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OPERATIONAL DETERMINATION OF PHYSICAL AND MECHANICAL PROPERTIES OF CAST SAMPLES OF HIGH-STRENGTH IRON BY MEANS OF A MAGNETIC-MECHANICAL METHOD

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The effect of the chemical composition of high-strength cast iron VCh35 on the content, shape and diameter of graphite inclusions and on the presence of structurally-free cementite and defects is studied. A relationship is determined between the structure and metallurgical defects and characteristics of the mechanical and magnetic rigidity of cast samples. Relationships are established in a group of factors and property characteristics: chemical composition – microstructure – mechanical rigidity – magnetic stiffness. The basis of a method is established making it possible to perform operative non-destructive monitoring of the melt quality preparation for high-strength iron casting.

Key words: high-strength iron, cast sample, mechanical rigidity, magnetic rigidity, magneto-structural, magneto-elastic, and chemical analyses, microstructure, metallurgical defects.

INTRODUCTION

In the practice of casting and metallurgical production an important question is conditions for preparation and crystallization of metallic melts on alloy final physical and mechanical properties.

The phenomenon of the dependence of normal elasticity modulus E on size, shape, and amount of pores and all possible inclusions has been used for a long time for evaluating the properties of cast components and welded joints [1].

The level of magnetic anisotropy energy (crystalline and magneto-elastic) of magnetically-soft alloy depends on its chemical composition, degree of remote and near ordering development of active stresses.

Presence of other elements apart from carbon in chemical composition is reflected in the magnetic properties of cast iron with spheroidal graphite (CSG) due their effect on magnetization, graphite grain shape, and base metal structure [2]. Silicon is present within the structure of molten cast iron, similar to carbon both in the form of inherent clusters and in solution. They have a significant effect on structure formation and cast iron mechanical property indices. This element prevents creation of Fe – C bonds on a competitive basis slowing down diffusion of carbon in austenite and preventing formation or reducing the stability of both eutectic and eutectoid carbides.

A purely ferritic structure of the CSG metal base in a cast condition is achieved with (3.0 – 3.3)% Si, (0.3 – 0.5)% Mn, < 0.05% P [3].

Silicon as a graphitizing element facilitates decomposition of cementite and a reduction in cast iron magnetic stiffness [2]. By changing silicon concentration it is possible to prepare a different metal base structure and correspondingly the level of cast iron ductility in a cast condition [4].

An increase in magnesium content within the limits of 0.01 – 0.05% leads to formation in cast iron of graphite inclusions spherical in shape with a minimum interface, providing in demagnetization fields around them and correspondingly coercive force H_c [5]. The residual content of magnesium in cast iron providing total graphite spheroidization and the required set of physical, chemical, and service properties for CSG normally comprises 0.03 – 0.06%, and depends on the amount of sulfur, oxygen, and other impurities in the original cast iron [3].

Elasticity modulus E of high-strength cast iron with an increase in the degree of graphite inclusion compactness grows due to a reduction in stress concentration and intensity of active microplastic deformation around them during testing in a field of macro-elastic deformation [6].

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The aim of this work is development of a non-destructive monitoring procedure for the quality of high-strength cast iron melt preparation for casting based on electric and magnetic properties of cast samples.

METHODS OF STUDY

The relative stiffness of specimens as nominal stress σ_E was determined as a parameter specifying by a graphical method cast iron elastic properties. On the tensile diagram the elastic section was extrapolated to a point of intersection with the vertical loading line plotted for points corresponding to $\delta = 2\%$. Stress σ_E, equal to the ratio of this load to initial cross sectional area, also characterizes specimen elastic properties.

Magneto-structural and magneto-elastic analyses were performed on the end surface of specimens of cylindrical shape (∅ 16 mm, h = 18 mm) by means of an MAS-2 instrument using an original procedure.

The magneto-structural and magneto-elastic analysis characteristics used were the following: difference $\Delta H^{st-c} = H^{st} - H^{c}$, where H^{st} and H^{c} are specimen residual magnetization field intensity after magnetizing on a steel and copper support plate; $\ln H_2/H^{st}$ is natural logarithm of the relative capacity for remagnetization by a low-energy pulse (H_2) of the region of a specimen on a steel pate (two-parameter criterion connected with losses for remagnetization).

The magnetic pulse with intensity of several thousand oersted and frequency of 4×10^4 Hz penetrates into the body of a ferromagnetic specimen of low weight to a depth of about 2 mm. The stress field difference function for residual magnetization ΔH^{st-c} after measurement on support plates with different mechanical reaction (stiffness) depends of the effect of magnetic and elastic properties of the specimen cast structure on the result of magneto-mechanical reaction of a specimen-plate under different conditions [7]. The magnitude of field intensity and residual magnetization H in the general case is proportional to coercive force H_c measured by means of ferroprobes.

The shape, amount, and size of graphite inclusions, matrix structure, defects of various scale levels with application of an external load on cast affects the internal stress field and the internal stress field and their magnitude, and also coercive for H_c, whose connection with internal stresses is well established [8].

The range of values of weight fractions of chemical elements in the selected test specimens of CSG and according to GOST 7293–85 [9] with a wall thickness up to 50 mm is correspondingly the following: 3.28 – 3.71) and (3.2 – 3.8) % C, (0.08 – 0.10) and (0.2 – 0.6)% Mn, (2.37 – 3.09) and (1.9 – 2.9)% Si, not more than: 0.02 and 0.1% P, 0.021 and 0.020% S, 0.059 and 0.050% Cr.

Metallographic study of the heads of broken specimens of high-strength cast iron was conducted according to the GOST 3443–87 scale [10] in transverse sections.

In this work a microstructure criterion of the degree of perfection or completeness of occurrence of graphitization and spheroidization processes was adopted: content of inclusions of regular spheroidal shape ShGf5 and absence of structurally free cementite within a sample microstructure.

Graphite inclusion diameter for specimens of all selections varies within the limits ShGd15 – ShGd45 μm, area of inclusions ShG4 – ShG6 %, shape ShGf1 – ShGf5, and distribution ShGr1.

The metal base of all cast iron specimens is ferritic containing 100% ferrite. Within the metal matrix there are micro-volumes (up to about 10%) with structurally free cementite. The actual ferrite grain size is not uniform, and its size varies from 10 to 50 μm. Specimen hardness (135 – 152 *HB*) corresponds to GOST 7293–85 [10] (130 – 170 *HB*).

The selection of specimens for comparison was from rolled product (steel 45).

RESULTS

The scale of values of weight fractions of silicon and magnesium in the selection, containing spheroidal inclusions of regular shape ShGf5 in the structure (Table 1) and presence of structurally-free cementite point to the incompleteness of graphitization and spheroidization processes in the test CSG.

In the metal base of specimens *1 – 6* microvolumes are observed (about 10%) with structurally free cementite, and within the microstructure of the rest of the specimens this content is an insignificant amount. The reason for formation of an increased proportion of cementite in specimens *1 – 6* is probably a reduction in silicon content (2.37 to 2.45%) with an average weight fraction in a selection of 2.64% (Table 1). Presence of cementite reduces ductility, which is confirmed by the linear correlation of average closeness $\psi = f(\text{Si}, \%)$ (Table 2, Eq. 1).

The degree of graphite inclusion spheroidization also affects the ductility properties and depends on the residual content of magnesium that in specimens *1 – 6* is (0.017 – 0.022%) with an average concentration in a selection of 0.022%.

In order to evaluate the degree of effect of elements on graphitization and spheroidization processes a conditional chemical potential was introduced $(\text{Si} \times \text{Mg}, \%) \times 10^2$, whose connection with relative reduction of area $\psi = f(\text{Si} \times \text{Mg}, \%) \times 10^2$ (Table 2, Eq. 2) has good closeness ($r = 0.818$). The suggested potential of regular closeness ($r = 0.914$) is connected with a microstructure criterion of degree of spheroidization, i.e., the content of spheroidal regular shape inclusions ShGf5 that is a linear dependence and has an average closeness ($r = 0.731$) connected linearly with magnetic parameter H^{st} (Table 2, Eqs. 3 and 4).

A reduction in specimens *1 – 6* silicon content in liquation zones leads to formation and growth of austenite crystals up to reaching the eutectic temperature in a casting.

TABLE 1. Results of Chemical Analysis, Mechanical Tests, and Metallographic Studies for Specimens of High-Strength Cast Iron VCh35

Specimen	ψ, %	HB, kgf/mm^2	Element content, wt.%			Graphite inclusion characteristics			MO defects
			Mg	Si	C	Shape ShGS5 : ShGS4 : ShGS3	ShG area, %	Diameter ShGd, μm	
1	6.4	149	0.018	2.45	3.58	20 : 40 : 40	4	25	SI, MT, DI
2	4.7	149	0.020	2.46	3.71	45 : 45 : 10	4 – 6	25 – 45	d/f
3	6.8	146	0.018	2.42	3.62	33 : 33 : 33	4 – 6	25 – 45	SI
4	2.5	137	0.022	2.41	3.39	33 : 43 : 23	4 – 6	25 – 45	d/f
5	2.5	137	0.018	2.39	3.66	25 : 35 : 35	4	25 – 45	Pe, SI
6	4.9	146	0.017	2.37	3.42	20 : 55 : 25	4	25 – 45	Pe, SI, P
7	21.5	152	0.028	2.61	3.56	80 : 10 : 10	4 – 6	25	SI
8	17.1	143	0.026	2.69	3.28	90 : 5 : 5	4	25	d/f
9	17.0	140	0.028	2.77	3.32	90 : 5 : 5	4	25	Pe, SI, MT
10	26.0	149	0.026	2.63	3.56	80 : 10 : 10	6	25	SI, MT
11	23.5	135	0.023	2.57	3.51	90 : 5 : 5	4 – 6	45	d/f
12	20.0	146	0.024	3.09	3.40	90 : 5 : 5	6	25	d/f
13	22.0	137	0.022	2.97	3.28	90 : 5 : 5	6	25	d/f
14	15.5	149	0.021	3.06	3.38	90 : 5 : 5	6	25	SI
X_{av}	13.6	144	0.022	2.64	3.48	62 : 20 : 13	–	–	–

Notations: P is pores; SI is slag inclusions; MT is micro-tears; Pe is peeling; DI is discontinuities; MO is metallurgical origin; d/f is defect free.

Generation and growth of graphite crystals and ferrite during subsequent cooling proceeds both within austenitic crystal complexes, and in those formed during eutectic transformation. This is confirmed by the scatter of ferrite grain size (10 – 50 μm) and correlates with the significant scatter of graphite inclusion size (Table 1).

The effect of modifier (Mg) and graphite-forming element (Si) in CSG on elastic property σ_E (Fig. 1) is realized in

TABLE 2. Closeness of Open Bonds and Form of Established Relationships

Number of lines and Equations	Regression equation	R	r
1	$\psi = -44.9 + 22.197 \times \text{Si}, \%$	–	0.650
2	$\psi = -17.8 + 5.324 \times (\text{Si} \times \text{Mg}, \% \times 10^2)$	–	0.818
3	$\text{ShGf5} = -67.7 + 21.964 \times (\text{Si} \times \text{Mg}, \% \times 10^2)$	–	0.914
4	$H^{\text{st}} = 2286.4 - 83.553 \times (\text{Si} \times \text{Mg}, \% \times 10^2)$	–	0.731
5	$H^{\text{st}} = 1349 + 2.9 \times \text{ShGf5} + 8.4 \times \text{ShGf4} + 7.1 \times \text{ShGf3}$	0.738	–
6	$H^{\text{c}} = 1688 - 8.4 \times \text{ShGf5} - 5.0 \times \text{ShGf4} - 7.3 \times \text{ShGf3}$	0.875	–
7	$\sigma_E = -218 + 7.2 \times \text{ShGf5} + 10.2 \times \text{ShGf4} + 7.9 \times \text{ShGf3}$	0.448	–
8	$\Delta H^{\text{st–c}} = -234 + 10.3 \times \text{ShGf5} + 12.3 \times \text{ShGf4} + 12.9 \times \text{ShGf3}$	0.404	–
9	$\sigma_E = -126 + 0.37 \times H^{\text{st}}$	–	0.663
10	$\sigma_E = 583 - 0.047 \times H^{\text{c}}$	–	– 0.076
11	$\sigma_E = 1236 - 0.880 \times H_2$	–	0.900
12	$\sigma_E = 6 + 0.649 \times \Delta H^{\text{st–c}}$	–	0.883
13	$\sigma_E = 120.6 - 507.84 \times \ln H_2 / H^{\text{st}}$	–	– 0.955
14	$\sigma_E = 915.6 + 0.650 \times \Delta H^{\text{st–c}}$ (Steel 45)	–	0.781
15	$\text{ShGf5} = -0.03 + 20.859 \times (\text{Si} \times \text{Mg}, \% \times 10^2) - 17.585 \times \text{C}, \%$	0.915	–
16	$(\sigma_E / \sigma_{ECP}) = 0.069 + 0.938 \times (\Delta H^{\text{st–c}} / \Delta H_{CP})$	–	0.840

Notations: R is multiple linear correlation coefficient; r is paired linear correlation coefficient.

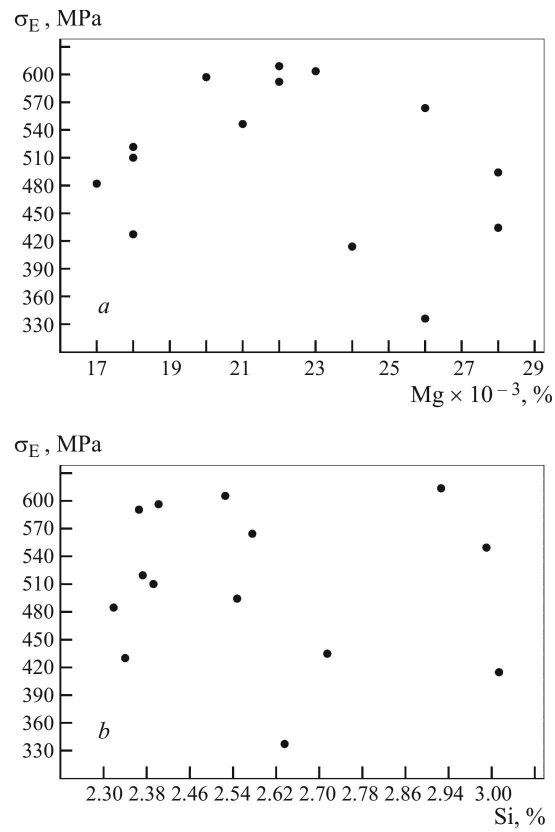

Fig. 1. Distribution of experimental points of elasticity characteristic σ_E of high-strength ferritic cast iron VCh35 along the Mg, % (*a*) and Si, % (*b*) content axis.

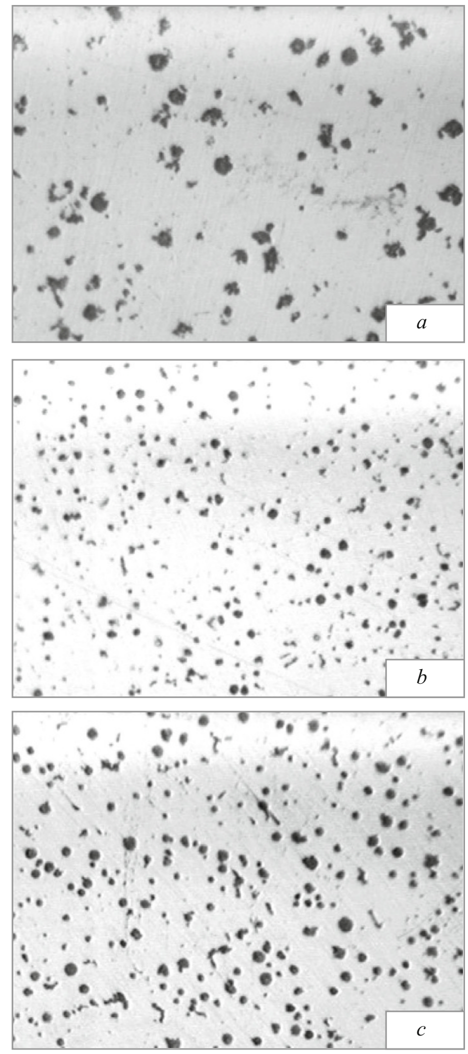

Fig. 2. Graphite inclusions within the microstructure of cast samples of high-strength ferritic cast iron VCh35 collected before pouring (× 150): *a*) equal content of regular (ShGs5) and irregular (ShGs4) shape (specimen *2*); *b*) large area (ShG6) of dispersed (ShGd25) inclusions, high content of regular shape (ShGs5) inclusions (specimen *13*); *c*) high content of regular shape (ShGs5) inclusions (specimen *7*).

terms of their effect on size, shape, and amount of graphite grains (Fig. 2), phase composition, substructure of the base, and phase properties. Maximum values of elasticity parameter σ_E correspond to the optimum range of magnesium concentration (0.020 – 0.025%) and silicon (2.40 – 2.90)%, and published data for standard mechanical properties [4, 11].

Values of weight fraction of magnesium and/or silicon outside these optimum ranges for specimens *1*, *5*, *6*, and *9* (Table 1) lead to a reduction in relative area occupied by inclusions to ShG4, i.e., with a known diameter size to a reduction in their amount in a field of view ad to the left of the boundary range to a reduction in content of spheroidal inclusions of regular shape ShGf5 to 20% (Table 1, specimens *1*, *5*, *6*). In addition, this amount of Mg and/or Si combined with defects of metallurgical origin causes a reduction in stiffness properties σ_E with respect to average value of X_{av} (Tables 1 and 3).

It should be noted that within the structure of specimens *2*, *4*, *11*, and *13* with $\sigma_E = 600$ N/mm^2 (Table 3) effects of metallurgical origin are not detected, which also have an unfavorable effect on them for mechanical stiffness.

The insignificant scatter of hardness values in the selection (17 *HB*, i.e., 12%) and lack of a simple connection with structural components makes it impossible to obtain positive results in differentiating specimens with respect to structure (Table 1).

A multiple linear regression equation describes the effect of graphite inclusion content with a different shape on magnetic property H^{st} with an average closeness connection, which significantly increases with measurement on a copper plate (Table 2, Eqs. 5 and 6). Correlation between H^{st} and H^c, and mechanical stiffness parameter σ_E is only statistically significant in the first case (Table 2, Eqs. 9 and 10).

A shift of experimental values of magnetic property characteristics H^{st} and H^c for specimens of the selection with respect to average values was such that with an increase in mechanical stiffness index σ_E there is an increase in the difference of $H^{st\text{–}c}$ (Table 3).

TABLE 3. Results of Magnetic and Mechanical Characteristic Measurements

Specimen	H^{st}/H^{c}	ΔH^{st-c}	H_2	$\ln H_2/H^{st}$	σ_{EP}, MPa	σ_E, MPa
1	1914/1025	889	806	– 0.865	561	540
2	1957/1082	875	745	– 0.966	612	627
3	1912/1045	867	783	– 0.893	575	550
4	1942/1125	817	763	– 0.934	596	620
5	1905/1239	666	935	– 0.712	483	459
6	1877/1135	742	839	– 0.805	530	513
7	1651/853	798	760	– 0.776	515	523
8	1430/889	541	961	– 0.397	322	337
9	1783/972	811	813	– 0.785	520	464
10	1782/1025	757	850	– 0.856	556	595
11	1772/776	996	662	– 0.985	622	634
12	1591/846	745	878	– 0.594	422	445
13	1764/786	978	667	– 0.973	616	641
14	1835/943	892	722	– 0.933	595	577
X_{av}	1794/982 (353/89 A/m)	819 (36 A/m)	792 (28 A/m)	– 0.819	538	538

It is not possible to interpret the change in characteristics σ_E and H^{st-c} by ratios of the content of graphite inclusions of different shape within the structure of specimens (Table 2, Eqs. 7 and 8), but a regression equation has an identical structure and is characterized by similarity on values of the closeness connection.

Use of remagnetization characteristic H_2 and two-parameter functions H^{st-c} and H_2/H^{st} made it possible to reveal simple linear connections of good closeness for stiffness parameter σ_E (Table 2, Eqs. 11, 12, 13).

The increase observed in relative magnetic stiffness after remagnetization in small fields H_2/H^{st} (Tables 1 and 3) under the effect of the following chemical and structural factors is observed:

– low nominal graphitization and spheroidization potential, presence of bonded carbon, development of graphite platelets; small amount, low degree of spheroidization and large diameter of graphite inclusions; presence of defects of metallurgical origin (specimens *5*, *6*);

– a high potential with a greater weight fraction of magnesium, rare inclusions of cementite, a small amount, high degree of spheroidization and average graphite inclusion size; presence of defects of metallurgical origin (specimens *8*, *9*);

– high potential with greater silicon weight fraction, greater amount, high degree of spheroidization ad fine graphite inclusions (localized graphite structure), absence of effects of metallurgical origin (specimen *12*).

Values of mechanical stiffness parameter σ_{EP} (Table 3) calculated by Eq. (13) (Table 2) correspond with good approximation to test results.

Results of studying the comparative selection of specimens of round rolled product (steel 45) in hot-rolled and normalized conditions confirm existence of a directly proportional linear correlation and equality of angular coefficients of a single nature of the relationship between σ_E and H^{st-c} (Table 2, Eqs. 14 and 12).

DISCUSSION

In studying the effect of carbon weight fraction on a competitive basis with conditions of nominal chemical potential of graphitization and spheroidization $(\text{Si} \times \text{Mg}, \%) \times 10^2$ on content of inclusions of regular spheroidal shape ShGf5 a connection has been revealed and established for the dependence $\text{ShGf5} = f(\text{Si} \times \text{Mg}, \% \times 10^2; \text{C}, \%)$ (Table 2, Eq. 15). With respect to closeness connection it does not surpass the relationship $\text{ShGf5} = f(\text{Si} \times \text{Mg}, \%) \times 10^2$ (Table 2, Eq. 3) and may be interpreted so that with a fixed weight fraction of magnesium and silicon in the region of incomplete spheroidization the increase in carbon weight fraction reduces the content of inclusions of irregular spheroidal ShGf5 due to an increase in inadequacy of graphitizing and modifying elements in the balance of processes and limitation of the time for primary and secondary recrystallization. A reduction in carbon concentration brings the weight fraction of elements to a balance and the content of graphite inclusions of shape ShGf5 increases, as also does the amount of them in the field of view, and graphite grains are finer (Fig. 2*b*). Therefore, an increase in carbon content reduces the degree of spheroidization, but formation of an increasing amount of graphite of spheroidal regular shape requires additional consumption of silicon and magnesium up to achievement of 100% spheroidization. Substitution in Eq. 15 (Table 2) of weight fractions of silicon, magnesium, [3], and carbon [9] for complete graphitization and spheroidization gives entirely appropriate results.

A group of specimens with a low weight fraction of residual magnesium and silicon, excess carbon (average in the group 2.56%, in the selection 3.48%, Table 1) is distinguished by the imperfect shape of graphite inclusions, presence of structurally free cementite, and a low ductility level (Table 1, specimens *1 – 6*). A high inclusion content of irregular shape (ShGf4, Fig. 2*a*), presence of lamellar precipitates of graphite, predetermines the maximum stress concentration during a change in magnetic characteristic H^{st} under stiff conditions and formation of maximum fields of scatter in determining H^{c}. This corresponds favorably to high experimental values of H^{st} and H^{c} (Table 3) and maximum positive and negative partial regression coefficients for the content of ShGf4 in equations (Table 2, Eqs. 5 and 6).

Within a group of specimens with a high weight fractions of magnesium and silicon, and reduced carbon concentration, the amount of graphite inclusions increases, diameter decreases, and they almost acquire a regular shape (ShGf5). In this case the level of cast iron ductility increases sharply (Table 1, specimen *7 – 4*). A very high content of regular shape inclusions (ShGf5, Fig. 2*b* and *c*) causes minimum stress concentration during measurement of parameter H^{st} and formation of minimum scatter fields in determining H^{c} (Table 3). This effect of structure corresponds to the low experimental values of H^{st} and H^{c} (Table 3) and minimum positive and negative partial regression coefficients with ShGf5 content (Table 2, Eqs. 5 and 6).

The closeness of the connection of H^{st} with inclusion shape and mechanical stiffness σ_E is commensurate (Table2, Eqs. 5 and 9) and characteristic H^{c} depends mainly on graphite inclusion shape, and there is no linear correlation with specimen stiffness (Table 2, Eqs. 6 and 10). The difference in stress field for residual magnetization (ΔH^{st-c}) is in the author's opinion a magneto-elastic function depending predominantly on internal stresses at the instant of measurement (Table 2, Eq. 12).

Specimens of the selection (*1. 5*, *6*, *8*, *9*) with a reduced amount of graphite inclusions within the field of view (ShG4) have average and low values of stiffness parameter σ_E, but average a high values of magnetic stiffness after remagnetization H_2 (Tables 1 and 3) that at first glance appears to be contradictory.

However a low silicon concentration and insufficiently high carbon determines the position of the eutectic point on the concentration axes for these specimens (apart from specimen *5*) above the actual value. i.e., hardening proceeds by a hypoeutectic version in accordance with the stable composition diagram. It commences with formation of primary austenite dendrites, for which occurrence of a graphite complex follows. As primary dendrites grow the volume occupied by graphite inclusions is limited and distributed between relatively small amount of coarse cavities (effect of austenite crystal scale) and layers between dendrites. They bend and deform due to dendrite pressure, continuing to grow from eutectic austenite. A reduced weight fraction of magnesium and increased sulfur stimulates graphite redistribution from compact cavities in layers between dendrites. It is well known that lamellar graphite precipitates reduce the cast iron elasticity modulus and increase magnetic stiffness.

Under conditions of a reduction in temperature of a small cross section specimen a low silicon content as a graphitizer and its natural capacity for forming liquation develops a region within which eutectoid transformation is implemented according to the metastable diagram and cementite appears in the microstructure. This phase is stiff in a magnetic and mechanical respect, and its effect on a ferrite matrix depends on the amount, shape, and size of particles.

In order to consider the large number of influential factors, comparative analysis was carried out for experimental point distribution on coordinates ΔH^{st-c} – Mg, %, ΔH^{st-c} – Si, %, and σ_E – Mg, %, σ_E – Si, % (Fig. 1). As a result of this a similar and identical picture was established for the effect of modifier and graphitizing element concentration on the magnitude of the magneto-elastic function ΔH^{st-c}, and mechanical stiffness σ_E . A similar curve with a plateau at the top was observed in the case of the position over the axis calculated arguments by Eq. 15 (Table 2) for the index of the degree of spheroidization of ShGf5r in which the weight fraction of chemical elements projects with independent variables.

Standardized characteristics of mechanical stiffness σ_E and magneto-elastic function ΔH^{st-c} are connected linearly with each other by an almost equal value of increase with closeness to zero of the free term of the equation (Table 2, Eq. 16).

The reason for different pinning of domain boundaries and rotation of the saturation magnetization vector I_s in determining the magneto-elastic function ΔH^{st-c} for CSG specimens are the same factors that affect mechanical stiffness, causing a closely linear magneto-mechanical connection (Table 2, Eq. 12).

CONCLUSIONS

1. An equation has been suggested on the basis of the weight faction of silicon, magnesium, and carbon that makes it possible to calculate the content of graphite phase for point ShGf5 in high-strength cast iron VCh35.

2. A linear correlation between σ_E , ΔH^{st-c}, ln H_2/H^{st} is based on their similar dependence on CSG structure.

3. The procedure of magneto-elastic analysis for CSG specimens is based on magnetic structure examination and magneto-mechanical effects.

4. The relationship between ΔH^{st-c} and mechanical stiffness is universal in nature for iron carbon alloys of different chemical composition with a structure consisting of ferrite, pearlite, graphite inclusions, and a small amount of structurally free cementite.

5. Under conditions of longitudinal pulsed magnetization of a ferromagnetic specimen of cylindrical shape and low weight on support plates the elasticity modulus of plate material and specimen significantly affects field intensity for residual magnetization.

6. The results presented for magneto-structural and magneto-elastic analysis of samples collected before casting, of ferritic SCG grade VCh35 with respect to accuracy, reliability, and permissible delay in information about the physical and mechanical parameters of structure formation within a sample correspond to the stated aims of the work and are in good agreement with results of chemical analysis, mechanical tests, and metallographic studies.

7. Combined use of chemical and physical methods makes it possible in a real time regime of carrying out melting to evaluate the effect of different chemical elements, production operations on uniformity and structure of finished cast iron in different sample sections, i.e., to accomplish monitoring of the preparedness of a melt for casting in order to obtain a controlled structure and required casting properties.

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