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THE INFLUENCE OF PREHEATED DUCTILE CAST IRON MOLD TOWARDS GRAY CAST IRON

Agus Yulianto, Rudy Soenoko, Wahyono Suprapto and As'ad Sonief
Department of Mechanical Engineering, Faculty of Engineering, Brawijaya University, Indonesia
E-Mail: agus_yulianto@ums.ac.id

ABSTRACT

This study is a preliminary research about the casting of gray cast iron by using ductile cast iron mold that has been preheated. Preheating is done to unify the hardness in gray cast iron. The mold heating was carried out at temperatures of 100, 200, 300 and 400°C. Meanwhile, the hardness testing was carried out by using Rockwell hardness test. The results showed that the higher the mold heating, the more the distribution of gray cast iron hardness.

Keywords: permanentnt mold casting, gray cast iron, ductile cast iron, solidification, hardness.

1. INTRODUCTION

Metal casting is a process of pouring molten metal material that is inserted into a mold, is allowed to clot inside the mold, and is then removed or broken to be a component of the machine [1-3]. Cast iron is largely used because it has good mechanical properties, the machinability is excellent, and the lack of sensitivity to the quality of the last surface exists. In the structure of gray cast iron, most or all of the carbon is in the form of flakes or graphite nodules. Graphitic cast iron has a dark gray or almost black fracture. After slow cooling, the graphite is formed when the cast iron is hardened from a liquid form (Xu *et al*., 2005) [4]. There are four influencing factors or are characteristics of the casting process, namely: the flow of liquid metal into the cavity of printing, the heat transfer during solidification and cooling of the metal in the mold, and the mold material effect and metal solidification of molten condition. Mold temperature that is too low will lead to gray cast iron which does not have enough time for an evenly distribution at the time of solidification that will cause uneven thickness and porosity. Various attempts have been made to improve the quality of castings as conducted by Bonollo. *et al* (2004) who state that a low temperature gradient (temperature castings - mold temperature) will make the longer solidification time [5]. Preheating in the mold will control the process of solidification that occurs in gray cast iron. Moreover, the mold used is ductile cast iron which has nearly the same mechanical properties. The purpose of this study is to determine the impact of preheating molds towards the distribution of gray cast iron foundry.

2. METHOD

2.1 Material

A material used in this study is the gray cast iron with a chemical composition. The mold in the form of ductile cast iron has a composition. The casting is done by permanent mold using ductile cast iron. The shape of the mold is tapered cylindrical and the bottom diameter is smaller than the top. The study was conducted in one dimension. The melted objects were considered isothermal. Gray cast iron is produced from cupola kitchen. Before the metal is poured, the mold is heated with a variation temperature of 100°C, 200°C, 300°C and 400°C.

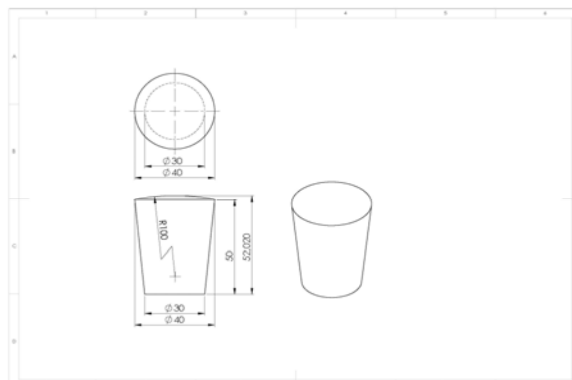

Figure-1. The product of casting.

2.2 Hardness testing

The test specimens were obtained on the side of the middle of the specimen. It aims to figure out the hardness distribution from the edge to the middle and then to the edge again. The directions of the point cutting taken on the hardness testing can be seen in Figure-2.

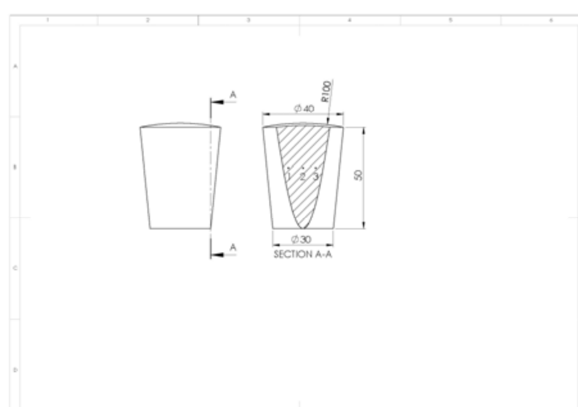

Figure-2. The directions of specimen cutting for hardness testing.

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Rockwell hardness test was used to test the hardness by administering the load 1471.5 N. Penetrator used is diamond 120°.

3. RESULT AND DISCUSSIONS

Hardness test results of gray cast iron casting by preheating the mold can be seen in Table-1.

Table-1. The result of hardness testing.

Point	Temperature of mold preheating (°C)				
	without heating	100	200	300	400
1	91.63	88.67	80.21	75.07	69.64
2	41.21	48.6	50.66	54.66	58.92
3	91.88	88.88	80.31	75.11	69.52

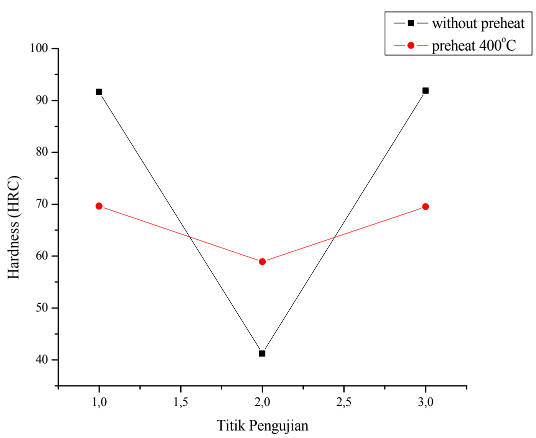

Figure-3. Testing result without and with preheating 400°C.

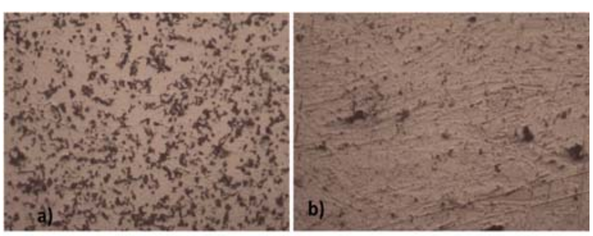

Figure-4. Morphology of specimen a) without mold preheating and b) with preheating 400°C.

Figure-1 shows the concentration of inhibitor effect to the inhibition efficiency in 0.5 M HCl.

Based on the Figure-1, the rate of corrosion inhibitors could inhibit metal effectively with the increase of concentration inhibitor. This was caused by the interaction between inhibitor molecules larger than inhibitor interaction on the metal surface (Fekry *et al*, 2011). Due to the efficiency inhibition in 21 days lower than 14 days of immersion time, the adsorption of inhibitor is physisorption. The chemisorption involves high energy and immersion time (Quartarone *et al*, 2003).

Potentiodynamic polarization studies

The efficiency inhibition can be determined by potentiodynamic polarization. Potentiodynamic polarization measured with the variation of the concentration of the extract CA at ambient temperature.

Tabel-1. Inhibition Efficiency Calculation of Polarization Measurements

Figure-2 shows the results of tests on specimens with and without preheat 400°C. Seen in the mold preheating 400°C the striking difference is in hardness distribution in which the hardness distribution with preheat 400°C is more equitable. Table 1 shows the higher temperature of preheat, the more equitable the hardness distribution. The preheating of the mold maintains the fluidity of cast metal [6-7]. With the preheat on the mold, the viscosity of the molten metal would be lower. The more preheating temperature of the mold, the smaller the temperature between molten metal and the mold temperature is. As a result, the cooling rate of cast metal becomes slower. The preheat element is to successfully provide the mold to achieve recrystallization so that it leads to the occurrence of diffusion between the molds and the cast metal. This makes the solidification on metal casting run slowly. The very slow solidification process allows the good grain growth. [8] The growth of grains which runs slowly produces a more uniform grain. This results in the hardness distribution which is getting equitable. Figure-3 shows the morphology of the mold preheat at 400°C is more equitable. The specimen without any molds shows more graphite signifying the greater hardness.

4. CONCLUSIONS

The preheating of the mold makes the distribution of the hardness greater. The highest hardness distribution occurs at a temperature of 400°C preheat.

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