and minimal inclusion of tramp elements. Exothermic materials should be applied immediately to the pouring cup when the mold is filled to achieve controlled thermal properties and superior casting results.

Addition of Bottom Pouring Flux:

Bottom pouring flux is composed of chemical compounds designed to melt quickly and spread evenly over the surface of molten steel. The resulting molten slag forms a protective coating on the steel's surface, creating an optimal meniscus shape and preventing surface oxidation. The key functions of bottom pouring flux in the casting process are as follows:

1. **Preventing Meniscus Freezing**: The flux minimizes vertical heat transfer, preventing the steel meniscus from freezing and ensuring smooth flow during the pouring process.
2. **Preventing Steel Oxidation:** The molten slag created by the flux acts as a barrier, shielding the liquid steel from exposure to oxygen, thereby preventing oxidation.
3. **Lubricating the Shell:** As the steel solidifies, the flux provides essential lubrication to the newly formed shell, facilitating the withdrawal of the steel from the mold and reducing friction.
4. **Controlling Horizontal Heat Transfer:** The flux helps regulate the horizontal heat transfer from the steel shell to the mold, ensuring uniform cooling and preventing defects.
5. **Absorbing Inclusions:** The flux absorbs non-metallic inclusions from the molten steel, improving the quality and purity of the cast steel product.



These functions are critical to maintaining the integrity of the casting process, ensuring high-quality steel production, and minimizing defects such as surface oxidation, uneven cooling, and contamination.

The casting powder used in ingot steel production via the bottom pour process integrates the essential properties of traditional bottom pour fluxes and hot topping compounds into a single, easily applicable mixture.

This innovative formulation simplifies the casting process and reduces production costs while resulting in steel with fewer impurities. The optimal flux composition typically comprises 28-42% calcium oxide (CaO), 13-21% alumina (Al_2O_3), 22-35% magnesium oxide (MgO), and 3-8% silica (SiO_2). Additionally, it is preferred to maintain a calcium oxide to magnesium oxide weight ratio between 0.8:1 and 1.9:1.

By utilizing this advanced casting powder, steel manufacturers can enhance the quality of their products while streamlining their operations.

Monitoring of Liquid Steel Pouring

Once the crane is positioned above the mold with a ladle full of liquid steel, the pouring process requires careful monitoring to ensure quality and safety:

1. **Dedicated Oversight:** A designated operator should oversee the pouring process to prevent slag from contaminating the mold cavity.
2. **Leakage Management:** In the event of molten steel leaking from the casting mold during pouring, immediate measures must be taken to stem the flow. Adjustments should be made to adopt a slow and controlled pouring rate to minimize leakage.
3. **Continuous Flow:** It is crucial to maintain an uninterrupted flow of molten steel to avoid cold shut defects in the castings. If sampling for component analysis is required during pouring, a sample ladle should be utilized to extract molten steel, clearly marking the heat number.
4. **Residual Steel Handling:** Any leftover molten steel in the ladle after pouring should be redirected into a pre-prepared mold or a designated dry pit. The surface should not be disturbed post-pouring to prevent accidental contact.
5. **Process Parameters:** The pouring rate and fluid flow dynamics must be meticulously monitored as the molten metal travels through the trumpet, spider, runners, ingates, and into the mold. Key aspects such as metal temperature and the design of the trumpet-spider-runner-gate system should comply with established standards. Notably, in the initial 25 seconds of teeming, one mold may receive slightly more metal than the others (L. Zhang and B. Thomas, State of the Art in the Control of Inclusions during Steel Ingot Casting).

By implementing these measures, the quality of the steel casting can be ensured while maintaining a safe and efficient pouring operation.

Release of Ingot from Mold

The residence time of the ingot in the mold must be minimized, as it significantly impacts mold lifespan. Immediately after teeming, the inner mold walls reach temperatures nearly equivalent to that of the molten steel, while the outer surface remains at approximately 100 °C. As the ingot remains in the mold longer, the outer surface temperature gradually increases. It is crucial to note that cast iron loses its structural integrity rapidly with rising temperatures.

Any lateral pressure from the relative movement between the ingot and the mold during stripping can lead to bottom breakage of the mold or scooping out of the mold metal from its inner surface. Scooping can also occur if the ingot adheres to any area of the mold. Once the steel has cooled and solidified, the mold is removed using giant tongs, and the ingot is transferred to a heated soaking pit, where it is maintained at approximately 1200-1250 °C. From there, the heated ingot proceeds to a rolling mill or forging press, where it undergoes hot working to manufacture various forged items or rolled products.

A quality mold is expected to produce around 100 castings over its lifespan. However, even high-quality ingot molds can experience a phenomenon known as "broken feet," where fragments of the material break away from the inside of the mold foot during the stripping process. Unlike other damage types that may affect mold longevity, broken feet frequently occur during the initial castings. If this issue does not arise early on, the likelihood of it happening later diminishes significantly.

Moreover, the occurrence of broken feet is more prevalent at higher temperatures of the mold foot, particularly if ingot plates that have not fully cooled are utilized during casting. By monitoring and controlling these factors, the integrity and lifespan of ingot molds can be enhanced, contributing to a more efficient casting process.

Process Metallurgy of Mold for Ingot Production

Cast iron ingot molds used in steel ingot production face the challenge of broken feet, which significantly reduces their average lifespan. To mitigate this issue, increasing the phosphorus (P) content in the cast iron is beneficial. Specifically, molds should be cast from a type of cast iron with a composition that ensures the silicon (Si) content is lower than the manganese (Mn) content.

The nominal composition for high-quality molds typically includes the following parameters:

- **Silicon (Si):** Less than the manganese content
- **Manganese (Mn):** Higher than the silicon content
- **Phosphorus (P)**: Increased concentration to enhance fluidity and reduce brittleness
- **Carbon (C):** Adequate levels to improve the casting's structural integrity

By optimizing these elemental compositions, the durability and functionality of cast iron ingot molds can be significantly improved, leading to a more reliable casting process and extended mold life.

C	about	3.8	-	4.7	%
Si	about	0.55	-	1.15	%
Mn	about	0.74	-	1.3	%
S	about	0.01	-	0.035	%
P	about	0.14	-	0.195	%

Metallurgical Considerations for Cast-Iron Ingot Molds in Steel Production

Cast iron ingot molds utilized in steel ingot production are prone to the risk of broken feet, which significantly reduces their operational lifespan. One approach to mitigate this issue is by increasing the phosphorus (P) content in the cast iron, particularly by ensuring that the silicon (Si) content is lower than the manganese (Mn) content. While phosphorus can enhance fluidity during casting, it is also known to weaken the metal and increase brittleness. Therefore, there is a general tendency to minimize phosphorus levels in cast iron for ingot molds, typically aiming for percentages below 0.1% by weight.

During the teeming process, both the mold walls and bottom extract heat from the liquid steel. The rate of heat extraction follows a relationship proportional to the square root of time, where the constant value depends on the heat flux between the already solidified shell and the surrounding cooling medium. After one minute, the solidified shell thickness is approximately 20 mm, increasing to about 40 mm after four minutes. This solidified shell has a higher density than the liquid steel, which can result in oxide cavities forming at the top of the ingot. Fortunately, these cavities tend to be eliminated during subsequent hot rolling or forging processes. To minimize the formation of such cavities, it is advisable to keep the top of the ingot hot using insulating hot tops and by incorporating exothermic compound powders.

Ingot molds for steel production typically consist of upright cast iron, box-like shells that are open at one or both ends and vary in weight. To close the bottom of the mold for casting, a thick cast iron stool is employed, serving as the closure for the mold cavity. It is crucial to maintain a reasonably tight fit between the mold and the stool to prevent any leakage of molten steel. For molds that are open at one end only—known as big-end-up closed bottom molds—the bottom is already sealed and does not require an additional stool. However, it is common practice to place a hot top over the open end of these molds during casting. Again, ensuring a close fit between the mold and the hot top is essential to prevent leakage of molten steel.

Provision of Secondary Refining in Steel Production

Some induction furnace melting units are equipped with secondary refining systems, such as Ladle Refining Furnaces (LRF) and Vacuum Degassing (VD) units, to produce clean, gas-free steel. For these refining processes, the ladle containing tapped liquid steel must be transferred to the LRF before the ingot teeming. In the LRF, liquid steel is heated using an electric arc, allowing for the addition of alloying elements, composition adjustments, and the introduction of slag to facilitate deep desulfurization and deoxidation, preparing the steel for subsequent treatment in the degassing unit. It is worth noting that only specific grades of forging-quality steel undergo vacuum degassing.

Following treatment in the LRF, the ladle is moved to the VD unit. The primary function of the vacuum degassing process is to remove gaseous impurities, reducing oxygen levels to approximately 5 ppm or lower and hydrogen levels to less than 2 ppm. This process also significantly decreases sulfur content, resulting in higher quality steel.

Hot Forging and Rolling Processes

In the hot forging and rolling stages, ingots are heated and then mechanically worked through processes like hammering, pressing, and rolling to achieve the desired shape. The forging process alters the internal structure of the steel, enhancing its mechanical properties. Other methods for shaping hot steel include extrusion (for producing tubes) and stamping (for components like screws and tools).

Ingot Casting in Steel Production

Ingot casting remains a traditional method for producing liquid steel, although it accounts for a small percentage of global crude steel production. Nevertheless, this casting technique is essential for certain low-alloy steel grades and special forging applications, where large dimensions, high quality, or small lot sizes are required.

Typical applications for conventional ingot casting include:

- **Power Engineering**: Components such as shafts for power generation plants and turbine blades.
- **Oil and Gas Industry**: Equipment like conveying systems and seamless tubes.
- **Aerospace Industry:** Critical parts including shafts, turbines, and engine components.
- **Shipbuilding:** Components like engine and drive shafts.
- **Tool Making and Mechanical Engineering:** Heavy forgings and materials such as cold, hot, and high-speed steels, as well as bearings and drive gears.
- **Automotive Engineering:** Parts including shafts and axles.

Overall, the provision of secondary refining and the traditional ingot casting process play crucial roles in producing high-quality steel for various industrial applications.

Ingot Mold Repair

Ingot molds are crucial equipment in the steel ingot production process within a steel melt shop, designed to cast various sizes of steel ingots that require high metal quality, strength, and heat resistance. However, the repeated use of these molds during ingot teeming can lead to thermal distortion, resulting in cracking or chipping due to the high temperatures of the molten steel.

Repair Techniques

When damage occurs, several repair methods can be employed:

1. **Welding:** Damaged areas can be repaired using welding techniques. Traditional welding methods involve the use of welding rods and machines to fuse the damaged parts. However, for larger molds, thermite welding may also be utilized, as referenced in Japanese Patent Publication No. 48488/1982. It's important to note that thermite welding is not feasible for the side parts of smaller molds due to space constraints.
2. **Electric Arc Welding:** A common practice for repairing cavities in molds involves the use of a

bare cast iron filler rod alongside a mild steel electrode in electric arc welding. The mild steel electrode acts as both a heat source and a means of depositing mild steel, while the bare cast iron rod is manually fed into the molten pool. This results in a chilled semi-steel structure. While effective, this method is slow, generates slag, and is costly, often resulting in a weld structure that is hard and brittle. Complete fusion can be difficult to achieve with this technique.

3. **Thermite Welding:** This method involves filling the cavity with a mixture of powdered iron oxide and aluminum. When ignited, this mixture undergoes a vigorous chemical reaction, releasing a large amount of heat and creating a fused deposit in the cavity. Despite its effectiveness, the thermite process produces significant smoke and harmful fumes, which can be a disadvantage. The resulting weld structure is typically of a semi-steel nature.

Cost Considerations for Ingot Molds

When evaluating the overall cost associated with ingot molds, consider the following components:

- Initial Cost of Mold: The purchase price of the mold.
- Usage Cost per Ton: Costs incurred based on the tonnage of steel cast.
- Mold Handling Cost: Expenses related to the handling and maintenance of the mold.
- Inventory Cost: Costs associated with storing and managing mold inventory.
- Scrap Recovery: Financial return from the scrap recovered at the end of the mold's life cycle.

By carefully considering these factors and employing effective repair methods, the longevity and efficiency of ingot molds can be significantly enhanced, ensuring high-quality steel production.

Conclusion

Despite the prevalence of continuous casting in modern steel production, ingot casting remains vital for smaller batches of alloy and specialty steels, particularly those intended for forging or rolling. These ingots, produced in various sizes according to the requirements of specific applications, play a crucial role in the manufacturing of "special steels."

However, the presence of defective or cracked molds presents significant challenges to quality. Ingot molds that are compromised can lead to issues such as cracks in the ingots themselves, including edge cracking and crocodile cracking, ultimately driving up the cost of steel production.

Additionally, the solidification process subjects both the ingot mold and the ingot plate to high thermal stresses as a significant portion of the heat from the molten steel is transferred to them. This stress is compounded during the subsequent stripping of the mold from the solidified ingot, where severe mechanical stresses are introduced, followed by thermal loads as the mold cools. These factors contribute to wear and damage of the ingot molds, which not only limits their useful life but also adversely impacts the quality of the ingots produced.

Therefore, the lifespan of ingot molds emerges as a critical cost-determining factor for the final steel product. Ensuring the integrity and longevity of these molds is essential for maintaining both the quality of the steel produced and the overall cost-effectiveness of the ingot casting process.

Global Acceptance of Environment-Friendly Steel Produced by Indian Induction Furnaces

Kamal Aggarwal
Hon. Secretary General, AIIFA

Synopsis

The global steel industry is undergoing a significant transformation, with a growing emphasis on sustainability and reducing carbon emissions. Indian induction furnaces (IF) are at the forefront of this shift, producing environment-friendly steel using electric induction melting processes. The global acceptance of this steel is rising due to its low environmental impact, energy efficiency, and alignment with international environmental standards. By focusing on recycling steel scrap and integrating green technologies, Indian steelmakers are meeting the growing demand for sustainable materials, especially in regions like Europe and emerging markets. This comprehensive acceptance stems from various factors, including environmental benefits, energy efficiency, compliance with international standards, and contributions to global decarbonization efforts.

1. Growing Demand for Sustainable Steel

With industries worldwide increasingly shifting toward eco-friendly practices, the demand for sustainable materials such as steel has surged. Indian induction furnaces (IF), known for producing low-carbon steel through electric induction melting, are becoming recognized globally for their alignment with green manufacturing practices. This rise in demand is driven by the global push for reduced emissions, resource conservation, and the need for environmentally responsible production.

2. Environmental Benefits of Induction Furnace Steel

Indian induction furnaces use electricity, unlike traditional blast furnaces that rely on coal, resulting in significantly lower greenhouse gas emissions. Moreover, these furnaces predominantly use steel scrap as raw material, promoting recycling and reducing the need for mining virgin iron ore. This approach not only minimizes environmental degradation but also supports resource conservation and waste reduction, making it highly attractive to environmentally conscious markets.

3. Energy Efficiency and Green Technology Integration

One of the key advantages of Indian induction furnaces is their energy efficiency. These furnaces allow precise control over energy consumption, minimizing wastage. Furthermore, several Indian steelmakers have started integrating renewable energy sources, such as solar and wind power, into their production processes, enhancing their environmental performance. This integration of green technologies positions Indian steelmakers as key players in the global movement toward sustainable manufacturing.

4. Compliance with International Environmental Standards

Indian induction furnace steel producers are increasingly aligning their processes with international environmental standards like the Paris Agreement and the United Nations Sustainable Development Goals (SDGs). By focusing on reducing carbon footprints and adhering to eco-friendly production practices, these producers meet the stringent environmental criteria set by global markets, gaining broader acceptance.

5. Lower Carbon Footprint in Global Supply Chains

As the world moves toward carbon border adjustment mechanisms (CBAM), which penalize high-emission products, Indian induction furnace steel is well-positioned to meet these standards. With its lower carbon emissions, this steel is becoming an attractive option for companies seeking to reduce the carbon footprint of their supply chains, providing Indian steelmakers with a competitive edge in international trade.

6. Alignment with Circular Economy Principles

The principles of the circular economy—minimizing waste and reusing resources—are at the heart of the induction furnace process. By using recycled steel scrap, Indian induction furnaces reduce reliance on raw materials, decrease industrial waste, and contribute to sustainable production cycles. This alignment with circular economy goals makes Indian steel products more appealing in global markets where sustainability is a priority.

7. Growing Acceptance in European Markets

Europe, with its rigorous environmental standards, has seen growing acceptance of Indian induction furnace steel. As European industries increasingly prioritize sustainability, sectors such as automotive, construction, and manufacturing are turning to low-carbon materials. Indian steel, known for its recycled content and low emissions, meets these strict criteria, resulting in greater market penetration.

8. Contribution to Global Decarbonization Efforts

Indian induction furnace steelmakers are actively contributing to global decarbonization by adopting green technologies and optimizing production processes to reduce emissions. These efforts support the international community's push for sustainable steel production, which is critical for achieving global climate goals, including those set forth in the Paris Agreement.

9. Collaboration with Global Industry Leaders

To further strengthen their environmental credentials, Indian steel producers are increasingly collaborating with global organizations and industry leaders focused on sustainability. Through partnerships in research, technology exchanges, and innovation, Indian steelmakers are adopting international best practices, which enhances the global acceptance of their products.

10. Supporting Green Building Initiatives

The growing trend toward green building and sustainable construction is creating new opportunities for Indian induction furnace steel. With its lower carbon footprint and use of recycled materials, this steel is becoming a preferred choice in eco-friendly construction projects worldwide. Certifications such as LEED, which promote sustainable building practices, further bolster the demand for this steel in green building initiatives.

11. Technological Advancements in Induction Furnaces

Indian steelmakers have made significant technological advancements in induction furnace operations, particularly in areas such as continuous casting and direct rolling of hot billets. These innovations have improved the quality and sustainability of steel production, enabling Indian steelmakers to meet the stringent environmental and quality standards required by global markets.

12. Global Push for Green Steel Certification

As the world moves toward certifying steel as "green," Indian induction furnace steel is well-positioned to achieve these certifications. The use of recycled materials, energy-efficient processes, and adherence to strict environmental standards help Indian steelmakers secure recognition from international certification bodies, boosting their global acceptance and marketability.

13. Sustainability in Emerging Markets

Emerging markets, particularly in Africa and Southeast Asia, are increasingly adopting sustainability-driven policies, making Indian induction furnace steel highly attractive. These markets are seeking eco-friendly materials for their infrastructure projects, and Indian steel, with its lower carbon emissions and alignment with sustainable production principles, is emerging as a preferred choice.

14. Favourable Trade Policies for Green Steel

Governments around the world are introducing policies that favor eco-friendly imports and impose penalties on high-emission products. Indian steel produced in induction furnaces is benefiting from these trends, gaining a competitive edge in international trade. These policies are expected to continue promoting Indian steel as a key supplier of sustainable materials.

15. Impact on Global Supply Chains

The growing acceptance of environmentally friendly steel from Indian induction furnaces is positively influencing global supply chains. Multinational corporations, driven by environmental, social, and governance (ESG) goals, are increasingly sourcing low-carbon materials. This trend is positioning Indian steel as a valuable component in sustainable global supply chains.

16. Competitive Advantage through Sustainability

By focusing on sustainability, Indian induction furnace steel producers are gaining a significant competitive advantage in the global market. As consumer preferences and business priorities shift toward eco-friendly products, Indian steelmakers are well-positioned to capitalize on this trend, offering a viable alternative to more carbon-intensive steel production methods.

17. Alignment with Global Climate Goals

Indian induction furnaces' reliance on electricity and steel scrap aligns with international climate goals, such as achieving net-zero emissions by 2050. This alignment positions Indian steel as a desirable option for international buyers focused on reducing their environmental impact and complying with climate commitments.

18. Government Support for Green Steel Initiatives

The Indian government is actively supporting greener technologies in steel production, including the use of induction furnaces. Through policies aimed at reducing emissions, promoting renewable energy, and encouraging innovation, the government is providing the necessary support for Indian steelmakers to meet global environmental standards and enhance their presence in international markets.

19. Contribution to Sustainable Infrastructure Projects

Indian induction furnace steel is contributing to global sustainable infrastructure projects, especially in areas such as renewable energy, smart cities, and eco-friendly transportation networks. With the rising demand for green materials, Indian steel is playing a crucial role in shaping environmentally conscious infrastructure development worldwide.

20. Promising Future for Global Expansion

The future prospects for Indian induction furnace steel in global markets are promising. As sustainability becomes a priority for industries worldwide, Indian steelmakers are expected to experience increased demand for their low-carbon products. Their role in the global steel supply chain will likely expand, driven by the international shift towards eco-friendly materials and practices.

In conclusion, the growing global acceptance of environmentally friendly steel produced by Indian induction furnaces highlights the industry's successful adaptation to the increasing demand for sustainable materials. By leveraging steel scrap recycling, reducing carbon emissions, and adopting energy-efficient technologies, Indian steelmakers have positioned themselves as pivotal players in the shift toward greener, more responsible production methods. Their adherence to international environmental standards and alignment with circular economy principles further cements their role as key contributors to global sustainability and decarbonization efforts.

Looking ahead, the outlook for Indian induction furnace steel in global markets is highly promising. As industries across the world increasingly prioritize sustainability and low-carbon solutions, this steel will be instrumental in shaping eco-conscious supply chains and fostering sustainable infrastructure development. Backed by strong government support, innovative practices, and strategic collaborations with global industry leaders, Indian steel producers are well-equipped to strengthen their competitive edge and expand their role in the global shift toward sustainable industrial practices.

Panel Formed to Review Methods for Calculating Emission as per EU Norms
Date: 25/10/2024

To look into technical aspects of CBAM, which can translate into 35% tax on select Shipments

New Delhi: India has set up a technical committee to discuss the challenges associated with the monitoring reporting and verification calculations in the EU's Carbon Border Adjustment Mechanism (CBAM)

Officials said the committee, with members from industry and ministries such as commerce and industry, steel and power, and industry representatives, will review the existing methodologies and framework for MRV of embedded emissions.

“there is pressing need to address the technical aspects and challenges of CBAM and safeguard India's interests in the global carbon regulatory landscape,” said an official.

The EU's CBAM will translate into a 20-35% tax on select imports into the EU from January 1, 2026. From that date, EU importers will have to declare and purchase CBAM certificates to cover the emissions associated with producing imported steel products.

New Delhi has strongly criticized the move and is in dialogue with the EU on the issue. At the World Trade Organization, India has opposed the measure, terming it unilateral and is looking at multiple actions to deal with it.

The committee will identify, develop and recommend solutions to the Bureau of Energy Efficiency, indentify gaps and challenges in current practices and propose improvements and alternative methodologies that align with CBAM requirements.

The CBAM will impact the cement, iron and steel, aluminium, fertilizer, electicity and hydrogen sectors. The EU tax drill began on October 1, 2023 when non EU steel producers reported direct and indirect emissions.

India's exports tp the EU in FY24 amounted to $75.9 billion, with mineral fuels, electrical machinery and iron and steel being the top products.

“The committee will provide expert insights and technical knowledge to figure out how to tackle this protectionist measure” said the officials.

As per the Council on Energy Environment and Water, India's exports of around $37 billion, which is approximately 43% of the country's exports to the EU as of 2022, are likely to be impacted due to the bloc's various non-tariff measures including the CBAM.

Source: The Economic Times

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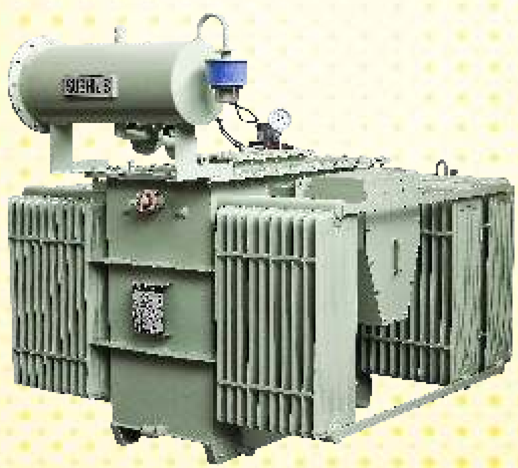

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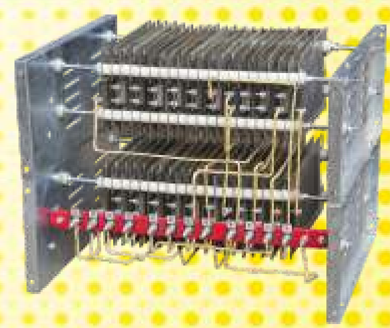

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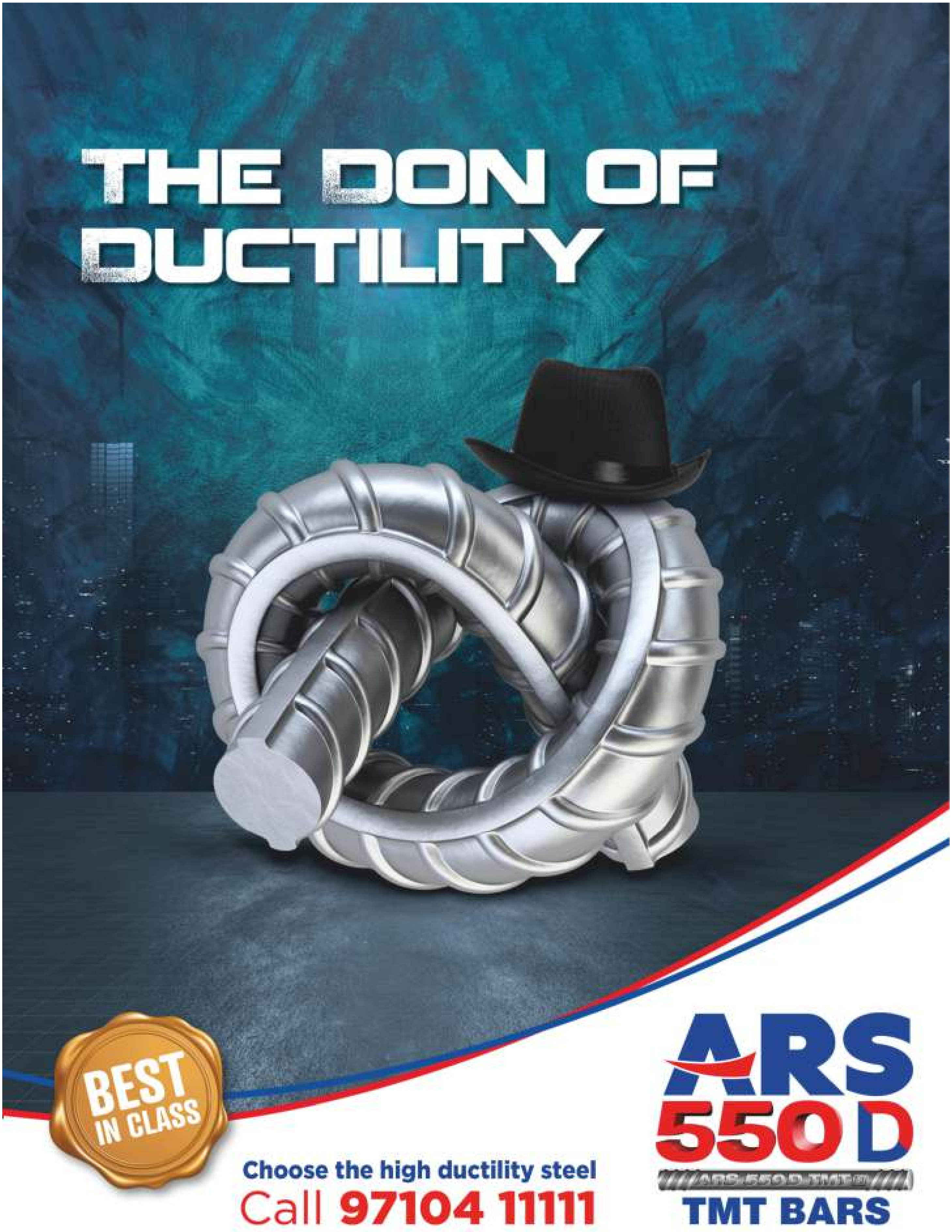
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