The Effect of Different Inoculant Material on Microstructure & Mechanical Property of SG 500/7 Iron in Green Sand Casting Process

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ABSTRACT

Microstructural modification of spheroidal cast iron alloys by various inoculants is a well-known practice to improve their mechanical properties. The microstructure of nodular cast irons is represented by the presence of spheroidal graphite nodules. Graphite nodularity decreased as the Melt was held for longer periods of time before casting after inoculation and nodularisation treatments. The microstructure consists of graphite nodules Embedded in austenitic matrix and carbides. Inoculants play a great role in changing the structure–properties of ductile iron. In this research paper we try to figure out impact of various inoculant on Micro structure & Mechanical Property of SG 500/7 in Green sand Casting. For this Experiment we select mainly three type of Inoculant: Sr Based, La Based, & Ca-Ba based Inoculant. Micro structure Image analyses have been carried out to measure nodule count and nodules dimensions.

Keyword : - *Green sand casting, Hardness Test, Microstructure Analysis, pre inoculation, post inoculation, SG 500/7, Tensile Test etc….*

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1. Introduction

Green sand casting is a low cost way of producing a few of the engineered components of present day device and equipment. The practice of melting steel and pouring it right into a preferred shape dates again centuries. At the same time as the primary idea of sand casting hasn't modified over time, however the strategies have modified[1]

Green sand is a prepared aggregate of silica sand (each new and reclaimed), numerous bonding clays, carbonaceous substances and water. The components are blended to shape the prepared Green sand. An important component inside the casting manner, green sand instruction has emerge as the focal point of technique automation in latest years. The molten iron is then poured into the mold. The liquid metallic is introduced to the mildew cavity via a gating gadget designed to maximize casting first-rate and yield. Within a matter of mins, the molten metal is solidified. The casting is then allowed to chill in the mould for a predetermined duration of time earlier than shakeout is been completed to get rid of the casting from the mold.

When cool, the gating machine is eliminated from the casting and recycled as scrap/go back. Secondary cleaning operations will take away any excess sand adhered to the casting floor. Finally, parting line flash and gating marks are eliminated in a grinding operation. The raw casting is now prepared for similarly processing. (I.e. machining, painting, plating...) In some instances, no in addition processing is necessary because the component has been designed to feature as a raw casting.

1.1 SG Iron

SG iron become observed in 1948 at the American Foundry men Society Annual conference. It was visible that by including magnesium before pouring prompted. The graphite to shape nodules rather than flakes. This ended in a brand new material, with extremely good tensile energy and ductility. Adding these mechanical residences of this material to the benefits already offered by way of cast iron quickly led to it locating its way into virtually every mainstream region of engineering, in lots of instances changing current Metallic castings or forgings because of viable value savings. It is proven that, latest system and trends open new avenues to this family of materials.[2]

SG iron is an alloy of iron and carbon having nodules or spheroids of graphite embedded in a ferrite-pearlite matrix. The nodules are compact spheres and are sharp and ordinary. The graphite occupies approximately 10-15% of the entire material quantity and due to the fact Graphite has negligible tensile power, the main effect of its presence is to reduce the effective go-sectional region, which means that that ductile iron has tensile strength, modulus of elasticity and impact energy proportionally lower than that of a carbon steel of otherwise similar matrix structure. The matrix might also range from a gentle ductile ferrite shape thru a hard and higher strength pearlite shape to a difficult better and relatively difficult martensitic structure. Well known engineering grades of ductile iron normally have the structures that are ferrite, ferrite/pearlite or pearlite. Controlled processing of the molten iron precipitates graphite as spheroids as opposed to flakes. The spherical form of the graphite removes the material's tendency to crack and helps save you cracks from spreading. The residences of SG iron are affected by factors like Si, Mn, Cu, Ni and so on.

Besides carbon nearly all of the elements increase hardness and tensile strength. While besides Si, all different factors promotes pearlite, besides Si, Cu, Ni all different elements promote carbide formation. Experiments have shown that heat treatment operations can improve the properties of SG iron touch an extent that it may overcome the properties shown by steels. Today austempered ductile iron is considered a bright prospect having a good combination of properties.

1.2 SG 500/7

The Mechanical Property of SG 500/7 Indicates 500 as Tensile Strength & 7 as the percentage of elongation, The Min Hardness of Material is 170 BHN & Max Up to 230 BHN. & the average chemical Composition is given below.

ELEMENT	Percentage
carbon	3.40-3.85%
Phosphorous	0.10%
Manganese	0.10-0.30%
Sulphur	0.02%
Silicon	2.30-3.10%
Magnesium	0.07%

Table 1: Chemical Composition [21]

2. Inoculation

Inoculation is a way of controlling the microstructure and properties of cast iron with the aid of minimizing undercooling and growing the number of graphite nucleation activities at some stage in solidification. Inoculants are delivered to molten cast iron (each gray and SG forged irons) prior to casting, which give heterogeneous sites for nucleation of graphite as opposed to iron carbide (cementite, Fe3C) for the duration of subsequent solidification stage.[4]

The number one goal of nucleation is to prevent melt undercooling to temperatures underneath the metastable eutectic, in which iron carbide section is shaped. The cast iron solidification mechanism is liable to shape chilled iron systems while inoculation is inadequate. The impact of inoculants on microstructure fades with time and for this reason it is very critical to precisely control the preserving time among inoculation and casting in sand mold. Both brief and lengthy holding times between inoculation and casting adversely have an effect on the scale and size distribution of graphite in casting. Historically, inoculants have been based totally on graphite, ferrosilicon or calcium silicide. The maximum popular inoculant today is ferrosilicon containing small quantities of factors consisting of Al, Ba, Ca, Sr and Zr.[5]

Inoculation reasons significant development in mechanical properties due to microstructural modifications in cast iron. However, value of some of these inoculants is high and there's a demand in solid iron foundries to use low price inoculants with reduced fading impact. The fading effect of inoculants depends on the mechanism of inoculation.[8]

2.1 Pre Inoculation

Pre inoculation is an unusual approach of treating grey cast iron. On this method, inoculants are brought to the steel move as it flows from the switch ladle into the pouring ladle. The quantity of inoculant needed on this treatment varies among 0.15 and 0.4 wt. %, depending at the efficiency of the inoculant. However, whilst graphite inoculant is used then its amount is constrained to approximately 0.1 to 0.2 wt. %. The chosen grade of inoculant for ladle inoculation is delivered to the metallic move while tapping from furnace to ladle, or ladle to ladle [7].

Fig -1: Pre Inoculation

2.2 Post Inoculation

Specific difficulties stand up with the usage of automated pouring furnaces in which conventional ladle inoculation is not feasible. So in this case, the late circulation inoculation treatment is accompanied. This type of inoculation is done before pouring.[6]

Fig -2: Post Inoculation

3. Experiment Details

For the various experiments we select basically three type of inoculant material which can be used to find out inoculant effect on mechanical & micro structure property of SG 500/7 Iron.

Inoculant	Si	Zr	Ba	Ce	Mn	Sr	Ca	La	Al
Ca-Ba	72-78	NIL	2-3	1-2	NIL	NIL	1-2	NIL	1.5
Sr Based	73-78	NIL	NIL	NIL	NIL	0.6-1	0.10	NIL	0.50
La Based	71-80	NIL	NIL	0.6-1	NIL	NIL	0.10	0.5-1	0.60-0.65

Table -2: Selected Inoculant Materials

3.1 Process Parameter

Grade	Inoculant Material	Method
SG 500/7	Ca-Ba Based	pre
	Sr Based	Post
	La Based	

Table 3: Selected Process Parameter

Total No. of experiments to be performed =1*3*2

=6

4. Result & discussion:

In this section we try to find various tensile & hardness result with respect to micro structure analysis

4.1 Tensile & Hardness Results:

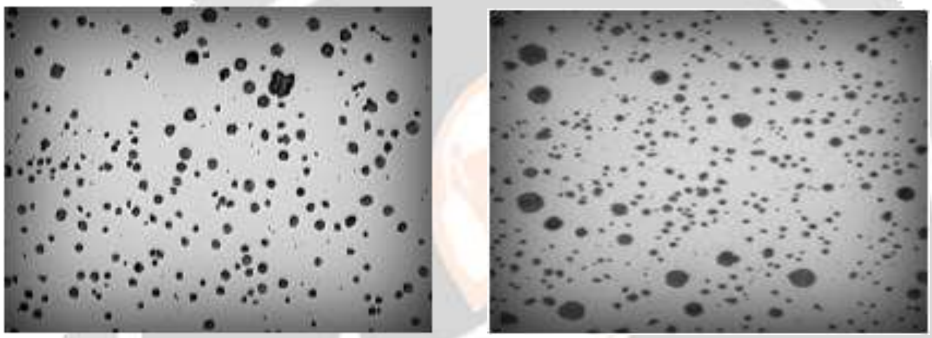
Sr No	Materials	Inoculant Material	Inoculant Method	Tensile Test (N/mm^2)	Elongation	Hardness (BHN)
1	SG 500/7	Sr Based	Pre	533	8.81	184
2	SG 500/7	Sr Based	Post	561	10.90	187

3	SG 500/7	La Based	Pre	577.53	8.19	190
4	SG 500/7	La Based	Post	**641.7**	10.21	205
5	SG 500/7	Ca-Ba Based	Pre	600.78	8.07	197
6	SG 500/7	Ca-Ba Based	Post	**675.18**	10.02	209

Table 4: Tensile & Hardness Results

4.2 **Microstructure Analysis**

(a) Micro structure of SG 500/7-Sr Based

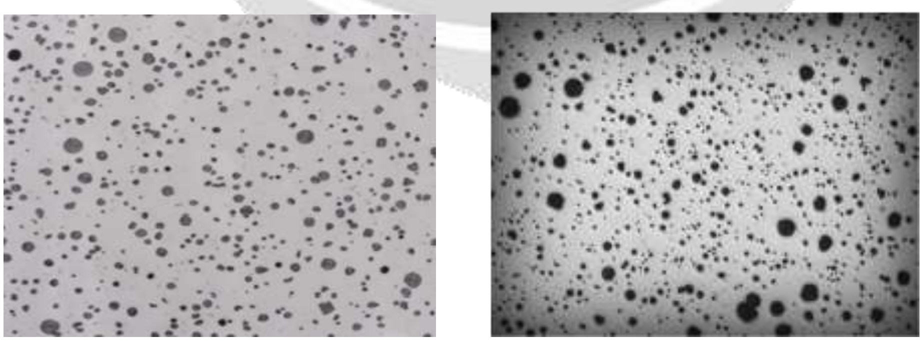


Pre Inoculation Post Inoculation

Fig 3: Micro structure of SG 500/7-Sr Based Pre & Post Inoculation at 100X

These Figures show that Micro structure of SG 500/7 Cast Iron with Sr Based Inoculant. In the First fig show Pre Inoculation Treatment & Second fig show post Inoculation treatment at 100X Magnification. This both figure mainly content ferrite & small amount of Pearlite structure, but by the Image Analyser we try to figure out nodularity percentage and we achieve 85% for pre inoculation & 87% for post Inoculation treatment

(b) Micro structure of SG 500/7-La Based

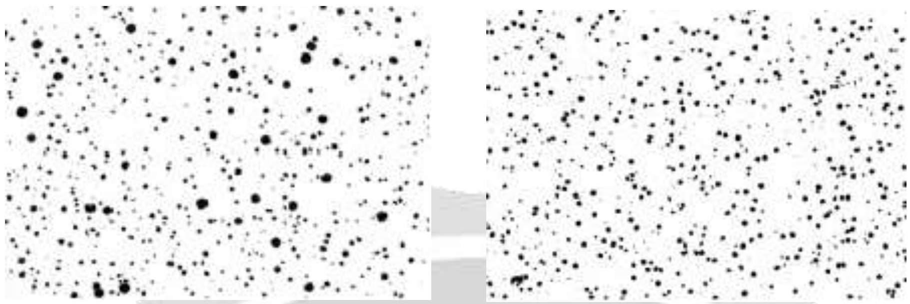


Pre Inoculation Post Inoculation

Fig 4: Micro structure of SG 500/7-La Based Pre & Post Inoculation at 100X

These Figures show that Micro structure of SG 500/7 Cast Iron with La Based Inoculant. In the First fig show Pre Inoculation Treatment & Second fig show post Inoculation treatment at 100X Magnification. This both figure mainly content ferrite & small amount of Pearlite structure, but by the Image Analyser we try to figure out nodularity percentage and we achieve 91% for pre inoculation & 94% for post Inoculation treatment.

(c) Micro structure of SG 500/7-Ca-Ba Based



Pre Inoculation Post Inoculation

Fig 5: Micro structure of SG 500/7-Ca-Ba Based Pre & Post Inoculation at 100X

These Figures show that Micro structure of SG 500/7 Cast Iron with Ca-Ba Based Inoculant. In the First fig show Pre Inoculation Treatment & Second fig show post Inoculation treatment at 100X Magnification. This both figure mainly content ferrite & small amount of Pearlite structure, but by the Image Analyser we try to figure out nodularity percentage and we achieve 92% for pre inoculation & 95% for post Inoculation treatment.

5. CONCLUSIONS

- We move forward to testing these specimen which include tensile, hardness, spectro & micro tests. After getting the various result we try to put various analysis for optimum results.
- After analysing Tensile & Hardness Result we show the same pattern for the various inoculant materials

	Sr Based	La Based	Ca-Ba Based
Tensile	Low	Moderate	High
Hardness	Low	Moderate	High
Elongation	High	Moderate	Low

- So by this result we found Ca-Ba type of inoculant use for the high tensile & hardness and Sr based inoculant use for the high ductility. But when we compare this to the standard all three value is going high.
- In this experiments we select two method for inoculation treatment ex Pre inoculation & Post Inoculation Method. By the result we found post inoculation method is highly beneficial when we compare with another one.

Sr No	Pre Inoculation	Post Inoculation
Tensile	Low	High
Hardness	Low	High

5. ACKNOWLEDGEMENT

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