ALL INDIA INDUCTION FURNACES ASSOCIATION

AIIFA

INDUCTION FURNACE NEWSLETTER

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What's Inside

हमारे सभी सदस्यों को 72वें स्वतन्त्रता दिवस पर हार्दिक शुभकामनाएँ

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- **Better opportunities for MSMEs**

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- Wide range of Ferrous and Non-Ferrous Metal Products, Ores, Minerals & Ferro Alloys etc are available on **M3**
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- An initiative of Ministry of Steel, Government of India, **M3** is an effort of Central Govt towards convergence of **'DIGITAL INDIA', 'MAKE IN INDIA'** and **'EASE OF DOING BUSINESS'**
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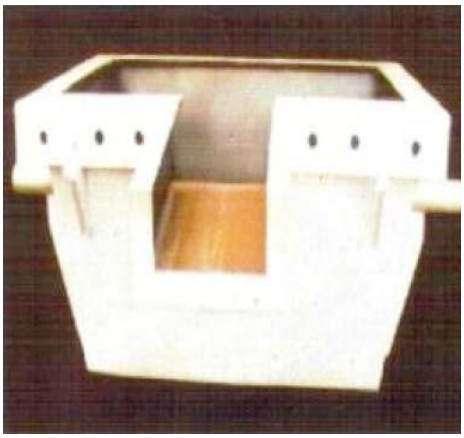
Ladle
5ton - 60 ton



Tundish for Continuous Castel

Geared Ladle
300 Kg - 5000 Kg

Charging Bucket

Ladle Preheater

Vaccume Degassing Vessel

Leading Manufacturer and Exporter of Ladles for Steel Plants & Foundries (Lip Pouring & Bottom Pouring), Tundish for Continuous Casters, Ladle Pre-Heaters (Vertical & Horizontal) Scrap Charging Buckets (Multi Leaves & Clam-Shell Type), Water Cooled Panels (Tubular & Plate Type) Water Cooled Roof for L.R. Furnaces, Fume Extraction Systems, Fabricated Sheet Metal Components, Machinery Parts, All types of Fabrications in Mild Steel, Stainless Steel & Aluminum.

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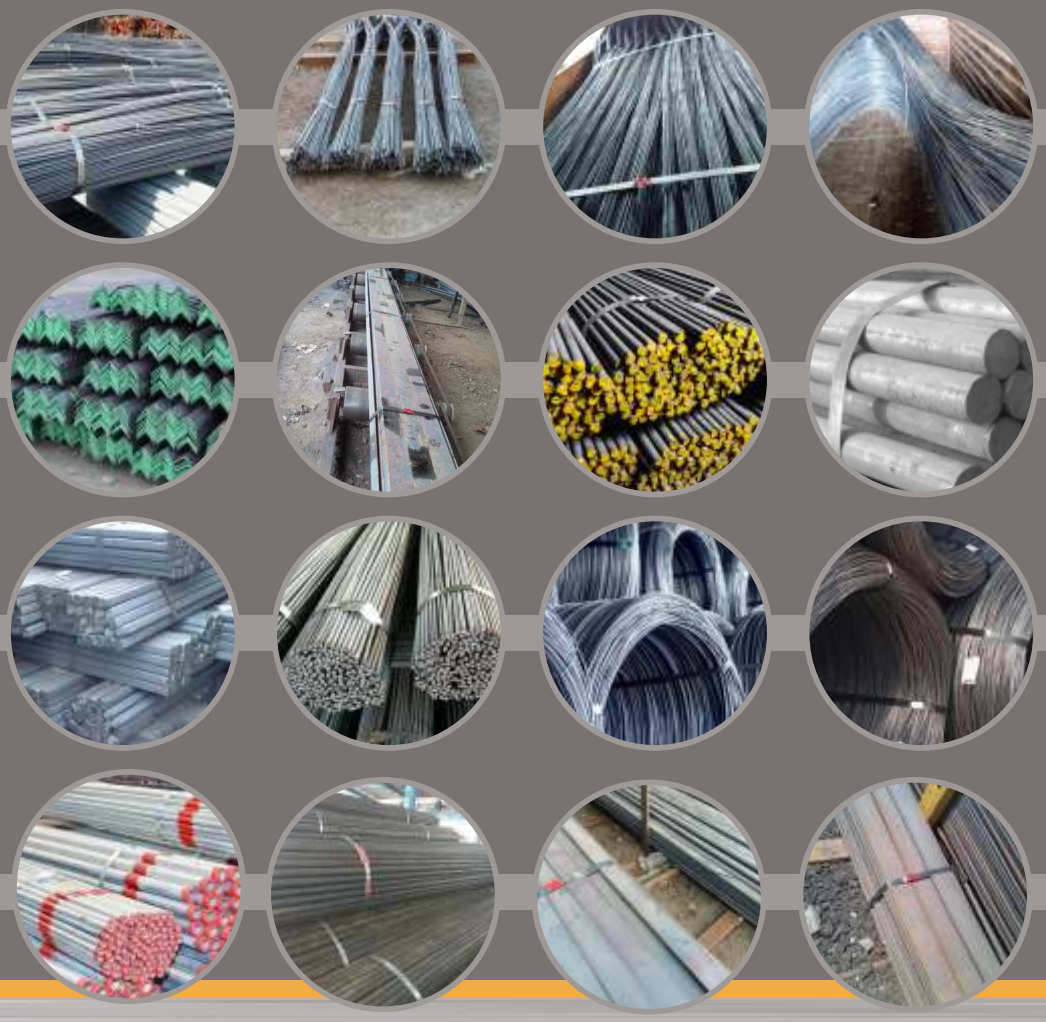

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ENVIRONMENT FRIENDLY STEEL

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Block the Date
22nd October, 2018

Hotel Le-Meridien
New Delhi, INDIA

"Let's fulfill the enormous demand by Make in Steel, Make in INDIA"

National Steel Policy 2017
Emerging, Innovative & Future (EIF) Technology for Manufacturing of Clean, Green and Economical Steel in India

32nd National Seminar
AIIFA 2018

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Invitation to join as a Sponsor in AIIFA's 32ndNational Level Conference

Dear,

All India Induction Furnaces Association (AIIFA) being the premier steel industry association of Electric Induction Furnaces in the country represents a major section of steel units, producing steel through this route. I am happy to inform you that AIIFA is going to organize 32nd National Level conference on 22nd October, 2018 at Hotel Le-Meridien, New Delhi on **"Emerging, Innovative & Future (EIF) technology for manufacturing of Clean, Green, and Economical steel in India- National Steel Policy 2017"**.

2.0. There are over 1300 Induction furnace units and over 1700 steel rolling mill units scattered across all states in the country. The sector accounts for direct employment of over 10 lakhs people, ensures direct or indirect livelihood opportunities' to over 15 lakhs families and produces around 30 Million tonnes (MT) of steel annually, which is over 50% of the domestic crude steel production every year.

3.0. The role of AIIFA is to act as a bridge between the Government and the industry for driving various schemes, participating in the Government's research programs and ensuring capacity enhancement of its units. It also play a vital role to bring various issues of the industry with various related Ministries and concerned Departments and also create awareness of programs and policies of Central/State Government among the members of the association so that their knowledge could be enriched and also could help to adopt latest route of steel making/processing (EIF-Continuous Casting of Steel- Direct Rolling of Hot Billets into finished products) for production of quality steel and also for mitigation of GHG emission.

4.0. We are feeling proud that since last three decade, the association has been conducting national level meets, on yearly basis, to share and discuss the progressive ideas and ways to make the steel industry stronger. The past initiatives, taken by the association, in this direction, have made grand success in terms of interacting with the Hon'ble Ministers and top bureaucrats of the concerned Ministries and also acquainted with the policies and program of the Government for achieving 300 million tonne target of steel capacity in India by 2030. The quantitative and qualitative growth of the AIIFA organized national meet is self-explanatory in determining its importance.

5.0. We take immense pleasure in informing you that, like every year, this year, AIIFA is organizing the above National conference to showcase the disruptive and cutting-edge technological innovations in the steel and associated sector which can bring in a big transformation in the operational efficiency, cost-

effectiveness and take the whole steel making process to the next level by electrical route. The above seminar is likely to be inaugurated by Hon'ble Minister of Steel, Government of India. **The Hon'ble Minister of Commerce and Industry, Hon'ble Minister of MSME, Hon'ble Minister of Power, Hon'ble Minister of State for Steel, Secretary (Steel) and Joint Secretary (Steel)** may also likely to address the gathering. Beside this, the personalities from Steel Industry especially from Public Sector units, Central Government officials, R&D Institutions related to Steel and Steel Products, Rolling and Re-Rolling Mills Industries, Sponge Iron/DRI Producers, Ferro Alloys Producers, United Nations Development Program (UNDP), CSIR-NML, NISST, JPC and other eminent industrialists including members of AIIFA from various parts of the country are also expected to join this event.

6.0. The National council of AIIFA takes the privilege in inviting you on this occasion and request you to kindly participate into the conference. . You are requested to confirm your participation in the above conference. It may be noted that the above conference cannot be successful without your cooperation and without your blessing on the organizers and its team.

7.0. Kindly note that, this event would offer an excellent opportunity to reach your message about your ambitions and services to your potential clients. Sponsorship is proven to distinguish companies from their competitors and is the perfect way to ensure delegates remember your company. By sponsoring, you will have the best opportunity to reach the decision makers and senior level of industry executives and analyst. Looking at the importance of this conference, we would like to propose and request you, kindly support this event by joining as a sponsor, so that the event will be grand success. There are multiple sponsorship opportunity are available which will definitely suit your requirement. Please choose one of them and confirm:

Category	**Principal Sponsor**	**Platinum Sponsor**	**Gold Sponsor**	**Silver Sponsor**
Amount in INR	**Rs. 11,00,000/-**	**Rs. 6,00,000/-**	**Rs. 4,00,000/-**	**Rs. 2,00,000/-**
Offered	**10** Complimentary Delegates for the seminar	**6** Complimentary Delegates for the seminar	**4** Complimentary Delegates for the seminar	**2** Complimentary Delegates for the seminar
	Opportunity to distribute company literature/flyers during the session	Opportunity to distribute company literature/flyers during the session	Opportunity to distribute company literature/flyers during the session	Opportunity to distribute company literature/flyers during the session
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Note:

- *Your contribution towards R&D Fund and Building Fund is exempt from imposition of GST, accordingly you are not liable to deduct any TDS on contribution to these funds.*
- *Any payment for Sponsorship will attract GST @18% and the payer is supposed to deduct TDS.*

Kindly deduct TDS@2% on the payment towards Advertisement only.

We hope you will extend your full support to make the success of the above seminar on 22nd October 2018. We also hope that you will consider our request with full cooperation and enthusiasm.

An early reply shall be highly appreciated in this regard

Thanks & Regards

P. Mishra

Sr. Executive Director

9582695440

E-Mail: aaiifa6@ gmail.com

Defect Free Sound Ingot Production from Induction Furnace

Srikumar Chakraborty *
Abhijit Niyogi **

Continued from Previous Article

The exothermic compositions used as anti-piping compounds are generally of an alumino-thermic composition i.e. containing finely divided aluminium and oxidizing agent. It is possible to use aluminium in relatively pure elemental form, as powders, turnings, sawings or the like but since it is desirable to keep the cost of the anti-piping compound as low as possible it is convenient to use the commercial material known as ball mill dust which is the ground product from slags obtained in the metallurgy of aluminium and usually contains alumina, flux residues and the like and a proportion of aluminium metal. However, the proportion of aluminium may vary widely depending on the source of the ball mill dust but is generally 10 to 30% by weight.

The compositions contain oxidizing agents for the aluminium, suitable materials being strong oxidizing agents such as alkali metal, and alkaline earth metal nitrates and chlorates, and reducible oxides such as iron oxide and manganese dioxide.

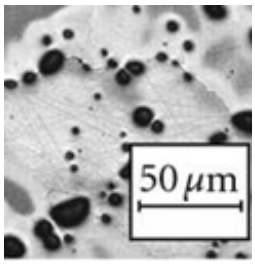
It is also known practice to include a proportion of a fluoride, e.g. an alkali metal or alkaline earth metal fluoride, or aluminium fluoride, or a mixed fluoride salt, e.g. cryolite, or a fluoro complex salt such as a titano, boro or silico fluoride.The composition burns and expands to leave a layer of a heat-insulating residue. Anti-piping or hot topping compositions have been used for several years, and generally include as the basic expanding media acid treated graphite flakes.

In this respect the Rumbold et al of U.S. suggests using 1-50% by weight (preferably 3-20%) of acid-treated graphite and 10-50% by weight of an exothermic component such as aluminum and the like combined with a refractory heat-insulating material. The hot topping taught by the Osborne et al patent, however, is not exothermic, i.e. does not ignite itself and burn, returning heat to the ingot.

The high quality exothermic and insulating powders are used to cover the surface of the steel in ingot casting to assist feeding. Generally, sufficient material is provided at least a 25mm layer on the ingot head but the actual thickness should be increased depending on ingot size varying from as low as 0.6 Kg per tonne up to 2 Kg per tonne, depending on the product type, ingot dimension and, to a lesser extent steel quality. There is a range of APC recipes available in the country to cater for different ingot sizes. Application of pre-weighted bags of material is carried out simply by placing on the metal surface using a shovel, hooked tool, or by throwing.

In the of bottom pouring of steel, recommended practice is to add the material once metal is within the feeder head. The function of the feeder head is to prevent lateral heat losses of the feed metal to the mould wall. In the feeding of ingots it is also necessary to prevent the excessive heat losses to the atmosphere from the radiating upper surface of the molten steel applying exothermic anti-piping compound.

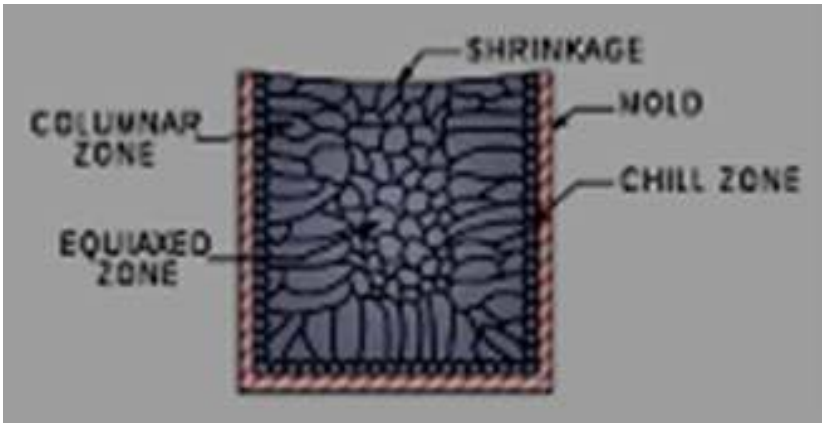
Ingot Solidification : The ingot casting process requires a specific treatment of the different phase changes of metal, liquid, mushy and solid, from the beginning of pouring to the end of solidification. Segregation of certain elements, solidifying defects and micro-sized inclusions in cluster form often happen at the center of the cast ingot during the solidification process whereas the coarse equiaxed grains is the intrinsic structure of the center of ingot due to the inherent solidification characteristics (**shown in the picture**) . All these severely damage the performance and service life of the ingot. The methods to improve the quality of steel ingot are concentrated in the mold design, ingredient optimum design of the insulating plates, composite technological parameters of casting.



The liquid steel in the mould begins to cool at the surface, and chills forming a solid envelope about the molten mass in the interior. The contraction resulting from cooling causes the metal to be drawn to the solid part as it cools, and in this way the central part of the ingot finally cools in a honey-combed state. The formation of the cavity at the center of the ingot is called piping. By the action of gravity on the molten metal this cavity is formed well toward the upper end of the ingot. The piping should be cut off in the discard.

Liquid steel solidifies as ingot in the mould in the following pattern –

1. After teeming liquid steel, portion of liquid steel near the mould walls and bottom is chilled by the cold surfaces and a thin shell or skin is formed on the ingot surface with fine equiaxed grains.



2. An air gap develops between mould and skin due to expansion of mould through the heat transferred from solidification of steel and contraction of skin formed.
3. The solidification front perpendicular to the mold faces moves inwards and towards the centre resulting formation of columnar crystals which rarely extends to centre of mould.
4. Slow rate of solidification create bigger size equiaxed grains at central portion of the ingot.

Segregation in Ingot: In the solidified stage of ingot, the impurities in liquid steel and alloying elements from chemical composition are solidified as non-uniform distribution in different regions depending on the rate of cooling and concentration varies at different parts of ingot. This difference is caused due to different solubility of impurities in liquid and solid phases at the equilibrium temperature and also by the rejection of the solutes from a solidified alloy into the liquid phase as micro and macro segregation.

A. Micro-segregation - Steel ingots have internal discontinuities containing non-metallic particles of different chemical composition and sizes, as well as sites with different chemical composition of the steel (**shown in the attached picture**). Differences of the metal's chemical composition arise from limited solubility of accompanying and alloying elements in the steel during solidification. Accordingly, the resulting crystals inevitably have a different concentration of impurities of micro-volume than the original melt from which they were formed and termed as micro-segregation. Steel always solidifies forming dendrites, therefore it is also termed as dendritic segregation of steel. Micro-segregation has a great

impact on the quality of steel as heterogeneity formed in steel which can to some extent be influenced metallurgically by suitable composition of basic raw materials (e.g. by limiting the concentration of impurities), technology of production and casting, but perfect homogeneity of the steel product cannot be achieved.

B. Macro-segregation –Chemical heterogeneity with the level exceeding the dimensions of dendrites and primary grains is called macro-segregation. Larger areas with different content of impurities are formed through a process of micro-segregation.

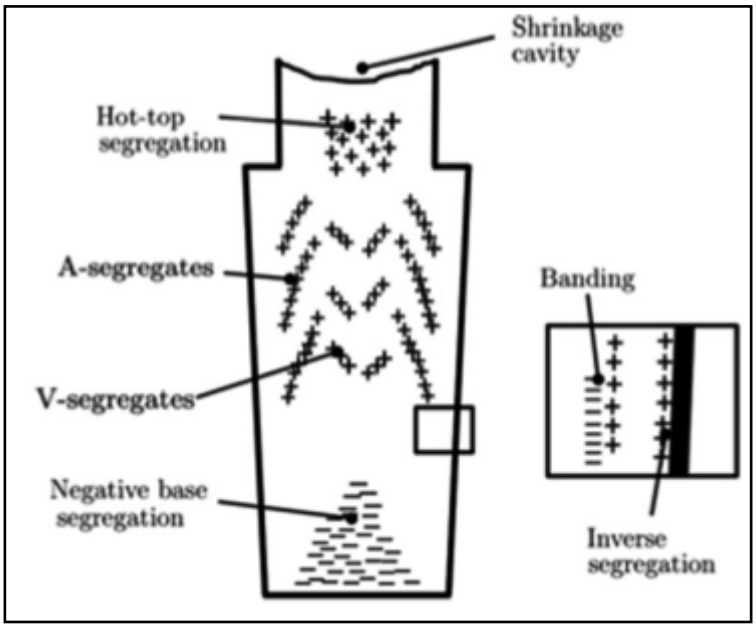
Because during solidification of ingots and castings, typical areas form which have higher or lower content of elements in comparison with chemical analysis of the melt, this is referred to as a negative and positive deviation, or positive or negative segregation. **(Macro Segregation shown in the Picture below)**

The area of negative segregation is at the bottom of the ingot, and depending on the conditions of solidification its magnitude may differ. Positive segregation is usually found in the upper part of ingots and its maximum occurs in ingots of rimmed steel at a distance corresponding to about 80% of the ingot's height. Ingots of killed steels have the highest content of impurities in the head portion. Clusters of solidified impurities of enriched melt between the dendrites, which are called exudates, are also typical for ingots and castings. Basically, these can be classified into two basic types of exudates, gap exudates (V - segregation) and rod-like exudates (A – segregation).

Casting powder is a very important part of the casting process as it prevents direct contact of the liquid steel's surface with atmospheric air in the mold. Upon the entry of the liquid metal into the mold, the hanged paper sack that contains the casting powder burns to release it onto the surface of the liquid steel.

The powder melts into mold flux and the turbulence in the flow then picks droplets of it and circulates them in the entire bulk steel in the mold. Some of the droplets are trapped in the first solidifying melts at the bottom of the mold and that may be responsible for the macro-segregation.

The refractory used for the trumpet and runner systems is the same, it has been observed that macro inclusions from this refractory constitutes about 28.6% of the total number of macro inclusions found (Reference : segregation of macro-inclusion research in special steels, OVAKO, page 33, 34). Most of these macro inclusions are suspected to have come due to the high turbulence, shear stress and expected temperatures associated with the flow. Attention is to be given to check the refractory materials for improving the stability of the refractory during the initial pouring process.



Defects may also arise resulting from the pouring of liquid steel and cooling of the ingot in the mould. A mass of molten metal naturally begins to cool at the surface, and as this chills, it forms a solid envelope about the molten mass in the interior. The piping defect caused from contraction due to cooling forming cavity resulting liquid metal to be drawn to the solid part as it cools, and in this way the central part of the ingot finally cools in a honey-combed state. The formation of the cavity at the center of the ingot is called piping. By the action of gravity on the molten metal this cavity is formed well toward the upper end of the ingot, and for this reason, the ingot is always cast on end. The piping should be cut off in the discard.

Surface cracks will appear if the ingot is taken hot from the mould and exposed to air sufficiently cold to make this surface contract enough to disrupt. These cracks may ruin steel otherwise good, because in forging or rolling the ingot, cracks simply close up but do not weld together, and in this way the material is more or less weakened.

In pouring, globules of steel are apt to splash against the sides of the mould and become chilled into shot. These fall into the molten metal but may not be wholly re-melted, particularly if they rest against the sides of the mould. When the ingot solidifies these shot are more or less separate from the metal surrounding them. These defects are called cold-shuts.

Also in pouring, a film of metal from the ladle may strike on the inside of the mould and become chilled, sticking to the mould. This forms a lamination, as molten metal rising in the mould does not entirely re-melt it.

Use of Slide Gate : Today, few IF units use hydraulically operated slide gate during teeming liquid steel in mould for the advantage of allowing high temperatures of steel with long times of processing, reusable precise control of steel outflow. In slide gate, the ceramic part consists of a ladle brick, upper and lower nozzle, the upper one being fixed and the lower one is movable. The ladle brick is usually the same as for the stopper gate. The upper nozzle is situated in the ladle brick while the lower nozzle is in the sliding part of the gate. Slide gate plates are the most important part of the gate. They are exposed to the aggressive effects of steel as well as to sliding friction. The entire slide gate, including its mechanical part and holder, is a system which can be prepared outside the ladle. It can be very easily attached to the ladle . Slide gate plates are mostly made of alumina or zirconia.

Advantages: It allows high temperatures of steel with long times of processing Reusable Precise control of steel outflow. Manufacture of hydraulic operated slide gate for small ladle is difficult where manufacturers suggest for use manually , but for 8 or 10 T and bigger ladle , same is effective.

Heat Losses from Ladle : Based on observation at different places and conducted research, the suggestions for the reduction of heat losses in the teeming ladle are

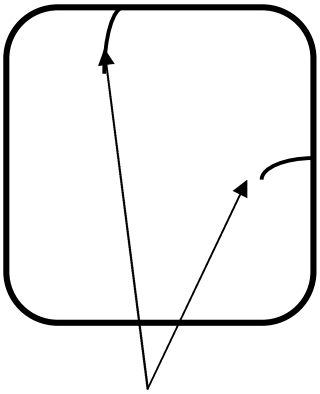
1. ladle preheating ,
2. Keeping as to up end and play the burners on the base of the ladle, where the preheat is most useful during the teeming operation,
3. Efforts to be given to use same ladle in every two hours of operation (considering tapping in 2 hrs), so temperature losses from the metal could be appreciably reduced.
4. Preheating ladle to a high temperature may cause slag remaining in the ladle and same will tend to flow clogging the stopper rod. This may partly be overcome using slide gate nozzle.

Putting ladle cover on heated ladle will, hopefully, reduce radiation losses during holding and teeming of the liquid steel. Reduction in the emissivity of the molten steel surface by additions of vermiculite can also result in a lower rate of heat loss by radiation from the steel surface. Pre-heating of the cover, however, offers little improvement to the operation. For good insulation, the refractory bricks for the ladle would have a low thermal conductivity, allow density, and a low heat capacity. Porous bricks would satisfy these requirements and could be used as a sandwich layer in the base of the ladle, which is the last part of the brickwork to be in contact with the molten metal. (In the picture below ladle after tapping, liq. steel ladle taken for teeming)

Defects like Primary & Secondary pipes, blow holes , gases in Steel Ingots

Corner Crack

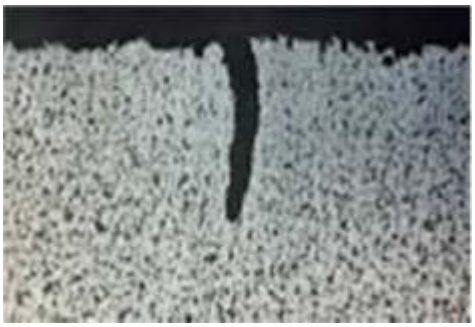
Panel Crk



Mid-Face Panel Crack

Good & Sound Quality ingot

Poor Quality Ingot



Poor Quality Ingot

Product from Good Quality Ingot

Product from Good Quality Ingot

Product from Poor Quality Ingot

(Images of Good, Sound Quality Ingot and also Poor Quality Ingots and Products shown above)

Conclusion: Currently induction furnace steel producing industries are the largest energy consuming sector in the country out of the total industrial energy consumption. Steel industries all across the globe are highly energy intensive, of the total cost of producing steel 20% is spent on energy. The increasing cost of energy and even its current and future availability shows the need to refocus attention on energy conservation in steel production. In most of the steel industries some heat cannot be useful for converting into any useful work & goes waste so it becomes essential to save this heat either by using recovery equipments or by using some heat resisting components. Induction Furnace melting units put their best efforts, mobilizing all needed resources in teeming liquid steel, entire ingot casting process following the standard practices in the entire process to achieve good quality and sound ingot for further hot working process .

References:

1. Foseco Hand Book Page 144-145.
2. Mathematical modeling work by Z. Tan et al.
3. H.F.Marston's experiment on the surface as well as slag entrapment at teeming stage.
4. Bartholomew et al. recommended use of "board flux"to be placed flat on the mold bottom and minimizes splash while it floats on the rising meniscus.
5. Rumbold et al of U.S. suggested using 1-50% by weight (preferably 3-20%) of acid-treated graphite and 10-50% by weight of an exothermic component.
6. The hot topping taught by the Osborne et al patent, however, is not exothermic, i.e. does not ignite itself and burn, returning heat to the ingot.
7. EVALUATION AND CONTROL OF STEEL CLEANLINESS REVIEW Lifeng ZHANG, Brian G. THOMAS Dept of Mech. Engg., University of Illinois at Urbana-Champaign 144 Mech. Bulg., 1206 W. Green St. Urbana, IL 61801, USA,
8. Ingot casting , Metals hand Book.
9. Segregation of macro-inclusion research in special steels, OVAKO, page 33,34.
10. Observation in mini steel plants having IF units

●ex ASP, Member of Metallurgical Consulting Team, email:srichakraborty41@rediffmail.com

●● ex DGM I/c(RCLab), ex Consultant, Dasturco, Chief of Metallurgical consulting team

Pneumatic Rammer

Direct Furnace Charger

Orange Peel Grab

Scrap Hydraulic Pusher

Lining Breaker

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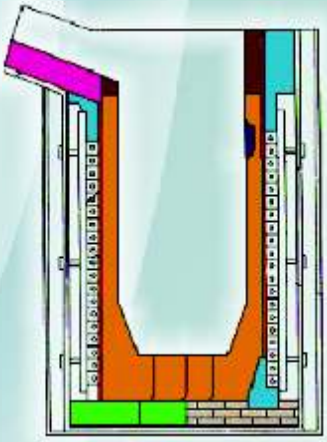

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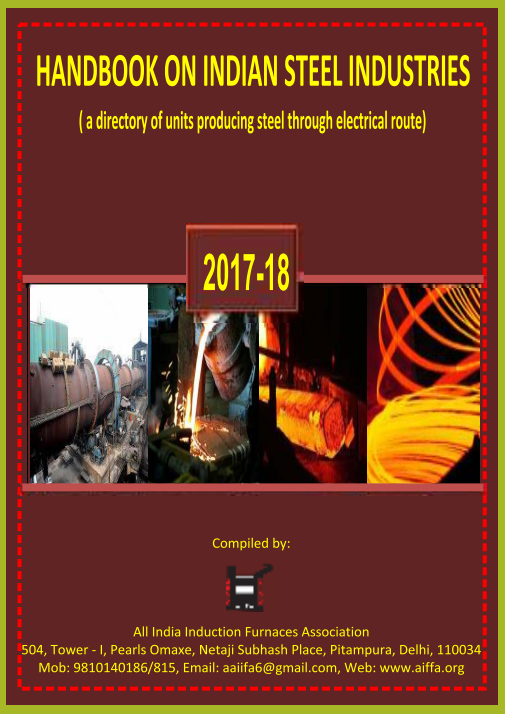

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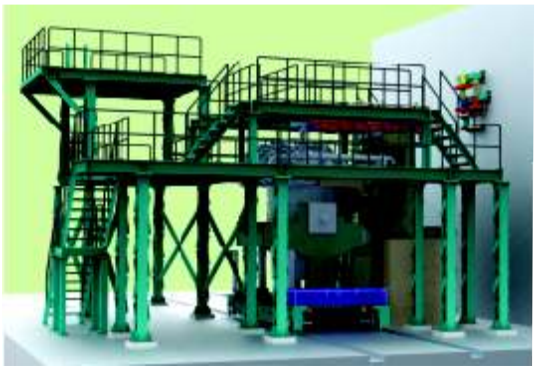

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