Impact Factor (SJIF): 3.632
International Journal of Advance Research in Engineering, Science & Technology
e-ISSN: 2393-9877, p-ISSN: 2394-2444
Volume 3, Issue 2, February-2016

Effect Of Addition Of Magnesium In Spheroidal Gray Cast Iron

Mrs. Mamta P Patel

Department of Mechanical Engineering, Babaria Inastitute of Technology, Vadodara 391240, India

Abstract- *This paper presents the results of an experimental investigation of the mechanical properties of spheroidal graphite (SG) iron where varying percentage of magnesium using as an inoculants. Total four test samples were carried out. The specimens were subjected to tensile strength, yield strength, percentage of elongation, hardness and percentage of modularity. The results indicate that the prediction percentages of Mg are not accurate. By help of formula, prepared four samples of different percentage of Mg (0.025%, 0.030%, 0.035%, and 0.040). Based on the experimental results this paper evaluate that S.G iron having the Mg about 0.035% in its final composition will give good mechanical properties as well as the desirable microstructure having the higher number of nodules.*

Keywords- *Mechanical properties, S G iron casting, Microstructure, Morphology of S G iron. Nodularity, Nodular count*

I. INTRODUCTION

SG Iron is an alloy of Fe-C-Si with carbon content greater than 2.11% and is used in the as-cast state or after treatment. Cast Iron offers the design engineer a family of casting alloys that gives a unique combination of low cost with castability, damping and availability.[3]. Spheroidal iron was produced by adding small quantities of magnesium and cerium which produces graphite spheroids instead of flakes.[3] The production of ductile iron is 30-35% cheaper than steel and 3-4% cheaper than non-ferrous alloys and only 20-30% more costly than normal grey iron. Ductile iron finds application as a substitute for steel, malleable iron and non-ferrous alloys because of excellent casting properties and machinability which improves production efficiency and reduces cost of production.[3]

In this work, magnesium was added in the form of an inoculants in varying quantities and its effect on graphite morphology, nodularity and mechanical properties were studied.

II. SAMPLE PREPARATION

2.1 Calculate for the amount of Magnesium required. In practice it is normal to allow for minimum residual magnesium content of 0.035 to 0.04 wt % in addition to the amount of Mg required to neutralize sulphur in iron. The amount of Mg alloy would depend on:

a) Temperature of metal, higher the temperature, lower the recovery of Mg.
b) Sulphur content of the base iron to be treated, higher the sulphur content, greater is the amount of Mg to be added.

The commonly used formula to calculate amount of Mg required to be added is:- **Mg required in alloy (%) =**

$$\frac{\text{MG}-\text{content required}\,\%}{\text{MG recovery}\,\%\times 0.01} + \%\ \text{S base}$$

2.2 The sample have been prepared at RIGHT TIME ENGINEERING PVT LTD, GIDC, VADODARA,GUJARAT. To produce the sample from scrap S.G.iron had been taken and melted at 1540^{o}C in the induction furnace for 45 minutes.

The furnace capacity is 750 kg. Mg addition takes place before pouring as an inoculants depending on the calculation. Adequate precautions are necessary as Mg tends to vaporize on pouring.

2.2.1 Sample 1 (with 0.025% Mg)

Mg required in alloy (%) = $\frac{0.025\,\%}{40\,\%\times 0.01} + 0.03 = 0.0925\%$

2.2.2 Sample 2 (With 0.030 % Mg)

Mg required in alloy (%) = $\frac{0.030\,\%}{40\,\%\times 0.01} + 0.03\,\% = 0.0105\%$

2.2.3 Sample 3 (With 0.035% Mg)

Mg required in alloy (%) = $\frac{0.035\,\%}{40\,\%\times 0.01} + 0.03\,\% = 0.1175\%$

2.2.4 Sample 4 (With 0.040% Mg)

Mg required in alloy (%) = $\frac{0.040\,\%}{40\,\% \times 0.01}$ + 0.03% = 0.13%

III RESULTS AND DISCUSSION

3.1 Chemical analysis:-

For studying the Chemical Analysis of the samples is done using optical emission spectrometer and the results obtained are as given in (Table- 1). We can observed gradually percentage of Mg is increased.

Table 1:- Chemical Composition

% Of Elements	Sample 1	Sample 2	Sample 3	Sample 4
C	3.330	3.580	3.330	3.460
Si	2.740	2.060	2.630	2.820
Mn	0.430	0.393	0.400	0.421
S	0.015	0.020	0.009	0.026
Mg	0.026	0.031	0.035	0.039

3.2 Nodularity analysis:-

The nodularity can also be studied by the images obtained from the optical microscope at 100X. The sample were used initially without etchant and then with etchant 2% nital as shown in fig 1 to fig 5. And also observed nodularity, noduler count and morphology of samples shown in Table 2.

Table 2:- Nodularity analysis

Description	Sample 1	Sample 2	Sample 3	Sample 4
Nodularity %	95.58	94.27	92.60	94.99
Noduler count	408	345	521	369
Pearlite %	Balance	Balance	Balance	Balance
Ferrite%	90	87	88	85
Carbide %	Nil	Nil	Nil	Nil

IV MORPHOLOGY OF GRAY CAST IRON WITH Mg.

Sample 1(0.025% Mg):-

We can observed sample no 1 having 0.025 % Mg under metallurgical microscope using 2% nital as an etchant (fig.2), we observed in this the percentage of nodularities are 96% and nodular count is 408.

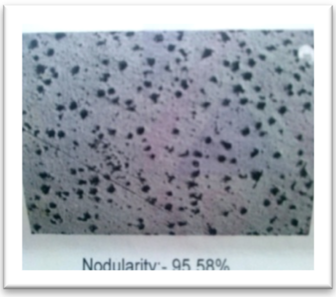

Fig 1:- Microstructure of Gray cast iron having 0.025% Mg Without Etchant

International Journal of Advance Research in Engineering, Science & Technology (IJAREST)
Volume 3, Issue 2, February 2016, e-ISSN: 2393-9877, print-ISSN: 2394-2444

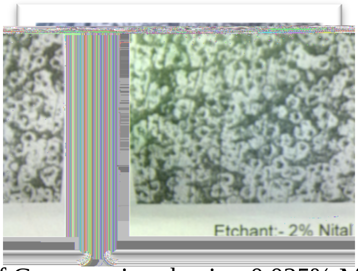

Fig 2:- Microstructure of Gray cast iron having 0.025% Mg With Etchant 2% nital

Sample no 2(0.030% Mg):-

We can observed sample no 2 having 0.03 % Mg under metallurgical microscope using 2% nital as an etchant(fig. 4), we observed in this the percentage of nodularities are 95% and nodular count is 345 which is slight less than to sample no 1.

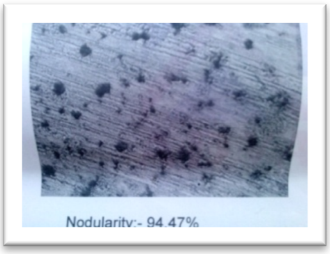

Fig 3:- Microstructure of Gray cast iron having 0.030% Mg, Without Etchant

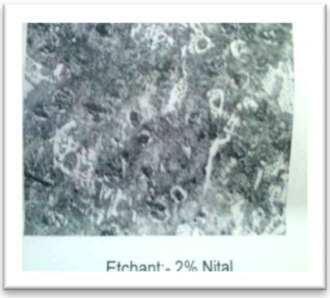

Fig 4:- Microstructure of Gray cast iron having 0.030% Mg, With Etchant 2% nital

Sample no 3(0.035% Mg):-

We can observed sample no 3 having 0.035 % Mg under metallurgical microscope using 2% nital as an etchant(fig. 6), we observed in this the percentage of nodularities are 92.6% and nodular count is 521. It shows more nodular count compare to other three samples.

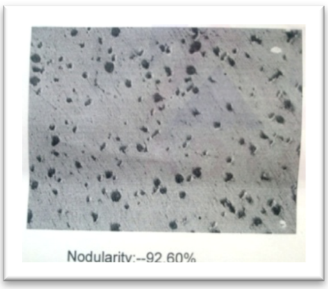

Fig 5:- Microstructure of Gray cast iron having 0.035% Mg, Without Etchant

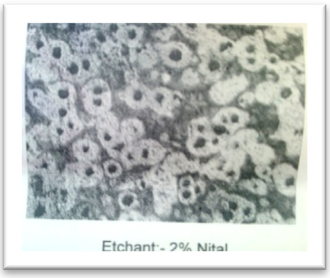

Fig 6:- Microstructure of Gray cast iron having 0.035% Mg, With Etchant 2% nital

Sample no 4(0.040% Mg):-

We can observed sample no 4 having 0.04 % Mg under metallurgical microscope using 2% nital as an etchant (fig.8), we observed in this the percentage of nodularities are 95% and nodular count is 369.

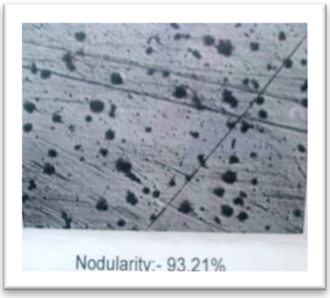

Fig 7:- Microstructure of Gray cast iron having 0.040% Mg, Without Etchant

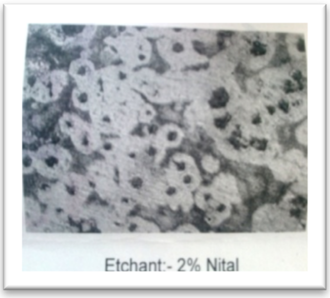

Fig 8:- Microstructure of Gray cast iron having 0.040% Mg, With Etchant 2% nital

Here we can observed all samples and conclude the morphology of gray cast iron having 0.035% Mg shows higher nodular count.

3.3 Mechanical Properties

For studying the mechanical properties the specimen were prepared according to ASTM (ASTM E8) standard where in the ration of gauge diameter to gauge length should be 1:5, Hence the sample varying Mg% were prepared by turning .The Mechanical properties obtained from prepared samples are shown in table 3.

Table 3:-Mechanical Property analysis

Mechanical Properties	Sample 1	Sample 2	Sample 3	Sample 4
Tensile strength (N/mm^2)	467	490	519	504
Yield strength (N/mm^2) (N/mm)	353	368	380	370

Elongation %	14.6	17.5	15.7	14.1
Hardness (BHN)	179	207	199	197

3.4 By comparing the various test result we came to the conclusion that s.g iron sample 3 having the Mg about 0.035% in its final composition will give good mechanical properties as well as the desirable microstructure having the higher number of nodules, as we increase or decrease the Mg percentage will get relatively poor mechanical properties and microstructure with lesser amount of nodules in it.

The matrix structure and hardness also can be changed by heat treatment. The high ductility grades are usually annealed so that the matrix structure is entirely carbon-free ferrite. The intermediate grades are often used in the as-cast condition without heat treatment and have a matrix structure of ferrite and pearlite.[1] The ferrite occurs as rings around the graphite spheroids. Because of this, it is called bulls-eye ferrite. The high strength grades are usually given a normalizing heat treatment to make the matrix all pearlite, or they are quenched and tempered to form a matrix of tempered martensite. However, ductile iron can be moderately alloyed to have an entirely pearlitic matrix as-cast.

Now comparison of mechanical properties such as tensile strength, yield strength, percentage elongation and brinell hardness of sample 3 with 0.035% Mg and heat treatment grades are 60-40-18, 65-45-12 samples [1].

Table 4:- Comparison of graded material and testing sample

Mechanical Properties	Sample 3	Grade of Heat Treated (60-40-18)	Grade of Heat Treated (65-45-12)
Tensile strength (N/mm^2)	519	414	448
Yield strength (N/mm^2) (N/mm)	380	276	310
Elongation %	15.7	18	12
Hardness (BHN)	199	149-187	170-200

VI CONCLUSION

On the strength of the results obtained from this research, the following conclusions were made:

1. The use of magnesium as a spheroidizing agent produces spheriodal graphite cast iron having microscopic nodular graphite grains. These nodules have a minimum effect on the mechanical properties of the cast iron. The mechanical properties are mainly determined by the type of matrix structure and this imparts the favourable physical properties of cast iron (low melting point, good fluidity and castability), with the engineering advantages of steel (high strength, toughness, ductility, hot workability and hardenability).
2. Comparison of testing sample and graded heat treatment material[1] we conclude that add 0.035%Mg in gray cast iron becomes nearer properties of graded heat treated material 65-45-12 are almost same.(Table 4), Due to nodular count is high which is 521.
3. The amount of Mg alloy used in the spheroidization process thereby reducing cost of production. The small shape of the nodule produced as shown in figure 6, also increases the nodularity of the cast iron.
4. The use of other varying combined addition produces graphite flakes in the cast iron microstructure.

V REFERANCE

1. http://www.mid-atlanticcasting.com/ductile_iron-alloys.html
2. IJCEE-IJENS Vol: 10 No: 03 "Effect of Graphite Nodularity on Mechanical Properties of Ductile Iron for Waterworks Fittings and Accessories" by A. I. Al-Ghonamy, M. Ramadan .N. Fathy, K. M. Hafez,A. A. El-Wakil
3. *Journal of Minerals & Materials Characterization & Engineering*, Vol. 6, No.1, pp 25-37, 2007 "Effect of Magnesium and Calcium as Spheroidizers on the Graphite Morphology in Ductile Cast Iron" by Oluwole, O.O, Olorunniwo, O.E.,Ogundare, O.O., Atanda P.O. and Oridota, O.O
4. M. Ostojić, A. Beroš, Nodularni liv, Univerzitet u Zenici, Zenica, 2008
5. S. I. Karsay, Ductile Iron-production practicies, American Foundry Society, 1975
6. J. E. Gruzlesky, Microstructure Development During Metalcasting, American Foundry Society, Des Plaines, Illinois, 2000
7. P. Beeley, Foundry Technology, Butterworth-Heinemann, 20
8. M.X. Wei, S.Q. Wang, X.H. Cui "Comparative research on wear characteristics of spheroidal graphite cast iron and carbon steel" Wear 274– 275 (2012) 84– 93.
9. R. Konecná, G. Nicoletto, L. Bubenko, S. Fintová "A comparative study of the fatigue behavior of two heat-treated nodular cast irons"
   Engineering Fracture Mechanics 108 (2013) 251–262.
10. Krause, D. E., "Gray Iron-A Unique Engineering Material" Gray, Ductile, and Malleable Iron Castings-