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SECTION 6. Metallurgy and energy.

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HARDNESS DETERMINATION OF A CAST IRON PISTON AFTER METAL MOLD CASTING

Abstract: Value assessment of Brinell hardness of a cast iron piston after metal mold casting is given in the article. It is determined that material hardness of the piston after cooling is changed in the range of 200 – 250 HB.

Key words: hardness, a casting, a metal mold, melt, grey cast iron.

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Introduction

Metal mold casting [1] is characterized by feature of metal melt cooling into a special mold in a short period of time. Analysis of a cooling process of cast iron and aluminium pistons into the cast iron mold is presented in the articles [2 – 4]. Melt of gray cast iron does not fill cavities of the mold in full due to high castability. The crystallization process occurs when the metal mold filling by melt of gray cast iron. Thus, structure of material in whole volume will be different after cooling of a casting [5 – 7].

The cast iron piston is exposed by mechanical processing and heat treatment after metal mold casting for giving a part of final dimensions, required surfaces roughness and hardness, respectively. It is possible to know of structural characteristics of the piston casting by changing of hardness of casting material before heat treatment. The method application of computer simulation of metal mold casting of the automobile piston allows to determine

mechanical properties and structure of gray cast iron after crystallization.

Materials and methods

The complete process of the casting piston into the metal mold (filling and cooling of melt) is simulated into the computer program LVMFlow [8].

The casting process of the automobile piston was carried out into the metal mold which had been made of gray cast iron. The mold was heated up to 200 °C for additional maintenance of required temperature of melt. The automobile piston was made of grey cast iron EN-GJL-300. Filling of the mold was performed at melt temperature of grey cast iron of 1290 °C. The following casting properties were adopted for melt: compressibility is 30 1/Mbar, CLF up is 50%, CLF down is 30%, CLFpres. is 24% and CLF Niyama is 3%. A vent was provided in a gating system of the metal mold for determination of calculated values of temperature changes which will



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be as close as possible to the production process of casting by this method. The mold filling by melt of gray cast iron was carried out through a slot gate.

Results and discussion

Hardness values (by Brinell) of the cast iron piston after cooling into the metal mold are presented in the Fig. 1.

A three-dimensional solid model of the cooled piston was cut on several fragments by thickness of 5

mm. The fragments of the casting were placed at the same distance from each other. To the left of the solid model of the casting is presented the color scale on which it is determined unit of material hardness by Brinell. The first fragment of the casting (near the scale) was turned to the gating system. Errors of color reproduction and location of contours on the fragments of the piston model were not more than 1%.

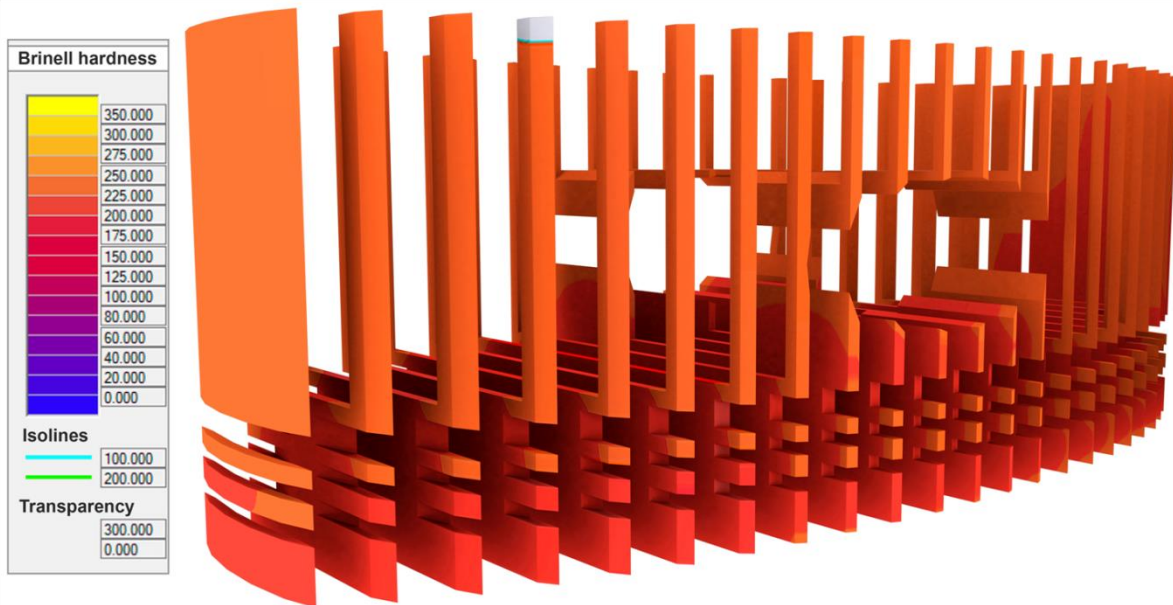


Figure 1 – Brinell hardness of the fragments of the cast iron piston after metal mold casting in a three-dimensional format.

The head of the automobile piston after cooling of the casting is oriented in the lower part of the metal mold. The piston skirt in the upper part of the metal mold will be primarily cooled at this location of the casting. Material hardness in area of the piston head is about 200 HB according to the color contours on the casting model. This is 50 units less than material hardness in area of the piston skirt. This is due to maximum cooling rate of material (approximately 30 °C/s) into a core of the piston head. Hardness reduction of material is observed on surface layers of the casting, located close to a feeder. The ratio of solidification time of the piston head to solidification time of the piston skirt is 5. Tensile strength of the casting material after cooling (crystallization) into the metal mold is changed slightly. The unfilled area into the fourth fragment of

the piston model (highlighted by the isoline) is incomplete filling of melt of grey cast iron into the metal mold due to premature cooling.

Conclusion

Thus, based on the performed analysis of the results of computer calculation of the casting process of the cast iron piston, the following conclusions can be drawn:

1. Hardness of the cast iron piston after cooling into the metal mold is 200 – 250 HB. Herewith, the casting elements of small thickness are cooled quickly and have large hardness than the massive elements (for example, the piston head).

2. Tensile strength of the cast iron piston after cooling into the metal mold and before heat treatment is 209 – 217 MPa.

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