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Effect of Cooling Speed on the Elements Distribution and the Mechanical Properties of the Cast Iron Lamination Cylinders

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Abstract: One can that the indudtry of cast iron foundry manufactures invisible products, no matter what vital, then that they are machined before becoing the components of machines where equipment for all industries. The knowledge of the pig iron and cast iron is not thing simple, complex are the phenomena which accompany, as well solidification as cooling in a solid state such alloys and complex also are the effects, on the pace of the solid product cold. Various components elements the castiron and can obstained satisfactory results, only the founders who inculed/understand prefectly, which occurs in the mould. The addition of alloy element suitable in the pig iron and cast iron makes it possible to modify the structure and to still improve the mechanical, physical characteristics...etc. Thus, one goes, one studied the influence of the mechanical properties and the distribution of the elements between the structural components according to the section of the cylinders at the speed of their cooling.

Key words: Mechanical properties, cast iron, lamination, cylinders, products, pig iron

INTRODUCTION

The solidity and longevity of the lamination cylinders are conditioned by a great importance of the structure and of the mechanical properties of metal, which depend in their turn on the chemical composition liquid alloy and its speed of cooling in the moulds. The most important is the principal technology condition of the foundry part elaboration (lamination cylinders) in cast iron at high strength.. Thus, the effect of the cooling speed on the distribution the elements between the structural composition and on the mechanical properties of the lamination cylinders, made of cast iron, is to be used (studied).

Tests mode: For the study one ran two cast iron cylinders were, modified by magnesium and ferrosilicon, of the following chemical composition as given in Table 1.

The cylinders of outline dimensions (diameter by length), respectively 430×1100mm (I) and 400×1100 mm (II) have been at cast a temperature t= 1280°C in shells of cast iron with paint layers thickness of 0.5mm. The thermograms of cooling (Fig. 1) are recorded by means of the thermocouples chromel-alumels on a potentiometer,

Table 1: Chemical composition of the cylinders 1 and 2

Cylinder number	C	Si	Cr	Ni	Mn	P	S
1	3.36	1.79	0.30	1.2	0.52-0.62	0.15-0.19	0.10
2	3.42	2.48	0.53	0.9	0.52-0.62	0.15-0.19	0.10

since the divergence of the indications of the potentiometer for the two cylinders does not exceed 10-15°C during crystallization and 1-2°C during later cooling, on Fig. 1 are shown the average curves, relating to the two cylinders. For mechanical tests, the cylinders were cut into disc shape, which are machined on later.

DISCUSSION

The analysis of the thermograms (Fig. 1) shows, that as the distance from the surface of the cylinder increases the speed of crystallization of the metal abruptly decreases. In the central part of the cylinder in the last stage of solidification, the speed of crystallization increases slightly compared to the intermediate zones where it is minimal.

The carbides content in the metal structure of the cylinders, measured in an exact way by the method (Saltikov, 2000) decreases progressively from the surface towards the center of the cylinders (Fig. 2).

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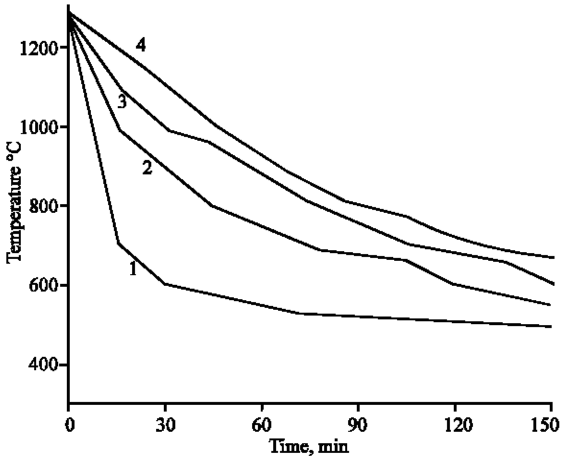

Fig. 1: Temperature of the cylinder versus the distance from surface: 1 (10 mm), 2 (45 mm), 3 (100 mm), 4 (150 mm)

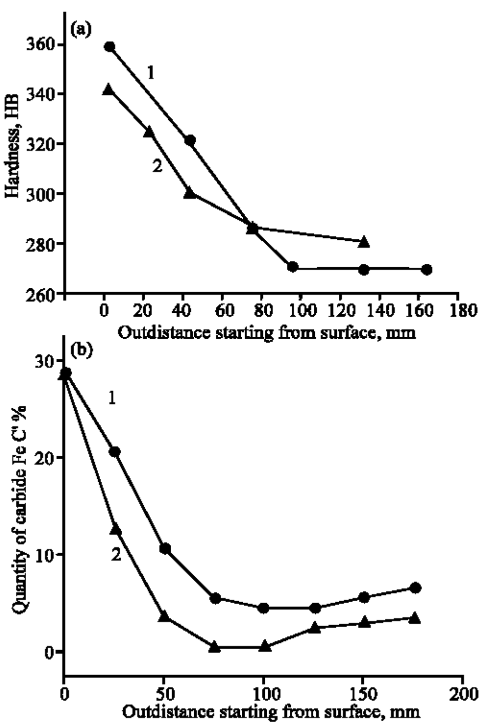

Fig. 2: Distribution of hardness (a) and quantity of iron carbide (b) according to the section of cylinders 1 and 2

On Fig. 3 is shown presented the distribution of the chromium, the manganese and the nickel (K_{Cr}, K_{Mn}, K_{Ni}) between the carbides and the matrix. These coefficients represent the relation between the content of the elements in carbides and the matrix, determined using X-rays on an installation of the MAP type (Lev and Kourassov, 2001).

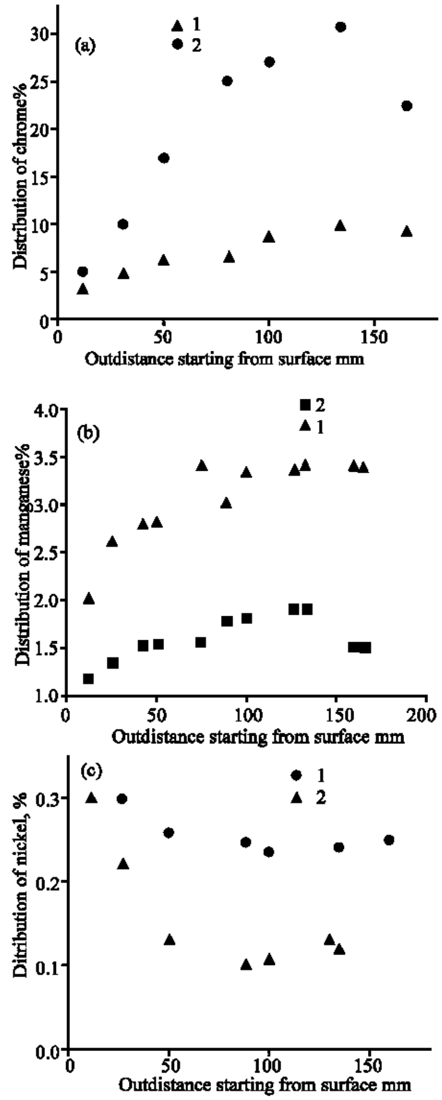

Fig. 3: Distribution of the elements KCr (a) KMn, (b) KNi (c) according to the section of cylinder 1 and 2

In chromium and manganese the affinity to carbon is higher than that of iron, that is why with the decrease of the cooling speed all the most important quantities of iron in cementite substitute of these elements. As the distance towards the depth of the cylinder increases, the cooling speed of the metal decreases; this is why the content of chromium and manganese in cementite increases because the elements arrive in time to disperse in the phases according to their physicochemical properties. The affinity to with carbon in chromium is higher than that in manganese, this is why KCr, is 3-8 times more than K_{Mn}.

Contrary to chromium and manganese nickel has less affinity to carbon compared to iron, this is why with the decrease of the cooling speed its content in cementite

Table 2: Results of the determination of the tensile strength limit of the samples

Outdistance compared to the surface of the cylinder, mm	10	45	100	160
σ_B, Kg mm^{-2}	99	105	109	104
	84	99	108	103

decreases. The reduction of the cooling speed during crystallization and the later cooling, supports the concentration of the nickel atoms in the austenite where the content of carbon is 3-3,5 times less than in cementite. A gain, two particular characteristics of cooling speed effect on chrome, manganese and nickel distribution can be noticed. As it was already noticed, during the solidification of the last portions of the cast iron in the central part of the cylinder, the cooling speed increases slightly in comparison with the bands of the intermediate zone (90-140mm of surface) where it is minimal. This relative increase of the cooling speed of carries out to that chromium and manganese do not manage to be saturated with carbides until this degree, in which it is reached in the intermediate zone, this brings back for us to the dimunition values KCr and KMn. Such is the conclusion that can be made in connection about the distribution of nickel in the central and intermediate zones. With the increase of the cooling speed of the metal in the nickel zone and at less degree manages to spread between cementite and austenite and its content in cementite increases in conformety KNi increases The second interesting characteristic presents the most new important distribution of the elements between the phases in the second cylinder: K^{I}_{Cr} $K^{II}_{Cr,}$, K^{I}_{Mn} K^{II}_{Mn} , K^{I}_{Ni} K^{II}_{Ni} (the numbers show the belonging of the distribution coefficients in accordance to the cylinders). In this characteristic, probably the effect of the increase in the content of silicon in cylinder 2 appeared.

In Table 2 the results of the determination of the tensile strength limit of the samples (in the numerator for the first, in the denominator for the second cylinder):

As it is clear the quoted data and Fig. 2 where are is shown the data of the hardness value, cylinder (1) has the highest value 1, which is relater to the reduction in the content of silicon and chromium and also with the high nickel content.

CONCLUSION

Thus, with the reduction of the cooling speed the quantity of the eutectic carbides decreases which leads to a decrease in hardness and an increase in the limit of resistance. In relation to this, magnetic cast iron cylinders intended for work under the high conditions of welding, it is advisable to cast them with less cooling speed of the surface, which enables to reach the highest strength of the work layer of the cylinder. With this objective, it is advises to cast this type of cylinders in shells which have at thickness of 2-5 mm, However, in the composition of the cast iron, silicon should not exceed 2%, chromium not more than 0.35% and nickel within the limits of 1.2-1.6%.

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