ALL INDIA INDUCTION FURNACES ASSOCIATION

AIIFA

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What's Inside

हमारे सभी सदस्यों को नववर्ष और लोहड़ी की हार्दिक शुभकामनायें

2019

AIIFA SECRETARIAT:

504, Pearls Omaxe, Tower-1, Netaji Subhash Place, Pitampura, Delhi-110034 INDIA

Tel: 011-2735 1346/1347
Mobile : 9810410186
Email: aaiifa6@gmail.com
Website: www.aiifa.org
Facebook A/c: aiifa1987 or 9810410186
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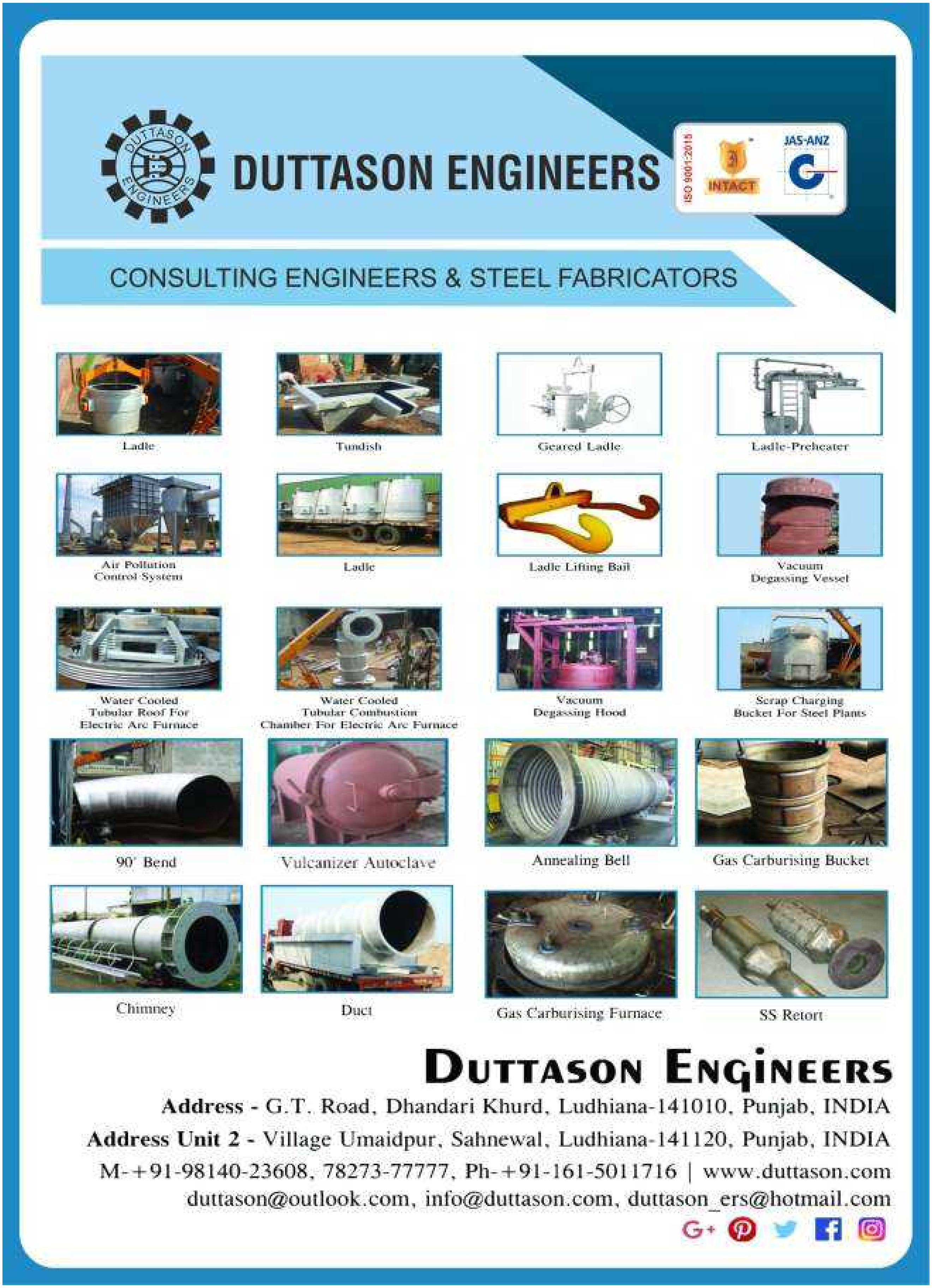
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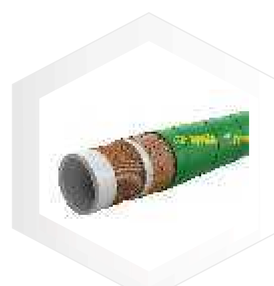

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406, R.G. Trade Tower, Netaji Subhash Place, Pitampura, Delhi, INDIA
rrsteelind@gmail.com; info@rrsi.co.in
www.rrsi.co.in

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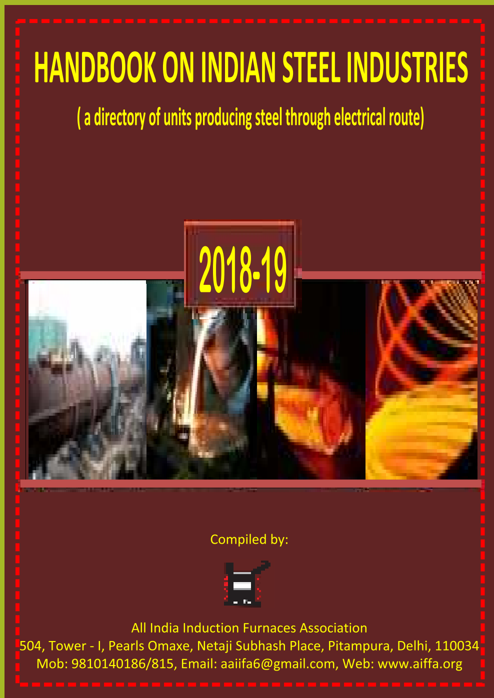
+91-98103 64141
+91-99538 64141
ashok@rrsi.co.in

ABHISHEK MITTAL
+91-88001 13348
+91-93101 64141
abhishek@rrsi.co.in



NEW !!!
HANDBOOK ON INDIAN STEEL INDUSTRIES
(a directory of units producing steel through electrical route)

Broadly Covered the following Parameters:

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Priorities and Preparedness for Leadership in Production of Reinforcing Bars by Indian IFs & Re-Rolling Units

Srikumar Chakraborty
Metallurgical, Member of Consulting

Continue from last issue

Solidification in continuous casting (CC) technology is initiated in a water-cooled open-ended copper mould where steel shell forms in the mould containing core of liquid steel which gradually solidifies in the casting process guided by a large number of roll pairs. The solidification process initiated at meniscus level in the mould is completed in secondary cooling zones using a combination of water spray and radiation cooling (Ref: S Mazumdar and S K Ray, RDCIS, Ranchi, India, Sadhana, Vol. 26, Parts 1 & 2, February–April 2001, pp. 179–198.). The standard casting parameters for billets are designed for proper shell formation eliminating surface and internal defects in the cast product achieving acceptable product quality without any breakage during casting.

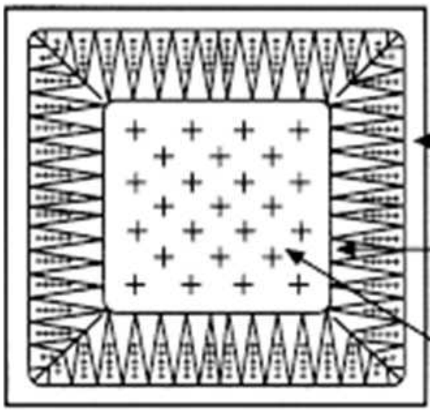
Based on the principle of normal ingot casting, it is presumed that main factors affecting the primary solidification of continuous casting are Mold Shape, Casting temperature &,Casting speed, However, Corner radius of mold affects longitudinal surface cracks of square billets. There is a suitable corner radius for each size of billets to get rid of surface cracks. Unevenness of the primary cooling induces longitudinal cracks on the surface of billets, Too high casting temperature induces longitudinal cracks on the surface of billets. These relationships in continuous casting are just same as those in normal ingot casting. Commonly, casting speed does not affect continuously cast billets but exceptionally in round billet, too high casting speed induces longitudinal cracks on the surface of billets.(Ref: Study on continuous casting of steel-I,Yoshio Aketa, Kantaro Sasaki, Kiyoto Ushijima,1959 Volume 45 Issue 12 Pages 1341-1345, J-Stage, TETSU- to- HAGANE)

The tested steel billets as input materials for rebar production are the only suitable material for producing consistently good quality steel. The main and major producers provide BIS test certificates with Rebar containing the detailed chemical and mechanical properties on purchase of billets by re-rollers. The cost of steel billet manufactured using the electric arc furnace is comparatively higher than BOF or IF route. Most people are familiar with reinforcing steel, commonly called "rebar". It is used in bridges, buildings, skyscrapers, homes, warehouses, and foundations to increase the strength of a concrete structure. Rebar (in picture above) is used in concrete to provide additional strength, as concrete is weak in tension, while steel is strong in both tension and compression.

Since the rolling operation in rebar production is often the last process step, any rejection for any reason at rolling stage is very costly and hence the quality control of rolling process is very important. Severe competition in Indian steel industry urges quality improvements in rolling processes. Among all the quality concerns, the surface integrity is an extremely important quality characteristic of the rolled products. Products with severe surface defects in rolled or concast billets for final rolling as rebar have to be scrapped. Therefore, it is highly desired to detect, reduce, and eventually eliminate the defect at liquid steel or concast stage if possible. Unfortunately, the surface defects remain as the most troubling problems in the hot rolling process. In re-rolling industry, direct rolling of concast billet is a technical evolution of hot charging, where continuous cast billet is directly pushed to the rolling mill, without the need for an intermediate process of re-heating. Different solidification zones during casting of continuous cast M.S. billets for rolling Rebar is shown below.

In this process, the need for a re-heating furnace is eliminated, resulting in a complete heat saving due to this redundancy.The direct rolling process can be adopted in composite units by controlling the secondary cooling of the continuous casting machine by means of Programmable Logic Control (PLC), hydraulic cutting of billets, high-speed transfers of hot billets, and a canopy covering over the conveyer belt.

Enhancement of rebar strength is generally achieved by three processes: (a) cold working, (b) thermo mechanical treatment (TMT), and (ci) micro alloying. The first process may be viewed as post rolling process while the second one is a part of rolling process and the third one is associated with the billet production process.Steel and concrete have similar coefficients of thermal expansion, so a concrete structural member reinforced with steel will experience minimal stress as the temperature changes.



However, attractiveness of rebar are

1. Ability to be bent simplifying the construction and provide for rapid delivery of fabricated material by re-rollers and users.
2. Reinforcing steel bar is robust and able to withstand rigors of construction.
3. Reinforcing steel bar is able to be readily recycled at the end of the structure design life.
4. Reinforcing steel does not need to be tied directly to the formwork and does not float in concrete.
5. Reinforcing steel is available in every region of the country. Due to the number and distribution of plants, LEED and other sustainability credits are available.
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Image of liquid steel tapping from IF, continuous casting of MS Billets, Hot CC Billet, Billet Reduction to Bar, Fin. TMT Bar in plain and fabricated state.

Liquid Steel Tapping

Continuous Casing of Billet

C.C. Billet for TMT Bar Rolling

MS TMT Bar Rolling

Rebar	Fabricated Rebar	Rebar Anchoring

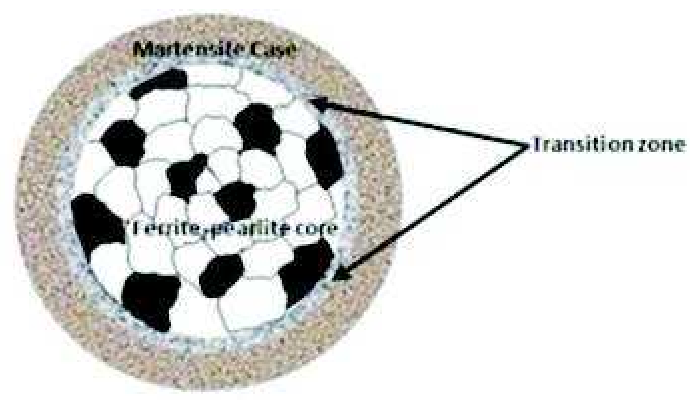
Technologically advancement in the rebar manufacturing process - **Thermo Mechanically Treatment (TMT)** technology is adopted for reducing process cost and better product quality, property where hot bars are subjected to quenching by means of an intense cooling installation by spraying arrangements which hardens the surface layer to martensite while core structure remains austenite. Coming out from quenching chamber, heat flows from core to surface getting tempered. In the cooling bed after completion of quenching, temperature homogenization in the cross section takes place and the austenite core is converted into ductile-ferrite-pearlite core. (T. Gladman, 1997).

THERMEX thermo-processing treatment have enabled production of desired high strength rebars that meet all requirements of civil construction - yield strength ranging from 450 to 550 N/mm2 or more toughness, high elongation value and ductility, weldability, excellent bend properties etc.A short, intensive but very precise in-line cooling of the rolled bar is imparted in THERMEX process through proprietary system. This treatment results in a cooled hardened periphery. On further cooling of the bar in atmosphere a Thermal exchange (THERMEX) occurs between the core and cooled outside martensite surface where by the resultant bar structure is a distinct tempered martensite at periphery and a fine grained ferrite - pearlite structure in the central zone

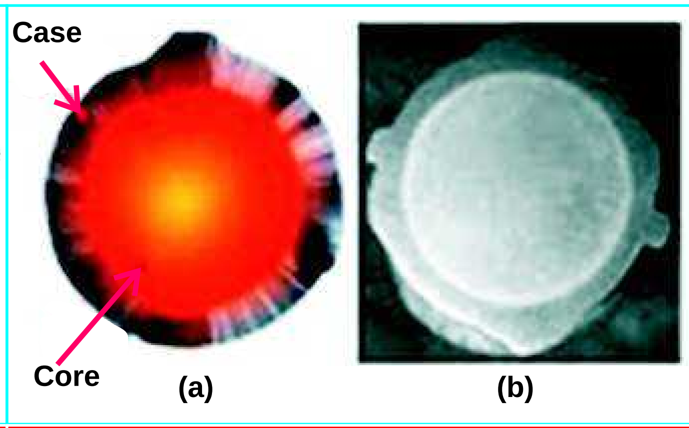
Tempcore®, the other thermo processing treatment process has become a very popular solution for producing high strength and weldable reinforcing concrete bars (rebars) from low C/Mn steel without requiring costly addition of V or Nb for most of the grades to produce. The Tempcore installation is in-line connected to the hot rolling mill, directly after the finishing stand. The three stages of the treatment are the quenching (intense cooling of the surface layer during a fixed time to obtain a controlled layer of martensite under the bar skin), the tempering of this martensite layer (through the heat released from the core of the rebar) and the transformation of the core from austenite into fine ferrite and perlite (+ bainite).

To correctly apply the process, the tailor-made design (achieved by CRM) of Tempcore cooling installation is of prime importance to meet the customer requests. The system is made on the basis of precise calculation and simulation tools, complemented by a very large expertise (more than 70 mills equipped around the world), taking into account the rolling data (dia, speed, finishing temperature, slit-rolling etc), the grades to produce, the mill layout, the specific mill constraints and the controllability of the process.

Today, the Tempcore process is implemented in new or existing mills to produce economically in a wide range of products with varying diameters. Up to 4 strands (slit-rolling) with individual cooling control per line has been designed for small diameters, as well as special development to preserve the cooling uniformity along the billet for large diameters up to 75 mm.



Martensite Case & Ferrite-Pearlite Core



Case & Core in Hot & Cold Condition of Bar

As technological advancement of these process, Bureau of Indian Standards (BIS) has considered this advancement of technology process while issuing the new code IS: 1786-1985 using this as first phrase. Micro alloying and thermo mechanical treatment process are worth mentioning in this field .The technological advances referred to in the IS code are the quenching processes 'Tempcore' and 'Thermex' which received world patents and quick global acceptance amongst engineers.

It must be stressed for the benefit of all (and the civil engineers in particular) that neither of these two patented processes employs any mechanical treatment whatsoever. Instead they obtain the unique properties in the re-bars by “quenching and tempering”. The resulting structure is a concentric tempered martensite periphery with a softer ferrite-pearlite core. (A. Kumar, et al, 1995), (K Priyesh, 2013)

Problems in Rebars: Heavy corrosion in embedded rebar in concrete structures is a major problem causing significant loss of money, time, construction. An effective method to measure corrosion is a fundamental requirement for maintenance planning, timely repairing, and removal for affected reinforced concrete structures.(The Scientific World Journal,Volume 2014, Article ID 957904, 9 pages, Civil Engineering Dept, Indore, MP, Academic Editors: H. Shih, İ. B. Topçu, and H.-H. Tsang) .Most important parameter regarding corrosion state in rebar are:

1. Half-cell potential,
2. Concrete resistivity, and
3. Corrosion current density.

In concrete with low resistivity potential distribution on surface represents potential at steel concrete interface. For better results interpretation of potential readings can be done in accordance with resistivity. With increase in concrete cover difference between surface and interface potential increases.

Content of this paper can be utilized to understand the principal of half-cell potential method, to plan investigation of corroded structures, and to select suitable corrosion monitoring technique.

Composition of steel and mechanical properties below specified standard may cause problem in rebar at least in vital areas. Chloride induced reinforcement corrosion is one of the most common durability problem associated even with modem good quality reinforced concrete structures exposed to a marine environment or to de-icing salts. The time to corrosion initiation depends on

1. How fast chloride ions penetrate the concrete cover to reach and touch the reinforcement and
2. the critical chloride concentration needed for depasivation of the steel reinforcement.

Performance Deterioration in Re-Rolling Units: The present mill layouts and mill conditions do not meet the technological advancement might be due to mill age, health, improper function of re-heating furnace, slow rolling rate, low level of rolling yield, high fuel and power cost which are, really, difficult to take up at one time by mill owners. But continued problems and their cumulative effects and other negative issues are deteriorating the performance of the re-rolling mills very fast affecting long time survival issue of the units. The problem vis-a-vis solution in the present environment though sounds technically feasible but many of them are not acceptable to change the situation. In the present competitive market inspite of having enough opportunities for improvement, entrepreneurs should consult experts to get their views for needing right approaches for rectification or revamping in specific areas setting priority for enhancing performance in positive directions.

Supports may be sought from knowledgeable and highly qualified members in line of Re-rolling association who may involve themselves in such constructive and innovative activities (It is learnt that Retired Soviet Experts with their sound knowledge and good health condition are providing necessary help in this field at very nominal charges, which has to be checked). However, for improving health of the mill making needed expenditure will, hopefully, bring satisfactory results. For the long term survival of the re-rolling mills in the SME sector the following actions are required immediately.

1. Mill association should play an active role for overcoming the fear element and the inertia which is presently preventing the mill owners to opt for change from the present way of working. There is necessity for the mill association to form a full time cell of 3 to 4 experienced professional people along with a budget for active guidance of the mill owners.
2. A massive drive is required from regulatory bodies, and government agencies to provide supports in the specific areas in various ways for which association may prepare White Paper on the subject and submit at appropriate level of Govt. .
3. Bureau of Indian standards (BIS) is needed to take up on a massive scale an exercise to educate mill owners regarding the advantages of standardization and necessity of product certification instead of enforcing only the product certification, BIS may like to create an environment, where mill owners themselves realize the benefits and voluntarily accept the product certification.
4. For technology up-gradation, or any other subsidies in sensitive areas beyond control of entrepreneurs should be properly put up to Government to get any package scheme so that entrepreneurs find attractive for making investments in technology up-gradation. It will be helpful, if such action is jointly taken by AIIFA and Steel Re-roller Association Since multiple ministries may be involved in the proposed exercise, it is necessary that such type of reports jointly prepared should reach Ministry of Steel for taking a lead role duly examined the report and co-ordinate the activities. In this regards IF & Mill associations and ministry should work as a team.

The conditions of the most of the re-rolling mills in the country can be termed as not healthy as operating with very old equipments & technologies and running at low level of productivities consuming high level of energy i.e. power and fuel. There are many problems and challenges associated with these mills. But, the skilled manpower are prerequisites for an energy efficient operation of rerolling mill and with re-heating furnaces. Proper care for improvement in drives, transmission system, rolls and bearings, roll pass design, etc. are now taking place in some of the mills. Use of AC motors with variable frequency drives, reduction gear system (in lieu of erstwhile pulley system), improvement in roll pass design, improved cooling technologies, roller bearings and fiber-bearing (in place of earlier used gun metal bushes), better selection of rolls, etc. are some of the technological developments which needs to be adopted in the industry.

All such measures are improving the energy efficient rolling, product yield by reducing wastes (like burning loss, scale, cutting losses etc). Most of the re-rolling mill is operated by contract labor experienced in line and supervisory personnel who are gaining experience on the job. Still, time to time they should be trained or educated for doing better performance. Time to Time, they should be discussed on matters of continuous improvement as shop floor people know better wat are the problems and source of generation Production of steel at competitive cost is vital for sustenance of rerolling industry and hence, the requirement of setting up of new energy efficient rolling mills is must.

Nowadays, about 95% liquid steel flows through concast route, production cost, down time will be reduced by rolling hot continuous cast products in rolling mills for better yield and fuel saving. In this venture it is suggested melting unit, concast shop and rolling mill should be better located at one place even for better coordination between intra and inter units/ stages. Pusher type furnaces using coal as fuel are predominant in many industry which results in very low thermal efficiency wasting much energy. It is expected that walking hearth type furnaces using pulverized coal will be implemented in future.

Use of coal gasification units, in which coal is gasified and used in reheating furnaces, will ensure cleaner operation of reheating furnaces. Renewable energy like biomass may also be used in future to improve techno-economic parameters. Use of low cost nonconventional fuels like biomass should therefore be promoted in the sector. Scientifically designed reheating furnaces (without over capability or under capability), automation and control system and availability of

Micro-alloyed steel by use of Nb, V, B and Ti in steel for manufacturing rebars will help in improving properties lowering inclusion levels . However, this method , though expensive, but is followed in many countries. The characteristic features of each of the abovementioned elements are:

1. Ti forms titanium nitrides, which are stable at high temperatures and thus prevent austenite grain growth during reheating. Since Titanium is an effective nitrogen scavenger, by forming TiN it ensures that there is enough Niobium in solution for an effective solute drag effect.

2. V (comparatively costly item) exhibits high solubility of its precipitates in austenite and is therefore in plentiful supply for precipitation hardening after transformation ensuring the precipitation of a high volume fraction of fine precipitates and thus enhancing the effectiveness of precipitation hardening. In the rebar steel, vanadium enables the carbon content to be reduced, and hence the weldability to be improved and strength lost by reduced pearlite content in lower-carbon steels is restored and enhanced by vanadium carbonitride precipitates.

   Vanadium-steel reinforcing bars, because they depend for their strength on precipitation, can be rolled on any mill, including modern high-speed mills, and are not subject to the restrictions of niobium steels, which depend for their strength mostly on the fine grain size that is produced by low-temperature rolling. In some old mills, the finishing temperatures are low, but these temperatures are achieved in modern mills only by a reduction of output. Vanadium steels can also be cast without difficulty and, unlike niobium steels, are not subject to corner cracking in continuous casting, nor are they prone to reheat cracking.

3. Niobium has a threefold influence on the mechanical properties of steel: grain size refinement during thermo-mechanical hot forming, lowering the γ to α transition temperature (Ar3), and precipitation hardening. Grain refinement is the only mechanism that simultaneously increases strength, toughness and ductility. This makes Nb the most effective microalloying element, even if added in small quantities. The grain refining effect of Nb is due mainly to delaying or preventing re-crystallization in the last hot forming steps. Flattened grains and a high dislocation density of the austenite enhance ferrite nucleation

The modern mini-steel plant in India is a step toward quality, flexibility productivity, efficient energy use and good working conditions for consistent performance. The increased energy costs due to strict environment norms have created the demand for a system that recovers the process thermal heat or improve rolling process so next further processing may be avoided. The Hot-charging system is a new development and its critical analysis for process energy optimization and energy cost to improve the rolling plant energy efficiency, improve the working atmosphere of the plant and environment both. The optimization strategy is also useful for pollution minimization by energy minimum use, which is now essential due to strict norms and regulation. (Critical Analysis for Sustainable Manufacturing Dr. Atul Modi et al, Prof. Department of I. P. Engineering S.G.S.I.T.S. Indore M.P. India e-mail: atul_123modi@yahoo.com.)

Important Note: China has decided Vanadium addition as micro alloy to improve quality as rebar production from IF has mostly been stopped due to poor quality product as well as environmental pollution.

Present Status of Rebar production in China : Chinese government announced its target of elimination of induction-based steel by 30th Jun 2017 for rebar production. In Jun'17 the government announced its success in closing induction furnaces capacity totaling to about 100 Million Ton/year by more than 600 companies nationwide. It is reported by CISA (Chinese Iron & Steel Association) that Induction furnace (IF) are used to manufacture low quality ground bar steel by using ferrous scrap. As most of the induction furnace in China operates illegitimately there is no official record of the steel produced from these furnaces. In the absence of any statistics, the capacity from induction furnaces is estimated to be 80 to 120 Million Ton per year which is about 8-10% of China's total steel-making capacity.

The closure of these induction furnaces had two consequences - significant fall in country's long steel exports and sharp increase in domestic long steel prices. There were anticipations in the market that China exported its closed induction furnaces equipment to ASEAN countries which was confirmed by SESAI (South East Asia Iron and Steel Institute) in Jan'18. China exported its unwanted and obsolete induction furnace equipment majorly to three ASEAN countries that included Indonesia, Thailand and Malaysia.

Production last year was pegged at 30 million-50 million Tons, and while that would make up 3.7-6.2% of China's total crude steel output, however, the market participants have said induction furnace steel output is not counted in actual output data by the National Bureau of Statistics. CRU has also reported in the same line.

Operating Procedure of Induction Furnace in China : The ultimate conclusion drawn by Chinese Govt. that, henceforth IF operation cannot be allowed for re-bar production,. Normally, among all steel making furnace, IF emits less amount of effluents and having electrostatic precipitator in all the steel making , as such IF unit should be considered as lowest offender. Therefore, what happened wrong for such decisions. It may happen the particular charge used as charge mix in their IF units for melting may emit higher level of pollutants from the types of chargesl.

Induction furnaces have been a thorn in the eye of Chinese steel industrial policy since 2002, but have largely been successful in evading measures. Operators have been astute in expanding furnace inner volumes, adding secondary processing units and branching out into casting and rolling in order to stay ahead of closure thresholds. Often, however, those added facilities are merely a facade for inspectors and are not put into operation, according to the CISA. **Induction furnace operators tend not to issue invoices for their purchases and sales and their full-time staff members are few and transient, which means they avoid costly social security contributions borne by legitimate steelmakers.** This is, of course, a great violation of process.

Market impact of induction steel in China : The slew of measures targeting induction steel has had an uplifting effect on the price of steel and raw materials. This follows the logic that the closure of induction furnaces would shrink the overall supply of steel, especially long products.

Further, given that the steel demand that had been met by induction furnaces should now be fulfilled by integrated steelmakers, iron ore demand should rise. Scrap supply should also increase as a result of less demand from the induction furnaces, which may lead to a decline in its prices.

Chinese steel prices have climbed steadily since the start of this year, after the CISA chairman articulated the central government's goal of eradicating induction furnaces by June 30.Long products have been the main gainers, with rebar in Beijing having jumped 32% to Yuan 3,940/mt ex-stock, and billet in Tangshan rallying 20% to Yuan 3,310/mt ex-stock as of February 27, as Platts data showed. Wire rod and hot rolled coil have risen 14% and 4% respectively.

China is taking action to remove low quality steel output, which is mostly produced by induction furnaces (IFs), by the end of June this year. CRU recently published a Special Feature in the Metallics Market Outlook that analyses why IFs have been targeted and shows, why these closures present an upside to hot metal production, albeit limited. CRU's baseline analysis suggests a complete clean up of the IF sector would result in a surplus 21 Mt of scrap that would need an increase in BOF and EAF scrap rates to consume. It is as likely that this scrap will be consumed, but there is some limited upside for hot metal production.

To be continued......

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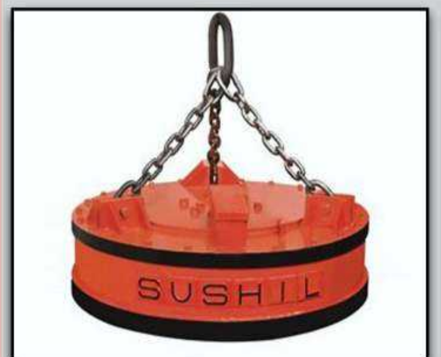

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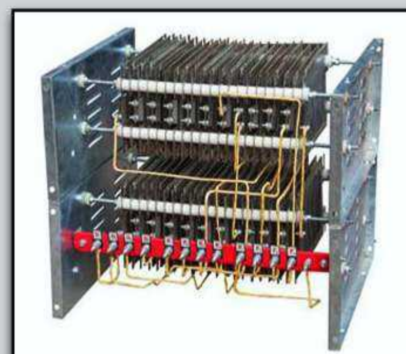
Sintering Heater

Master Controller



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Web: www.saruaikoh.com

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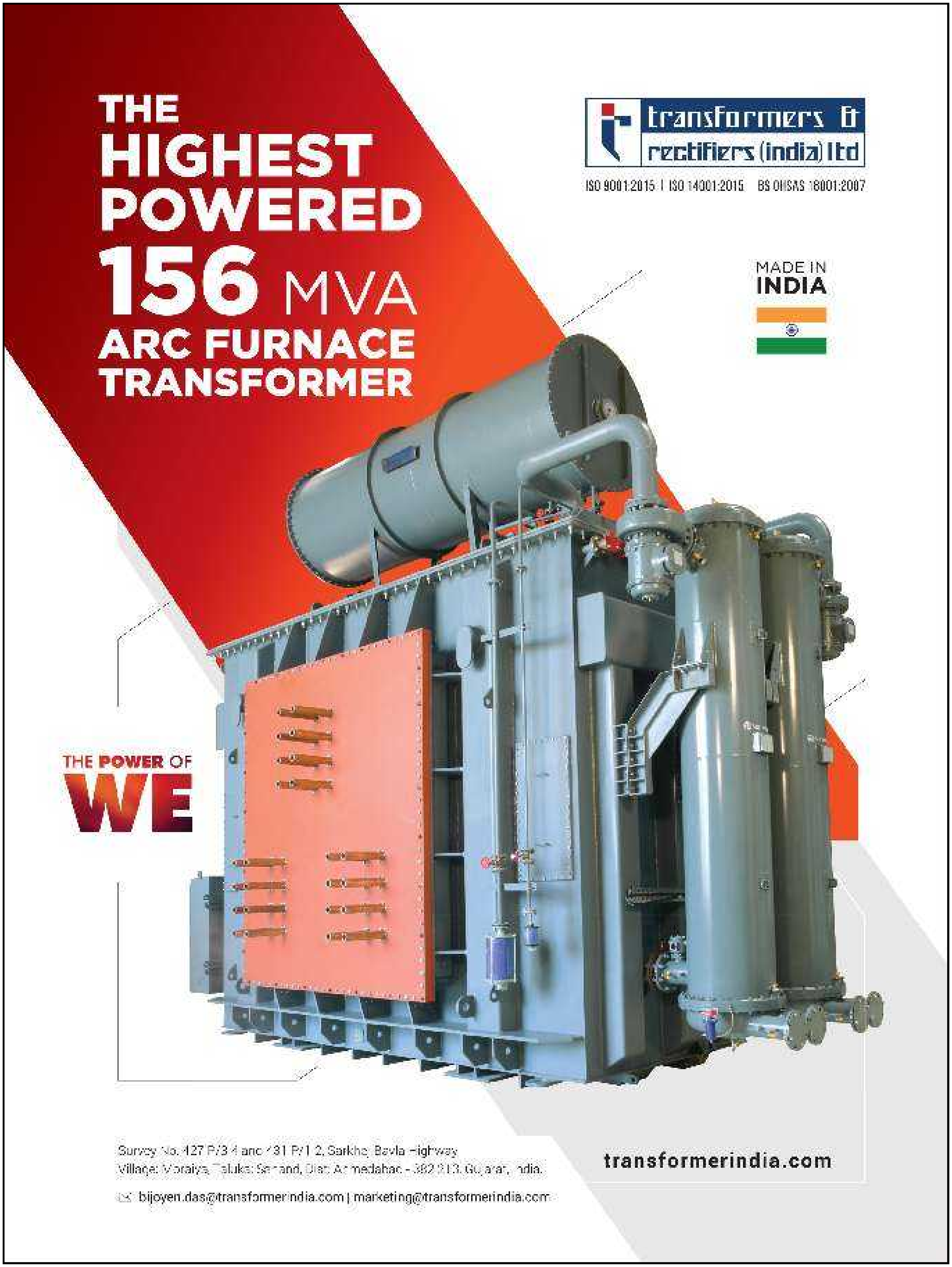
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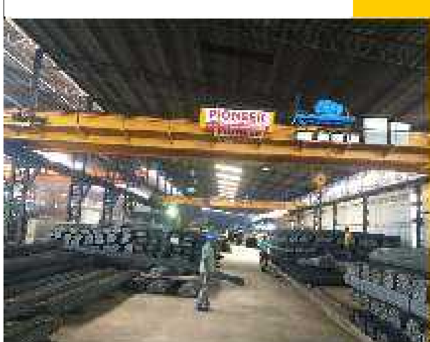

Head Office :
Opp. Arora Palace, Gill Road,
LUDHIANA-141 003 (PB) INDIA

Branch Office :
UG-8, Kirti Shikhar, Distt Centre, Janakpuri,
NEW DELHI-110 058 INDIA

Telefax : +91-161-2491935, 36, 2501937
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