1.1.21. MAGNETIC TESTING OF STRUCTURE OF THE CAST-IRON PRODUCTS: POSSIBILITIES AND RESULTS

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This report concerns the problem of non-destructive testing in metallurgy. In the paper, the problems of testing the structure of casting products are analyzed, which are solvable by use of the magnetic parameters. The recommendations on application of the testing means are provided.

Cast-iron is one of the most widely used and promising technological casting materials. Disruptions of the technological processes in production lead to unacceptable variations in the properties of casting products. To guarantee the conformance of the casting structure with the demanded one, the non-destructive testing methods can be employed. Diversity of the cast-iron structures determines the variety of tasks and methods of the structure testing. **The aim of this work** is to generalize the basic principles of magnetic testing of structure of the cast-iron products.

Magnetic testing of cast-iron products is based on the differences in magnetic properties of structural components of the cast-iron. An overview of the published data reveals that there is no relationship between the amount of carbon and the magnetic properties of cast-iron, because not the amount, but the state of the carbon in the cast-iron has the deciding influence on the magnetic properties. The results of investigations of the variation ranges of the coercitive force H_C, residual magnetization M_R, and saturation magnetization M_S for white, gray, malleable, and high-strength cast-irons at different structures of metallic matrices are summarized in the Table.

The elaborated methodology [1] allows to calculate the residual magnetization M_d of a casting product, magnetized in an open magnetic circuit by a field of intensity H_e using H_C, M_S and M_R of the material and the demagnetization factor N.

Discrimination of cast-irons with different structures by measuring their magnetic properties can be recommended in the following basic cases.

Table

Type of cast-iron	Type of metallic basis	H_C, kA/m	M_S, kA/m	M_R, kA/m
White cast-iron (WC)		1.04 – 1.28	1035	400 – 440
Gray cast-iron (GC)	Ferrite	0.2 – 0.4	1433	240 – 440
	Perlite	0.56 – 1.06	1393	320 – 560
High-strength cast-iron (HC)	Ferrite	0.12 – 0.2	1513	240 – 480
	Perlite	0.4 – 0.88	1473	400 – 640
Malleable cast-iron (MC)	Ferrite	0.12 – 0.2	1433	440 – 560
	Perlite	0.4 – 0.88	1393	480 – 600

The white cast-iron can be reliably distinguished from cast-irons of all other types by measuring either H_C or M_d. These parameters of the white cast-iron and ferrite cast-irons of other types differ by a factor 3 to 10, which practically excludes their confusion at testing. Differences in H_C and M_d of WC and perlite MC and HC are also sufficient for their reliable sorting (factor 1.2 – 3.0). Practice of the magnetic testing of the quality of annealing the products from WC to MC is one of the most successful and reliable applications of the magnetic non-destructive testing [2]. Moreover, in the magnetic fields not bringing the casting products with a high N to the technical saturation, we observe a higher (by 20 – 30%) sensitivity of M_d of the products to the structure of their material, than at magnetization to saturation [3]. Based on variations in H_C or M_d, the perlite or ferrite cast-irons of all types can be separated from each other. The problem is solved of the determination of the quantitative ratio of perlite to ferrite content in casting products with a high N made of MC based on measuring M_d [4].

When solving the task of assessing the quantitative ratio of perlite to ferrite content in HC, one must take into account [2], that increase in H_C, characteristic for increase of perlite content in the metallic matrix of a cast-iron, can also be caused by increase of the percentage of lamellar ferrite inclusions in the cast-iron with globular graphite. In [5] it is shown that at the same shape of the graphite inclusions, the variation of the perlite content in the metallic matrix of HC and GC from 0 to 100% leads to a factor 2.8 increase in indications Φ_d and ∇H of the devices MAKSI and MS [4], which are proportional to M_d of the casting products. The values of the parameters Φ_d and ∇H for the samples with a HC structure are on average 1.6 times smaller than for the specimen with a GC structure at the same ratio of perlite to ferrite. The obtained results, along with the data summarized in the Table on the possible ranges of variation of the magnetic parameters of cast-irons with different structures, allow to provide the presented on the Figure estimation of variation of the H_C for the casting products made of HC (1) and GC (2) at variation of the perlite to ferrite ratio in their metallic matrix.

The scientific state of the arts allows to forecast the possibility to apply the magnetic methods for the non-destructive control of heat treatment regimes, of the chemical, structural and phase composition, mechanical properties of cast-iron products. The instrumental implementation of the methods allows to conduct the monitoring in the factory workshops and laboratories [4].

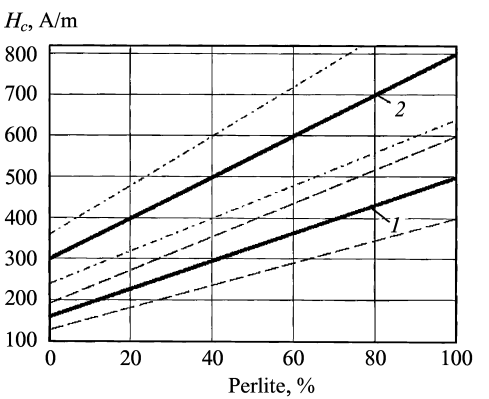

Fig. 1

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