Original Article: Investigating the Properties of Low Carbon Gray Cast Iron

Antonin Brklay
MSC in Material Engineering, Material Engineering Department, Faculty of Engineering, India

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ABSTRACT

Gray cast iron will be produced from the alloy of iron and carbon, which is about 2% more, or the cooling speed is low, or silicon, which causes the instability of cementite. Now, if the amount of carbon is less than 3.4%, low carbon gray cast iron is obtained, which is easier to cast than steels, which may have pearlite and pearlite properties. In the first stages of cutting the sample from the main piece, you are aware of its clarity, softness and neatness, and after cutting, filing is also done easily. But sanding it because of its high level of softness would be a problem. The result is that this steel is hyperiotectoid and according to the internal structure, i.e. the background of ferrite and pearlite grains, we understand that it contains 0.4% carbon and 5% ferrite and 5% pearlite, so we conclude that the more pearlite in the metal structure, the higher the percentage. Carbon is also more and the lower the amount and percentage of carbon, the higher the amount of ferrite, and the darkness of the surface under the microscope is the reason for this claim. The presence of sheet graphite causes gray cast iron to have unique properties. including having good machinability in conditions where the degree of hardness is such that the resistance to wear is excellent. The ability to resist burning in the last stages of the loss of lubricants is good, as well as the unusual elastic property that makes it capable of vibration. Several different factors affect the germination and growth of graphite sheets so that these graphite sheets can appear in different shapes and forms.

Introduction

Hyperlipidemia Polishing is fine sanding which is made up of waterproof sandpapers of 320-1000 numbers and mounted on aluminum metal which is placed under a tap and water is continuously poured on it during sanding. Etching means making the crystalline structure of the metal visible and creating a contrast between its different manufacturers. Fermentation agents [1-3]. A large part of cast iron is gray cast iron, which is usually called cast iron. Of course, the mentioned title is inappropriately used to define gray cast iron. While the name of cast iron has been chosen because the color of the fracture section is gray. The gray color of the broken cross section of this

***Corresponding Author: Antonin Brklay** (Brklay2008@gmail.com)

alloy is due to the presence of thin graphite sheets in gray cast iron [4-6]. When the chemical composition of molten cast iron and its cooling speed are suitable, during solidification, the mentioned carbon in cast iron is separated and sheets of graphite are formed [7-9]. The grains of these graphite's grow into the melt, and for this reason, they act freely to form sheets. The amount of graphite in cast iron, its size and its distribution are also effective on the properties of cast iron. It is important to specify the desired properties [10-12]. A type of background structure in cast irons with sheet graphite has less effect on the strength of these cast irons than the shape, size and distribution of graphite's [13-15]. In case, the type of background structure is an important factor in determining the hardness and machinability of these cast irons. Another group of cast irons, which are very important in engineering materials, are cast irons with spheroidal graphite or brittle cast irons. The shape of the graphite's in the casting conditions of these types of cast irons is spherical and they have appropriate strength and relative length increase [16-18]. The structure of the background in this type of cast iron has a great effect on their strength. Less amount of silicon in cast irons or more alloying elements such as wormwood and a set of factors that prevent carbon decomposition causes the third category of cast irons to be produced under the title of white or high hardness cast irons, low machinability and resistance to white failure. Malleable cast irons, another group of cast irons, first casting the parts in the form of white cast iron, then using a suitable thermal operation cycle to break down the carbides, which precipitates graphite in a special way. Meanwhile, the shape of graphite's changes compared to the type of malleable cast iron [19-21]. This means that the limits of their changes start from coated and compacted graphite's and end up with completely spherical graphite's, and in this way, the composition of the background phase in this type of cast iron starts from a ferritic structure and ends up with a pearlite structure [22-25]. In the microscopic structure of cast iron, phases and compounds such as ferrite, pearlite or other changed phases that form the background of the sample. They surround the graphite's or work of eutectic beads. Such eutectic alloy components are frozen in granular or cellular form during freezing [26].

Gray cast iron

Test theory: First, the piece of gray cast iron is made into a sack by a file, and then its surface is polished by sandpapers, and after the sanding process is completed, it is polished, and then it is placed in an etching solution, and after sanding, we take it for ten minutes, wash it with water and put it under the microscope [27-29]. Of course, before etching, no other details could be seen under the microscope except the graphite sheets. But after finishing the etching stage, it can be seen that it contains sheet graphite's with a completely pearlitic background and eutectic phosphide, and the dendritic structure related to the initial astints is very weakly seen in it [30].

Structure of primary dendrites in gray cast irons: By performing H polishing operations and microscopic or normal microscope tests, the shape of primary dendrites in pre-eutectic gray cast irons cannot be observed. But if a sample of recent cast iron is sanded and polished with great precision and delicacy, by using a light source and reducing extra lights and placing the sample appropriately [31-33], the said structure can be clearly seen. The samples are prepared and prepared using soft sandpapers placed on rotating discs, then they are studied by inclined light and by adjusting the direction of the sample and the direction of the light in order to create maximum light contrast. First, delicate islands of dendrites with a radial structure, and second, coarser and directionless dendrites in a sample that is observed at a slower speed [34].

Non-equivalent carbon in gray cast irons: (discussion)

The amount of sheet graphite's is the most important factor that affects the strength and other properties of gray cast iron, and the change in them is the main reason for the change in the strength of cast iron [35-37]. The structure of the background is complete pearlite if the amount of silica is less or the amount of manganese is more, and in the same way due to the presence of very small and partial amounts of pearlite stabilizing elements such as arsenic, cerium, copper, nickel and tin in the raw materials or returned scraps. It is possible to obtain a completely perlite background. In the case of cast irons that have less strength, the background structure is less important than the type of graphite's in cast iron. In the case of cast irons with high strength and resistance, the type of background structure is very important. So that in such cases, they try to produce completely political or visual structures [38].

Cast iron

Cast irons are alloys of iron and carbon that contain a number of other alloying elements such as silicon, manganese [39-41], sulfur and phosphorus. The eutectic composition of cast irons includes graphite (or iron carbide) and austenite, which turns into other phases as the austenite phase continues to cool, and similarly, other important factors that determine the properties of cast irons are the amount, size, shape and distribution of graphite's or in other words, the control of the mentioned factors is the most important principle in the production of cast iron [42-44]. The change of factors such as chemistry, germination method, solidification speed in cast irons and also the effect of some alloy elements in critical amounts cause a great change in the type, shape, size and distribution of graphite's. The strength in gray cast irons is proportional to softer and weaker graphite bases, or in other words, the strength in this type of cast irons is closer to the percentage of carbon because it depends on the eutectic composition, which is obtained by using the carbon equivalent ratio from the following equation:

$$CE= (\% +1/3\ Csi\%+D\%)$$

If the amount of carbon is equal to 4.3%, the eutectic structure occupies the entire cross-sectional area, and if its amount is less than 4.3%, the said cast iron has a pre-eutectic structure and contains eutectic structure, graphite and iron, and becomes in the same way, in post-eutectic cast iron [45], large sheet graphite's cause the cast iron to become softer and weaker.

Unbreakable cast iron

Ductile iron called nodular iron. Cast iron with spheroidal graphite and SG cast iron are also called. Due to the amount of carbon and silicon content, ductile iron belongs to the family of gray iron, and in terms of melting equipment, melting maintenance temperature and general metallurgy, these two are very similar [46]. The main difference between ductile iron and gray cast iron is that the graphite of ductile iron is released and formed as spheres during solidification. While gray cast iron graphite is released in sheet form. The release of spherical graphite in ductile iron is caused by the presence of a few hundred percent of magnesium metal in the melt. Since there is a small amount of elements such as sulfur. Lead-titanium and aluminum can affect the spheroidization of graphite and prevent it in some way, it is necessary to use molten cast iron to prepare ductile cast iron in comparison with the melt used for gray cast iron. In terms of the absence of impurities, it should be in a better condition. Adding a small amount of sodium along with magnesium to the melt minimizes the effect of impurities that prevent the formation of spherical graphite, and therefore the necessary conditions are provided to produce cast iron from relatively cheap raw materials. If there is sulfur in the primary cast iron, magnesium sulfur is formed and causes some of the magnesium to dissolve and become unusable, and magnesium sulfur also creates slag. Therefore, the low amount of sulfur in the primary ingot or the raw iron used is of particular importance. Of course, since good flexibility is one of the important properties of ductile iron, the amount of stable elements of controlling carbide and pearlite, for example, elements such as chromium, vanadium, manganese, tin, and phosphorus should also be low. The amount of phosphorus in cast iron should not be more than 0.06%. Especially if it is necessary that the production ductile iron has good impact resistance at low temperature.

Discussion and review of "Ductile cast iron"

The structure of spherical graphite's is observed in a cast iron cast in a sand mold. If the amount of magnesium required for spheroidization of graphite's is small, then the graphite's will be obtained in a compact or quasi-sheet form, in which case cast iron will have less strength and flexibility than cast iron with spheroidal graphite, and finally, if the amount of magnesium is high If it is less, in this case, cast iron with sheet graphite will be obtained. It should be noted that in some cases, due to special reasons, it is practically tried to create graphite's in cast iron in a compact or pseudo-sheet form.

The size of spherical graphite, which affects the mechanical properties, is influenced by the following two main variables

A- Cooling speed: Cast sections that have thin sections are cooled at a higher speed, and as a result, the size of spherical graphite's becomes smaller and their number increases in the cross section.

Silicon inoculation: With silicon inoculation, the number of spherical graphite's increases and the tendency to form carbides in thinner sections of the part decreases. In the same way, the number of spherical graphite's also increases with the increase in the amount of nucleating agent.

White cast iron

All eutectic carbon in non-alloyed cast iron parts that have thin and medium thickness during solidification in sand molds and contain less silicon. Without the use of inoculation, germinating materials turn into iron carbide. Such cast irons have white fracture sections and are called white cast irons. These types of cast irons are used in a non-alloyed form and with significant amounts of carbidizing elements such as cream or vanadium. The wear resistance of white cast irons is the main reason for using these cast irons in the industry. Malleable irons are also among the same group of irons.

Whitening of cast iron due to the penetration of tellurium

In cases where mold covering materials containing tellurium or bismuth are used to improve the surface quality of gray cast iron parts, the thin layer on the surface of the part will turn into white cast iron.

White cast iron

Required equipment

A piece of white cast iron - all kinds of sandpapers and etching and polishing solutions.

The purpose of the experiment: To investigate the microstructure of white cast iron before and after etching.

Experiment theory: First, a piece of white cast iron is made into a bag with a file, and then its surface is polished with the necessary sandpapers, and after finishing the sanding process, it is polished and then placed in the etching solution. And after finishing the sanding process, he polished it and then placed it in the etching solution. And after about ten minutes, we remove it, wash it with clean water and put it under the microscope, and the following phases appear: This high-carbon cast iron has a deborite eutectic structure, including iron carbide in a background of pearlite. In the same way, it is seen in the form of a low carbon white cast iron which is used in the production and production of black core malleable cast iron and contains planar carbides in a background of pearlite as well as amounts of pre-eutectic acicular carbides.

Discussion about white cast iron

By shining the right light on the polished and etched surface of a white cast iron sample, the macroscopic structure of the primary dendritic and eutectic iron-carbide austenite's can be distinguished from each other. Also, if cobalt powder is used to grind the grains before casting, a finer structure of dendrites is obtained. As a result of irradiating the light obliquely, the dendrites will not be clearly visible, but it is possible to see the granulation of the eutectic structure similar to the coarse form or similar to the fine form with signs of primary dendrites. The eutectic grain size in non-alloyed white cast iron is usually not subject to normal casting factors and is variable.

Investigating the structure of white cast iron

White cast iron is an alloy of iron and carbon with more than 1.7% of carbon in a semi-stable system, which either due to the presence of alloying elements (carmine, vanadium, sulfur, molybdenum) or the difficulty of high cooling turns into white cast iron. The name of white cast iron is derived from its cross section which is white and crystalline. The color of the white surface is broken due to the absence of graphite from the background. The difference between cast iron and gray cast iron is that there is rarely free graphite in white cast iron and there is carbon in the form of Fe_3C cementite phase, which is extremely hard and brittle due to the presence of this phase.

Malleable cast iron

Basically, malleable cast irons are low-alloyed or non-alloyed pre-eutectic cast irons, which are subjected to thermal and framing operations in order to create compact spherical graphite's and also access to a set of strength and softness.

Malleable cast iron parts are first cast as white cast iron. This means that all the carbon in this cast iron is in a composite form in the condition of black heat, then in the stage of thermal operation by heating up to the sleeve area and keeping the part for a sufficient time at this temperature, the iron carbide is decomposed in it and malleable cast iron is obtained. Heating the parts up to the austenitic region causes the accumulation of carbon in different areas, and after a certain period of time, carbonaceous carbon is formed in an austenitic background, and finally, continuing the radiation and using a suitable heating process, as well as the cooling speed, the structure of the cast iron background can be made of complete ferrite. It changed a political structure.

Different types of malleable cast iron with pearlite background can be produced by one of the following methods

A- Austenitizing, quenching and tempering of a ferritic malleable cast iron;

B- Konch in the air, playing after the completion of the first stage framing;

C- Conch in a liquid, annealing after finishing the radiation of the first stage;

D- Monch in air, reheat, quench in a liquid after finishing the framing of the first stage.

Malleable cast iron

Required equipment: A piece of malleable cast iron, all kinds of required sandpaper, polish, H solution.

Discussion (malleable cast iron)

Thermal processing of malleable cast iron after casting. Reheating the annealed white brain malleable irons to a temperature of 820-870 degrees Celsius and quenching them in air or in a liquid and finally annealing them improves the mechanical properties and increases the toughness and malleability of the malleable irons. The next thermal process that is performed in this cast iron is completely similar to the thermal process that is used in the case of black pearlite malleable irons in a neutral atmosphere, and in this case, the difference in carbon concentration in the thickness of the piece is reduced and in the central parts. The ferrite phase disappears. In the side part of the samples, it can be seen in the shapes of the change of a ferrite structure to a completely spherical polytic structure, and in the central part of the samples, in the shapes of the change from a structure containing snow-like carbons in a field with 20% ferrite and 80% poly to a structure a similar shape and a completely spherical politic structure is observed with glacial carbons.

Conclusion

In general, metallography is the study of the internal structure of metals and alloys and the relationship of this structure with the composition, production sample, freezing conditions, and their chemical and mechanical properties. One of the important tests of the quantitative and qualitative control unit of the production line is metallographic casting, which today has both the quality control and research aspects. If we want to know more about the importance of this laboratory, it is necessary to briefly state and pay attention to the important goals of this laboratory.

1- Investigating microscopic defects and some macroscopic defects of produced metals and alloys, such as coarseness, growth and heterogeneity of unwanted phases, non-uniform distribution of grains and phases, etc.

2- Identifying and approximating the chemical composition of the alloy by examining the internal structure and using the phase diagram of that alloy

3- The macroscopic method is mostly used and it is an aid to the freezing laboratory, and it consists of controlling the way and type of freezing and macroscopic growth of grains and the relationship with the casting conditions of that alloy, which control can be effective in improving the mechanical properties and health of the cast piece. It should be mentioned that the first goal is much more important among the mentioned goals and we divide it into two main parts.

1- Technological aspect;

2- Metal logical aspect.

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