

MANUFACTURING PROCESS OF GGG40 NODULAR CAST IRON

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Abstract

Cast iron has become a popular cast metal material which is widely applied in modern industrial production, because of its low cost and desirable properties such as good castability, convenient machining property, better wear resistance, etc.

Nowadays nodular cast irons are significant and preferred type of cast irons. Nodular cast irons that are similar to steels from the point of mechanical properties are most popular engineering materials; at the same time they are similar to cast irons in terms of chemical and physical properties. Most preferred nodular cast irons are respectively GGG40, GGG50, GGG60 and GGG70 in industry. GGG40 was chosen as casting material due to it is the most common of them according to foundry factory.

In this study, manufacturing process of GGG40 nodular cast iron was realized and presented. Sand mould casting was only used as moulding process. Firstly, various sand tests were carried out to provide the sand mould casting standards. Convenient moulds were prepared for tensile test specimens. Subsequently, chemical content of cast materials were investigated. And finally manufacturing of specimens were completed by means of supplementary processes.

Keywords: GGG 40, nodular cast iron, casting.

INTRODUCTION

Cast iron has become a popular cast metal material which is widely applied in modern industrial production, because of its low cost and desirable properties such as good castability, convenient machining property, better wear resistance, etc [1].

Nowadays nodular cast irons are significant and preferred type of cast irons. Nodular cast irons that are similar to steels from the point of mechanical properties are most popular engineering materials; at the same time they are similar to cast irons from the point of chemical and physical properties. Most preferred nodular cast irons are respectively GGG40, GGG50, GGG60 and GGG70 in industry (Table 1). Gray cast iron (GCI) is traditionally chosen in many industrial applications because of its flexibility of use, good castability, low-cost (20–40% less than steel) and wide range of achievable mechanical properties [2]. Ductile iron, also known as spheroidal graphite iron or nodular iron is made by treating liquid iron of suitable composition with magnesium before

casting. This promotes the precipitation of graphite in the form of discrete nodules [3]. Spheroidal graphite cast iron (SGCI) is a Fe–C alloy structural material. Due to its attractive properties, such as high castability, excellent wear resistance and relatively low cost as compared with alloy steels with equivalent mechanical properties, SGCI is widely used in automotive components, like crankshafts and bearing journals[4]. A. Roula and G.A. Kosnikov investigated the manganese distribution and effect on graphite shape in advanced cast irons. The manganese contribution to a change of the graphite shape (in nodular graphite cast irons) has never been revealed. They made obvious the negative action of this element on the nodularization of graphite [5]. C. Guillemer-Neel et.al. Studied Bauschinger phenomenon on ductile cast iron. It is shown that the Bauschinger effect reduces for cumulated plastic strain [6].

In this study, manufacturing process of GGG40 nodular cast iron specimens in order to investigate its mechanical properties was realized.

Table 1. micro structures and chemical compounds of nodular cast irons

Material Type	GGG 40	GGG 50	GGG 60	GGG 70	GGG 80
Micro Structure	Ferritic				Pearlitic

MANUFACTURING PROCEDURE

2.1. Prepare casting mould and mould sand

Convenient moulds were prepared for tensile test specimens using a model (Fig. 1). This mould was used in casting machine in the process.



Fig.1. A model for sand moulding

2.1.1 Mould Materials

Green mould sand has mould sand (Silisium), clay, moisture (water) and the other additive agents. Sand grains compose the main part of the green mould sand. Clay and water are cementing materials and the other additive agents are complementary materials of the green mould sand.

After the mould materials prepared, we want to know it is ready to cast or not. So we do some tests to mould sand and we will start casting, if the tests results are in setpoints ranges. Control and treatment of the process sand is not only important think but also demanding one.

2.1.2 Tests applied to mould sand

- Moisture
- Green Compression Strength
- Green Tensile Strength

- Compactibility
- Gas Permeability
- Wet Tensile Strength
- Temperature

Standard test specimen (Fig. 2) used at the most of these tests was prepared by Sand Rammer (Fig. 3)

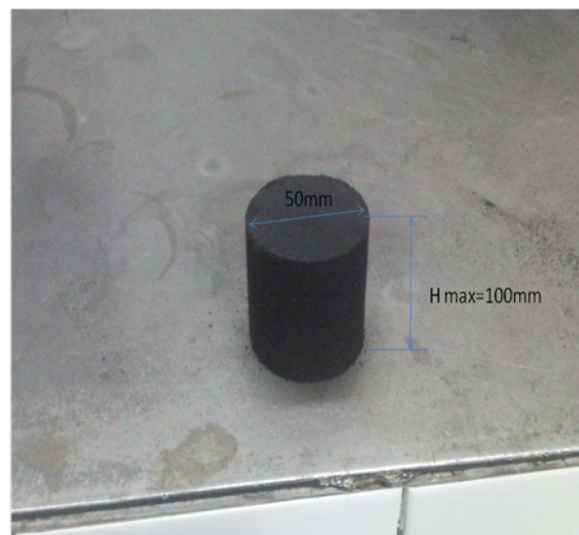


Fig.2. Sand test specimen



Fig.3. Sand Rammer

Moisture

In this study, we used a moisture testing instrument (Sartorius), to determine moisture % in (green) sand. Amount of green sand (50 gram) was placed into the moisture testing instrument and it dried to take the gauge of weight loss. Then the percent moisture result was calculated and displayed by this device.

In this mould sand, our moisture result was obtained as % 3.73.

Green Compression Strength and Green Tensile Strength

Same universal strength machine used for both of these tests and the rammed cylindrical test specimen (Fig. 2) is formed by placing a weighed amount of sand in a tube and rammed the sand three times. Then cylindrical test specimen placed parallel (perpendicular for green tensile strength) to the universal strength machine's equipments. This machine used for breaking the cylindrical test specimen and it must continuously registered the increasing force until a fracture occurs at cylindrical test specimen.

Finally, the results determined as 21.3 N/cm² for green compression strength and 2.535 N/cm² for green tensile strength.

Compactibility

Compactibility test instrument was used in this study. The standard test specimen tube was filled struck measure up to the top of the tube with green mould sand and it was placed to the instrument then the sand was rammed three times.

So the distance from the top of the test tube to the surface of the sand was read as percent compactibility and it was %38 in this test.

Gas Permeability

In this test, gas permeability ratio was determined which is venting characteristics of rammed sand.

Standard test specimen was prepared such as compactibility test once again and it was placed the gas permeability test instrument then the gas permeability percent was determined by the rate of flow of air, under standard pressure in the instrument as % 91.

Wet Tensile Strength

When molten metal enters a mold, the heat transfers from the metal into the sand, so during the process, sand layer at the mold-metal interface is known hot layer and it is exhale the moisture from there to outer cooler region of the mold away from the casting and

condense. Behind this hot layer, there is a wet and weak region that is known wet layer. The weakness of the wet layer can cause a rupture between the two layers, so we want to know that too.

The load required to break the wet layer is the wet tensile strength. The test specimen tube, which was filled with green sand and rammed three times, was loaded into the wet tensile test machine. Then wet tensile result was read digital display as 0.22 N/cm².

Temperature

Sufficiently sand was taken from the hopper and a thermometer was placed into the sand sample immediately, then the temperature, which was read that was recorded as 33°C

Table 2. Mould sand test results

<u>TESTS</u>	<u>RESULTS</u>	<u>SETPOINT RANGES</u>
Moisture	%3.75	%2.5 --- % 4.0
Green Compression Strength	21.3N/cm ²	20.0---- 24.5 N/cm ²
Green Tensile Strength	2.535N/cm ²	1.5N/cm ² Max.
Compactibility	%38	%36 ----- %42
Gas Permeability	%91	%50 Min.
Wet Tensile Strength	0.22N/cm ²	0.20N/cm ² Min.
Temperature	33°C	45°C Max.

2.2 Melting and casting process

Some of elements, such as cerium, calcium, lithium and magnesium are known to develop nodular graphite structures in cast iron. One of these elements is magnesium was used this manufacturing process to develop nodular cast iron. Mg boils at 1090°C, so that it is not easy to add it. Several different methods of adding magnesium have been developed, with the aim of giving predictable, high yields [3].

In this process sandwich method was used (Fig. 4.) and sand moulds were filled with molten iron by casting machine (Fig. 5.)

ELEMENTS	%
Carbon	3.18971
Silisium	2.59378
Manganese	0.19575
Phosphor	0.03165
Sulphur	0.00407
Chromium	0.02309
Cupper	0.09323
Tin	0.03123
Magnesium	0.02906
Molybdenum	0.00050
Nickel	0.01594
Vanadium	0.00362
Titanium	0.01455
Aluminum	0.01439
Boron	0.00019
Bismuth	0.00053
Lanthanum	0.0040
Cerium	0.0038
Iron	93.8216

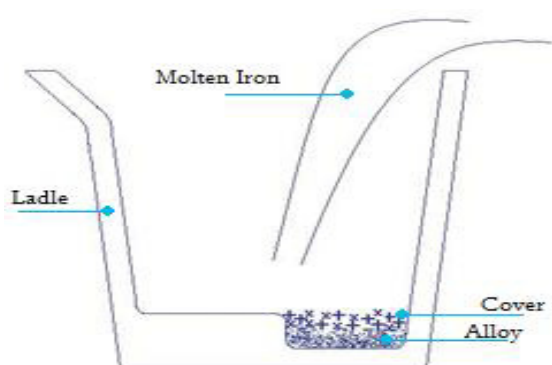


Fig. 4. Sandwich treatment

The cast temperature was determined by measuring apparatus during cast as 1401°C in figure 5.

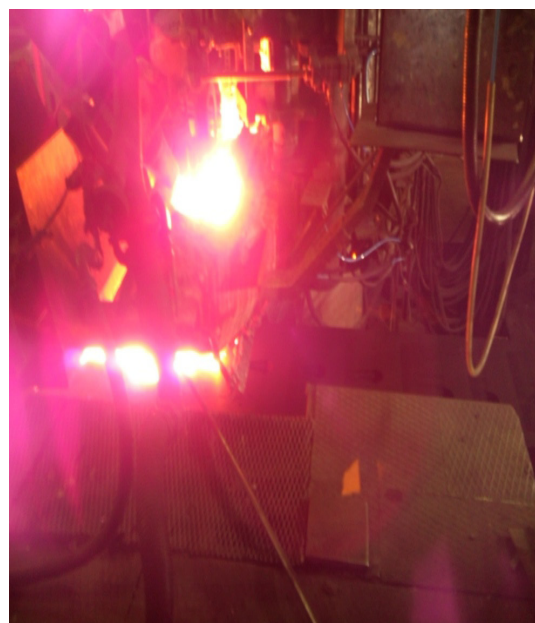


Fig. 5. Casting and temperature measuring

2.3. Chemical content tests

In this part, two type analysis methods were realized;

2.3.1 Spectrum analysis tests

Test specimen of spectrum analysis was taken with special spectrum equipment during the casting process. Then the necessary processes (sandpapering and decontamination) were completed. So the test specimen was placed the spectrum analysis test machine. The test specimen was burned by spectrum analysis machine from its two different zones (Fig. 6.).

Finally, the results of spectrum analysis were given as average of two zones data.

THE SPECTRUM ANALISYS RESULTS



Fig.6. Spectrum analysis test specimen that burned from its two different zones.

2.3.2 C-S analysis tests

For this test, the test specimen in figure 8 was taken from the cast (Fig.7.) It was forged by hammer, so that small pieces were occurred for testing. Then 35 gram of small pieces were filled to ceramic cup (Fig.8.). Filled ceramic cup was placed the test machine and it was burned by test machine for test. Finally the test result of C and S was read digital display as:

C % 3.62 S % 0.0033



Fig.7. C-S analysis test specimen



Fig.8. A ceramic cup and small pieces of GGG40

2.4. Supplementary Processes.

Supplementary processes have many various types. Bull block, vibratory tank and strainer were used in this manufacture process to clean the product sufficient.



Fig.9. Product was taken from end of strainer

After casting, products were arrived to the vibratory tank by belt conveyor. Then the mould sand was cut loose from the product in the vibratory tank. After this process they were traversed from strainer; so most of mould sand taked off the manufacture process in this place. End of this process, ultimate products were seemed like figure 9.



Fig.10. Ultimate product

The product was placed to bull block and it was cleaned by steel balls impact. Ultimate product was taken from bull block which was filled with steel balls, end of the manufacture process. It was showed in the figure 10.

CONCLUSION

This study is a realization and brief explanation about casting process of nodular cast irons. GGG 40 was chosen as cast material in this investigation.

All phases of this casting process were realized and explained. Sand tests, Carbon-Sulphur test and spectrum test have an important part of this work. Casting of different GGG series materials seem some of the potential studying subject.

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