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CONTROL OVER THE PROCESS OF FORMATION OF THE STRUCTURE AND PROPERTIES OF CAST IRON BY TERMAL ANALYSIS METHOD

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SUMMARY

On the basis of the application of thermal analysis and study of the regularities of eutectic crystallization of alloys of the Fe-C system, an automatic system of control and management of the process of formation of the structure and properties of cast iron during ist smelting was created. The process of formation of the structure of cast iron was regarded from the point of regularities of phase transmissions.

INTRODUCTION

In determining the parametres of crystallization and assessment of formation of cast iron structure durimg its smelting, one of the main methods of physical-chemical analysis is thermal analysis (TA). However, the existing methods of assessing structure-formation of alloys, mainly from the position of mathematical description of thermograms without taking into consideration the physical of the processes /1-3/, hamper the control over the formation of cast iron structure in industrial condition ans even the management of the structure-formation process.

Due to the diverasty of metallurgical and technological factors influencing the formation of the structure and properties of cast iron, the problem should be solved not from the position of accumulation of data in the form of thermogram, reflecting all the possible variants, deviations in the technology of producing cast iron, but by revealing general regularities of the process of structure-formation of cast iron and the influence of various factors upon it.

METHODS OF CONTROL

Taking into account that TA fixes phase changes of alloys during their heating or cooling, the process of formation of cast

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iron structure should be regarded from positions of regularities of phase conversions and, first of all, of eutectic crystallization. The problem of accuragy and stability of the guantitative analysis of phase conversions is solved in the giver work by applying fine-walled quartz samplers. The sizes of the sampler are determined by the condition of the minimal sample mass and its crystallization according to the stable system. For the grey cast iron the sample mass is about 8-10g and for the highly-durable one - 45-50g.

The change of the temperature of the analyzed sample during its cooling is fixed automatically by the computer.

The specially created algoritm of the mathematical treatment of thermograms, considering the real thermal balance of the investigated system, the phase composition and thermo-physical parametres of the structural components, permits to analyse the individual character of isolation of each phase during the eutectic crystallization and the formation of the alloy structure on the whole.

The thrmo-physical model of eutectic crystallization was put into the base of construction of the mathematical model of the process of formation of the primary cast iron structure(Fig.1). Curve 1 characterizes the process of release of the main eutectic phase - of graphite, curve 2 - the release of the driver phase - of austenite, curve 3 - the course of the whole process of eutectic crystallization, area I - release of the graphite that had freely grown in the liquid, area II - the joint release of the two phases, area III - the release of austenite at the last stage of crystallization, after the end of formation of graphite crystalls.

RESULTS AND DISCUSSION

In order to increase the efficiency of directed influence on the process of formation of iron cast structure and possibility of realization of optimazation of alloy composition, applying data on structure-formation processes, investigations were conducted on the influence of the main components of cast iron and the alloying elements on the character of phase conversions, taking into account the thermo-physical model of the process of eutectic crystallizytion. Fig.2 shows data on the effect of Mn, Ni, Zr, Co, Ce on sone main parametres of eutectic crystallization in correspondence wits Fig.1, where: a - is the change of the specific rate of graphite release, b - change of the specific rate of austenite relea-

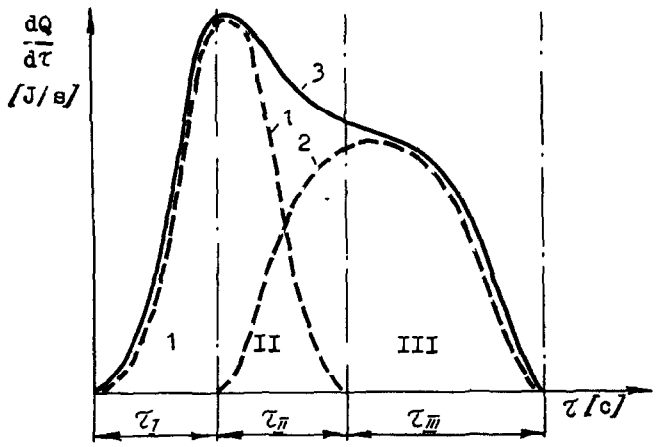

Fig.1. A thermophysical model of the eutectic crystallization of cast iron

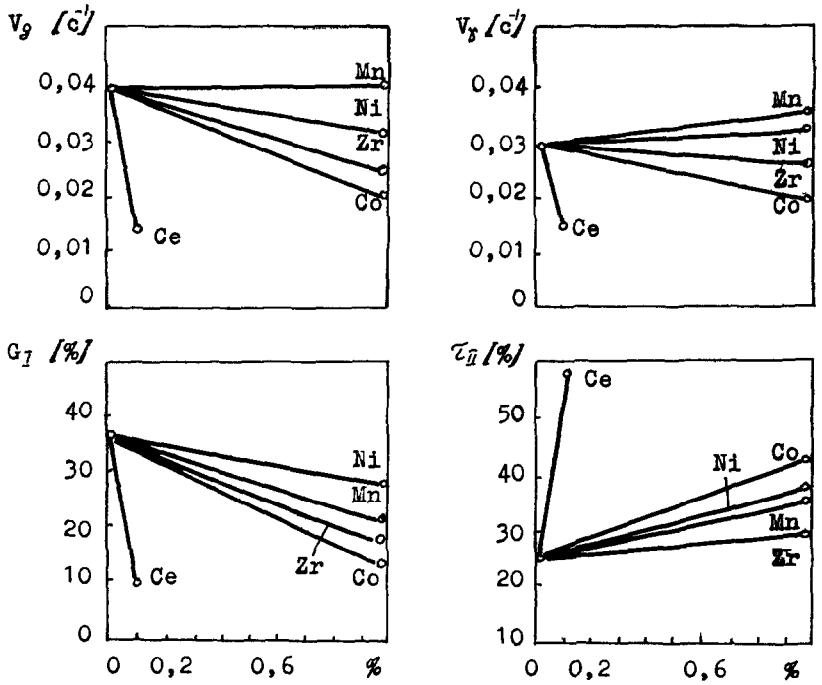

Fig.2. The effect of alloying elements on the parametres of the eutectic crystallization of cast iron

se, c - the quantity of the freely grown in liquid graphite, d - the portion of the stage of simultaneous growth of graphite and austenite.

Analyses of the given data testify that the introduction of alloying elements changes to this or that degree the character of growth of the phases. Decrease of graphite portion that had freely grown in liquid with a simultaneous decrease of the rate of the release of the phase furthers increase of the degree of branching of graphite crystalls. The introduction of cerium into cast iron leads to a sharp decrease of the rate of phase isolation at all the stages of conversion with a simulataneous growth of the total duration of the process. And here, in eutectic crystallization, the stage of simultaneous growth of graphite and austenite prevails. The given character of eutectic crystallization leads to the realization of conditions, furthering the formation of compact crystalls of graphite, with a sphere-like form.

The presented data on cast iron analysis on the basis of application of TA and from the position of processes, reflecting the physical essnce of structure-formation, served as a ground for the created automatized system of control and management of processes of formation of the structure and properties of cast iron.

CONCLUSION

The analysis of the process of formation of cast iron from the position of regularities of phase conversiors permits to bring the creation of automatized systems of control of the quality of alloys in conditions of a concrete production to the elaboration of a mathematical model of the process of structural-formation of the smelting alloy and to the setting of a computer.

REFERENCES

1 H. Fredriksson, B. Rogberg, Thermal analysis for interpretation of solidification sycle. The Metals Society, 689-690, 1979
2 R. Wlodawer, Gelenkte Erstarryng von Gusseisen. Düsseldorf, Giesserrei-verlag G.M.B.H., 395-438, 1977
3 E.F. Rynz, J.F. Janowak, A.B. Hohstein, G.A. Wargel, Trans. Amer. Foundrumens Soc. 79, 1971