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TATA METALIKS LIMITED

PRAYAS

Dear Customer,

First, let me, on behalf of my team at Tata Metaliks, express our sincere gratitude to you for considering Tata eFee as your preferred raw material for your products, amongst the several options available with you. We value our relationship and therefore, "PRAYAS" is a small effort from Tata Metaliks for our esteemed customers, like you, to provide something beyond pig iron - disseminate our knowledge gathered through years of learning, which could help you improve your processes and products to make your customers delighted.

We believe in long-term relationship and association with all our stakeholders and it is even more important when you are concerned, since our existence is only because of our customers, who buy not a product called Tata eFee, but a belief called trust. We assure you, that besides giving you high quality pig iron, consistent in chemistry and customized to meet your exact requirement, we will continue to provide you technical assistance through our engineers for improving your energy efficiency, reducing your rejections, making your operations greener and sustainable and reducing your cost. Our technical service also endeavours to provide valuable suggestions to you, in case you need, for developing new products for your customers.

You are aware that there is a gradual shift from grey iron to ductile iron in the casting industry due to superior properties of ductile iron. Therefore, we thought that it would help you in understanding the importance of various elements in the properties of ductile iron. We have covered carbon and silicon in this issue and other elements will follow in the subsequent issues.

We look forward to receiving, not only your valuable feedback for improvement of "PRAYAS", but also your suggestions on topics of interest which we could cover in future when we connect with you through the communication medium of "PRAYAS".

Thanks once again for being with Tata Metaliks and reposing the confidence in our product and services.

Happy Reading.

Yours sincerely,

Rajesh Mishra

(Executive Vice President)

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Editorial

Dear Readers,

It is well known from the production data of various countries, Ductile iron production is growing year on year, because of the properties attached to it like high strength with low casting section thickness etc. In the production of quality ductile iron, each element has its own vital role and effect on properties so we thought it is very appropriate to give insights of some elements' effects on properties.

Also a vital step in production of quality cast iron is INOCULATION. When comparing un-inoculated and inoculated irons, differences in microstructure are easily revealed, which will again strongly affect the final mechanical properties of the castings. The readers will feel happy to learn about inoculation theory in this edition.

In our continuous journey to Green technology and to make you stand at the same level, we have conducted a Technical Seminar in our Customer Service Centre and the glimpses of the same are also provided.

We are sure that these articles will enhance your technical knowhow and offer some salient points in quality castings production.

Regards,

M. Sambasiva Rao & Koushik Dolui

Editorial Team

M. Sambasiva Rao, Koushik Dolui, Munmun Pal & Monideep Majumder

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What is Inoculation?

Inoculation is a means to control and improve the microstructure and mechanical properties of cast iron. The inoculation process will provide sufficient nucleation sites for the dissolved carbon to precipitate as graphite rather than iron carbides (cementite).

Inoculation in Grey Cast Iron :

The grey iron microstructure is normally determined by the base iron composition, the cooling rate and the inoculation process. Controlled under-cooling promotes the normally desired A type flake graphite, characterized by randomly distributed graphite flakes in a fully pearlitic matrix.

Inoculation is a means to change the undesired graphite form into a more desired form.

Inoculation in Ductile Iron :

The extensive chill (carbides) in un-inoculated condition will destroy the mechanical properties of this iron and make it very difficult to machine such castings. Hence, inoculation is a crucial requirement for most ductile iron processes simply to make machinable castings.

Most common Inoculants :

The most common inoculants are ferrosilicon based alloys with small and defined quantities of Calcium, Barium, Strontium, Zirconium or Aluminium.

Inoculation addition methods :

1. **Ladle inoculation :** It is a common method where the inoculant is added to the metal stream as it flows from transfer ladle / melting furnace to pouring ladle. A small heel of metal should be allowed to accumulate in the bottom of the ladle prior to the addition. This allows the inoculant to be mixed and evenly distributed in the iron.
2. **Stream inoculation :** Inoculant is added to the stream of metal flowing from pouring ladle into the mould.
3. **Mould inoculation :** It involves placement of the inoculant in the mould such as in pouring basins, at the base of the sprue or in suitable chambers inrunner systems. Inoculants for this method can be power bonded into a pellet or precast slugs or blocks.

Inoculant size & percentage :

For Ladle inoculation : 6 to 12mm is preferable. Excessive fines should be avoided because they can float on the surface and loose their effectiveness through oxidation. The amount of inoculant needed in this method normally varies between 0.15 to 0.4% depending on the potency.

For Stream inoculation : A maximum particle size of 8 to 30 mesh and a minimum size of about 100 mesh are recommended. Addition levels range from 0.1 to 0.15%.

For Mould inoculation : Inoculant size varies from 20 to 70 mesh and addition rate is 0.05 to 0.1 %.

Fading of Inoculation Effect : Fading of inoculation results in carbide formation and poor

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graphite structures if the iron is held for prolonged time before pouring. The reason for this fading loss is coarsening and growth of micro-inclusions. The driving force for this coarsening is a reduction in the specific surface area of inclusions, thus reducing the total energy of the system. The fading rate of inoculation is directly related to the diffusion rate of reactive elements through the liquid metal.

Ductile Iron :

Ductile cast iron, also known as nodular iron or spheroidal graphite cast iron is cast iron in which the graphite is present as tiny spheres (nodules). In ductile iron, eutectic graphite separates from the molten iron during solidification in a manner similar to that in which eutectic graphite separates in grey cast iron. However because of additives introduced in the molten iron before casting, the graphite grows as spheres, rather than as flakes of any of the forms characteristic of grey iron.

Most ductile iron castings are used as cast, but some castings are heat treated according to the application of the castings. As the matrix structure is progressively varied from ferrite to ferrite plus pearlite to pearlite to bainite and finally to martensite. Hardness, strength and wear resistance increase but impact resistance, ductility and machinability decrease.

Ductile iron can be alloyed with small amounts of nickle, molybdenum or copper to improve its strength and hardenability. Large amount of silicon, chromium, nickle or copper can be added for improved resistance to corrosion, oxidation or abrasion or for high temperature applications.

The unique properties of ductile iron are as follows:

1. Lower density makes ductile iron weigh 10% less than steel for the same section size.
2. The graphite content provides damping properties for quiet running gears.
3. The low coefficient of friction produces more efficient gearboxes.
4. Ductile iron has less tendency to gear seizures from the loss of lubricant.

Ductile Iron Applications :

1. Ductile iron pipes for water
2. Automotive/trucking industry
3. Paper making machinery
4. Farm equipments
5. Construction machinery and equipments
6. Power transmission components
7. Oilfield equipments

Specifications :

Most of the specifications for standard grades of ductile iron are based on properties.

The ASTM system for designating the grade of ductile iron incorporates the numbers indicating tensile strength in ksi, yield strength in ksi, and elongation in percent. For example, grade 80-60-03 means 80 ksi minimum tensile strength, 60 ksi yield strength and 3% elongation.

The international system of grade designation uses the tensile strength value, in Mpa and elongation percentage. For example, grade 500-7 means 500 Mpa minimum tensile strength and 7% elongation. Properties are determined by their matrix structures, where the matrix structure depends on

1. Chemical composition
2. Cooling rate
3. Section size of the casting

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Effect of Carbon & Silicon on Ductile Iron :

Carbon: It influences the fluidity of the molten iron and shrinkage characteristics. As ductile iron solidifies, the carbon in solution precipitates out as graphite and causes an expansion of the casting which can off set the shrinkage as it cools from liquid to solid.

The size and number of graphite nodules formed during solidification are influenced by the amount of carbon. The optimum range for this element is usually 3.4 to 3.9 excess carbon (above the range) causes graphite flotation in case of heavy section castings. Graphite flotation occurs when low cooling rates and high "carbon equivalent" combine to produce large nodules that rise during solidification.

In induction furnace melting practice, carbon is derived from pig iron, carburisers, scrap and foundry returns. The carburisation of steel scrap charge is achieved by adding low sulfur graphite like graphite electrode scrap, coconut shell etc.

Silicon: It is a powerful graphitizing agent and the preferred range is about 1.8 to 2.8%. Within the normal composition limits, increasing amounts of silicon promote structures that have progressively greater amount of ferrite. Furthermore silicon contributes to the solution strengthening and hardness of ferrite. Increasing the amount of ferrite reduces the yield strength and tensile strength but increases the elongation and impact strength.

Silicon enters ductile iron from raw materials, including scrap, pig iron and ferro alloys and to a small extent from silicon containing alloys added during inoculation.

(Effect of other elements to be continued in next issue.)

Technical Seminar :

Tata Metaliks Limited conducted a Technical seminar on 14th February, 2013. Around 35 customers attended the seminar. We had invited Prof. Sadhan K Ghosh, Ph.D (Engg), Head - Mechanical Engineering, Jadavpur University, Kolkata as the key note speaker.

The key note speaker delivered a lecture along with a presentation on the topic "**GREEN MANUFACTURING – OVERVIEW OF GREEN FOUNDRY**" which gave insights on green manufacturing, green supply chain management, strategies to implement green technologies, importance of automization to minimize pollution generation, installation of pollution equipments to measure and control emission level of SPM, CO_2, CO, SO_2, NO etc. in various foundry processes.

Our colleague Mr. Abir Pal from Kharagpur plant delivered a speech along with a presentation on "**SUSTAINABLE DEVELOPMENTS IN FOUNDRIES** "which covered energy management. Environment and climate change mitigation, water management, waste management, energy audit, efficient operational practices in cupola, induction furnaces, moulding, coremaking , machine shop, air , electrical & utilities systems.

Mr. Abir Pal explained about the technological and process upgradations in various foundry processes to achieve sustainable development and the financial schemes available for foundries to improve energy efficiency.

Executive Director, Executive Vice President (Sales & Marketing), Chief (Corporate Planning & Marketing) & CQH graced the occasion with their presence.

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Laboratory Testing facilities at Customer Service Centre, Howrah:

Customer Service Centre is equipped with a laboratory to provide testing facilities for the following:

1. **Coke , Coal and Graphite Powder** : Includes % of Ash, Volatile Matter, Carbon, Sulphur and Phosphorus.
2. **Casting, Scrap & Pig Iron** : Includes % of Carbon, Silicon, Manganese, Chromium, Nickle, Molybdenum, Copper, Sulphur and Phosphorous.
3. **Limestone and Refractory bricks** : Includes % of Calcium Oxide (CaO), Magnesium Oxide (MgO) and Aluminium Oxide (Al_2O_3).

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