Effect of Molding Sand properties on Microstructure of Graphite Iron casting-FG 260

Abhijeet Londhe[1], V.S. Jadhav[2]
[1, 2] Department of Mechanical Engineering
[1]PG Scholar, Department, Govt. College of Engineering, Karad (M. S.), India
[2]Associate Professor, Govt. College of Engineering, Karad (M. S.), India

Abstract- *Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Sand casting process involves many parameters such as size of the sand grain, amount of clay, percentage of moisture, green compressive strength, permeability, number of ramming, mold type, mold hardness, etc.*

The quality of the product is determined by the quality of the mold.

If the casting process is not being managed properly, the problems may severe & and result in defects which render the products weak. Gray iron, or grey cast iron, is a type of cast iron that has a graphitic microstructure. It is named after the gray color of the fracture it forms, which is due to the presence of graphite. The most common flake graphite grade is FG 260 and It is used for housings where the stiffness of the component is more important than its tensile strength, such as internal combustion engine cylinder blocks, pump housings, valve bodies. FG 260 is high thermal conductivity and specific heat capacity are often exploited to make brake drum.

Keywords- Grain size number of sand (A.F.S. No.), moisture content (%), permeability number of sand.

I. INTRODUCTION

Cast iron are a family of ferrous alloys that possess a wide range of microstructures and physical properties that directly affect service performance. Therefore ability to monitor the microstructure of ferrous foundry alloys (i.e. Cast iron foundry) is an extremely useful method of controlling product properties and quality. Hence cast iron foundry is try to achieve and managed the process flow of green sand molding as a conventional process. So verifying the conventional process flow and recheck the properties if required.

The current days foundry industries in developing countries which suffer from poor quality and productivity due to involvement of number of process parameter. Sand casting process involves many parameters such as size of the sand grain, amount of clay, percentage of moisture, green compressive strength, permeability, number of ramming, shatter index, mold type, mold hardness, etc. to name a few.

Casting is a process of obtaining metallic products by allowing molten metal to get filled and solidify in a mold. The quality of the product is determined by the quality of the mold. In this competitive environment, it is very much important to maintain the quality of products and produce them right first time and every time. If the casting process is not being managed properly, the problems may aggravate and result in defects which render the products weak and of low quality, thus making them unfit for use.

Generally many of the casting defects are due to molding sand, cast specimens are tested to obtain their mechanical properties and density. The results obtained are evaluated to optimize process parameters at different levels. Hence to overcome the problems in the casting, optimization of the process parameters should be done. Optimization is required right from the stage of selecting the sand to removal of casting from the sand mold.

II. SAND PROPERTIES

Porosity Property- The ability of escaping the air or gases through the molding sand is called porosity. It depends on size and shape of grains, moisture content and degree of compaction.

Strength- The strength measured can be Compression, shear and tension.

Green strength- It is called green Compression which refers to stress required to rupture the sand specimen under compression loading.

Cohesiveness property- The ability to form bond between same material particles is called as cohesiveness property or shear strength.

Adhesiveness- The ability of bond formation of sand particles with other materials is called as adhesiveness.

Refractoriness- The ability of withstanding higher temperature without losing its strength and hardness is called refractoriness.

Collapsibility- The ability of breaking the mold with little amount of force is called collapsibility.

Flowability- The ability of flowing of molding sand into each and every corner of mold is called flowability.

III. GRAPHITE FLAKE DISTRIBUTION

The cast iron containing graphite in the form of flakes are called as gray cast iron. They have following useful properties:

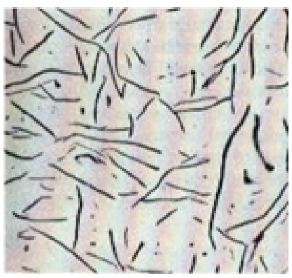
1) Excellent machinability.
2) Good compressive strength.
3) Good bearing property.
4) Fairly good corrosion resistance.

These cat iron have the following composition range.

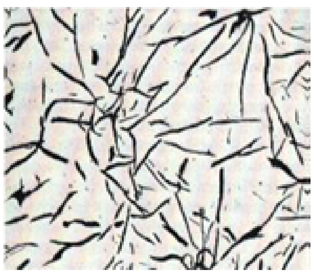
C- 3.2 to 3.7%
Si- 2.0 to 3.5%
S- 0.06 to 0.1%
P- 0.1 to 0.2%
Mn- 0.5 to 1.0%

Types of gray cast iron:

Depending upon the distribution of graphite flakes the gray cast iron into five types as follows:

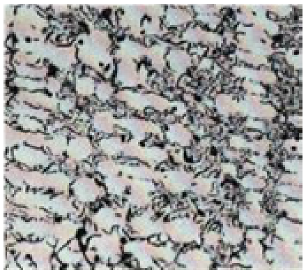


Type A: Uniform distribution, orientation

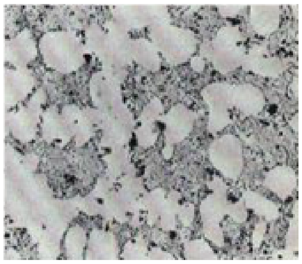


Type B: Rosette groupings, random random orientation

Type C: Superimposed Flakes Of various sizes, random Orientation



Type D: Interdendriticflakes, random orientation



Type E: Interdendritic flakes, preferred orientation

Graphite is very soft and weak, interdendritic segregation of graphite is not desirable because the cast iron becomes the cast iron becomes excessively brittle. Therefore, both types D and E are not desirable and more regular pattern of type E graphite is still more undesirable than type D. This types of distribution is observed when the alloy solidifies as hypereutectic alloy with coarse primary dendrites of austenite.

Type C shows superimposed flakes and is a mixture of few extremely large and quite straight graphite flakes with large number of much finer flakes. Due to the large amount of graphite and long flakes (superimposed one over the other), this type is also not desirable. This is observed when the alloy solidifies as hypereutectic alloy.

Type B graphite is observed in the mottled region that lies between white and gray. This type of graphite distribution also increases the brittleness and hence undesirable.

Type A graphite is most desirable because of uniform distribution and random orientation of graphite flakes, since they do not seriously interrupt the continuity of the perlitic matrix. This type of distribution is observed when the alloy solidifies as an eutectic alloy.

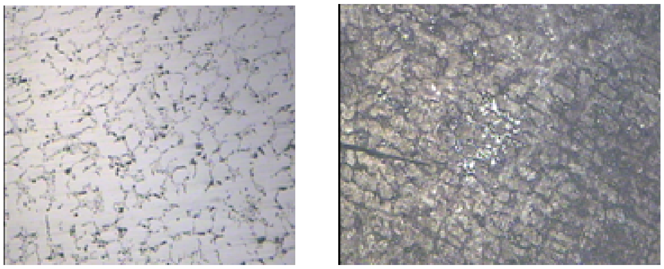
Once type A distribution obtained, the properties of gray cast iron depends on the length of graphite flakes. Short graphite flakes create less interruptions in the continuity of steel like matrix and hence give better mechanical properties.

IV. PROBLEM DEFINITION

The mostly affected sand parameters such as grain size, moisture content and permeability number of sand are tested of rejected casting which are below as:

The microscope report is,

Unetched Etched – 5% Nital



Total magnification: 100X

Sample-1	ASTM Class			Count / Sq.mm	
Average	6-8			610	
Graphite type distribution	Type A(%)	Type B(%)	Type C(%)	Type D(%)	
Average	6.20	1.24	2.08	90.48	-

Before etching: Predominantly D types of Graphite flakes are observed with some A, B and C types were observed.

After etched 5 % Nital: Randomly oriented dendritic structure was clearly observable. Pearlitic matrix was observed with following percentage of pearlite and ferrite

Sample-1	Frame Area (mm^2)	Flakes (%)	Pearlite (%)	Ferrite (%)
Average	0.0436	11.21	81.46	7.33

After these microscope results, the used sand parameters are,

Grain Size	50 (A.F.S. No.)
Moisture Content	3.0 %
Permeability No.	120

Hence because of these rejected casting results, sand process parameters are unknowingly verify and improve to achieve the Type A Graphite flake distribution.

V. SELECTION OF PARAMETER

Micro structural quality depends upon the solidification temperature that depend on sand properties the, proper selection and control of the process parameters are grain size number of sand (A.F.S. No.), moisture content (%), permeability number of sand.

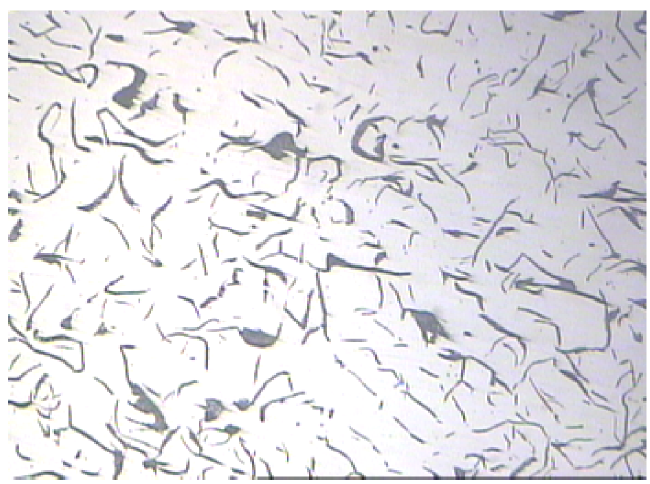
VI. TRIAL ONE RESULT

In this first trial, by varying the sand parameters as follows:

By using these parameters, the microscopic results are,

Grain Size	55 (A.F.S. No.)
Moisture Content	4%
Permeability Number	180

Unetched:



Total magnification: 100X

Sample-1	ASTM Class		Count / Sq.mm		
Average	4-6		613		
Graphite type distribution	Type A(%)	Type B(%)	Type C(%)	Type D(%)	Type E(%)
Average	24.69	71.45	3.86	-	-

Observation: Predominantly B type of Graphite flakes are observed with some A & C types were observed.

Etched-5% Nital-

Total magnification: 100X

Observation: Pearlitic matrix was observed with following percentage of Ferrite and Pearlite.

Sample-1	Frame Area (mm^2)	Flakes (%)	Pearlite (%)	Ferrite (%)
Average	**0.0436**	**11.01**	**88.63**	**0.63**

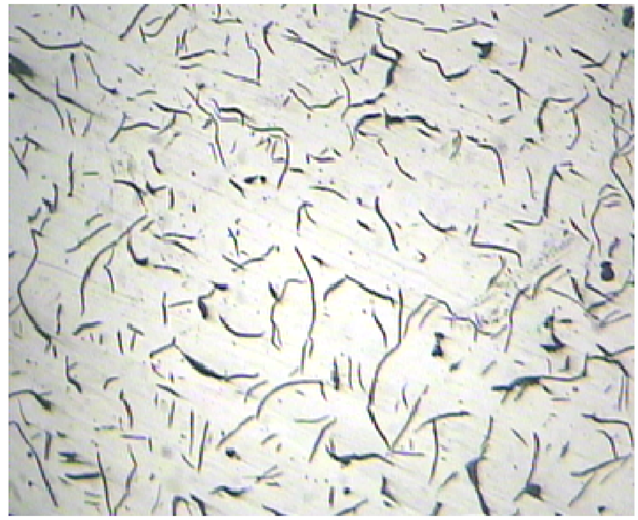
VII. TRIAL TWO RESULT

After the first trial, till it is not desired graphite flake distribution. Hence again by varying the sand parameters as,

Grain Size	60 (A.F.S. No)
Moisture Content	4.5 %
Permeability Number	220

By using these parameters, the microscopic results are,

Unetched:



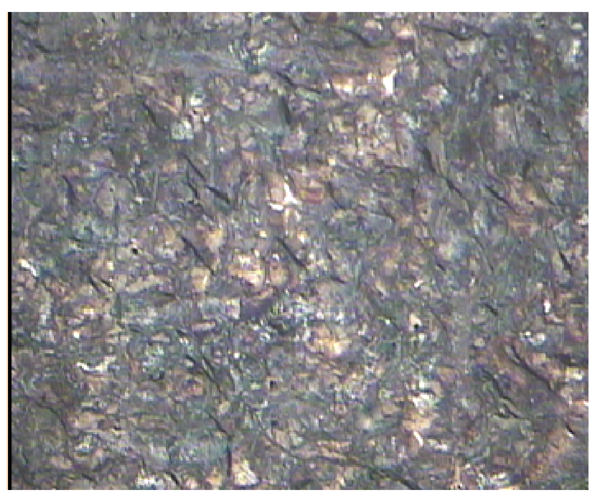
Total magnification: 100X

Sample-2	ASTM Class	Count / Sq.mm
Average	4-6	609

Graphite type distribution	Type A(%)	Type B(%)	Type C(%)	Type D(%)	
Average	89.21	8.20	2.59	-	-

Observation: Predominantly A & B type of Graphite flakes are observed with some C types were observed.

Etched-4% Nital-



Total magnification: 100X

Observation: Pearlitic matrix was observed with following percentage of Ferrite and Pearlite.

Sample-2	Frame Area (mm^2)	Flakes (%)	Pearlite (%)	Ferrite (%)
Average	0.0436	10.57	86.29	3.14

VIII. CONCLUSION

For better improvement of uniform distribution and orientation of flake graphite FG 260, the green sand parameters are set nearly as grain size fineness number is 60 (A.F.S. No.), moisture content 4.5 % and permeability number of sand is 220.

REFERENCES

[1] Rajesh Rajkolhe, J. G. Khan, "Defects, Causes and Their Remedies in Casting Process: A Review", International Journal of Research in Advent Technology,Vol.2, 2014

[2] MohamedMahmoud Mourad, Shimaa El-Hadad, Mervat Mohamed Ibrahim, and Adel Abdelmonem Nofal. " Effect of Processing Parameters on the Mechanical Properties of Heavy Section Ductile Iron ", Journal of Metallurgy, Volume 2015, 2015.

[3] Raghwendra Banchhor, S.K.Ganguly, "Modeling Of Moulding Sand Characteristics In Disamatic Moulding Line Green Sand Casting Process", International Journal of Advanced Engineering Research and Studies, 2015.

[4] Wasiu Ajibola Ayoola, Samson Oluropo Adeosun, Olujide Samuel Sanni, Akinlabi Oyetunji, "Effect Of Casting Mould On Mechanical Properties Of 6063 Aluminum Alloy", Journal of Engineering Science and Technology, Vol. 7, No. 1, 2012.

[5] M. Viquar Mohiuddin, A. Krishnaiah, S. Ferhathullah Hussainy, " Effect of Composition of Sand Mold on Mechanical Properties and Density of Al-Alloy Casting Using Taguchi Design Approach", Int. Journal of Engineering Research and Applications, Vol. 5, (Part -1). 2015.

[6] D. Drożyński, A. Bobrowski, M. Holtzer, "Influence of the Reclaim Addition on Properties of Moulding Sands with the Geopol Binder", Archives of Foundry Engineering, Volume 15, 2015.

[7] Wisam M. Abu Jadayil, "Studying the Effects of Varying the Pouring Rate on the Casting Defects Using Nondestructive Testing Techniques", Jordan Journal of Mechanical and Industrial Engineering,Volume 5, Number 6, 2011.

[8] Ashish Kumar Gupta, Dibakor Boruah, Nikhil Suresh, Nazish Kamal, Anil Kumar Singh, "Preparation Effect of Mould Systems on Microstructure and Mechanical Properties of Spheroidised Graphite Iron",Int. Journal of Engineering Research and Applications, Vol. 6, (Part - 4),2016.