1.1.36. APPLICATION OF MAGNETIC METHODS FOR STRUCTURAL-PHASE ANALYSIS AND EVALUATION OF ARTICLE SERVICE LIFE

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At various stages of technological process of articles production, including deformational, mechanical and thermal treatment, as well as in the process of operation, material of articles undergo structural changes and phase transformations.

For evaluation of structure, phase composition and determination of physical and mechanical properties of articles, magnetic non-destructive testing methods are wide spread. Recently, they were started to be used for diagnostics of changes in these properties in the process of operation of machine parts and structural elements. Observed similiraty of structural factors influence on magnetic and mechanical properties became the basis of application of magnetic properties for evaluation of structural state and strength characteristics of articles. Analyzing influence of various structural parameters on the retarding of glide dislocations and delay in displacement of domain borders, it is possibly to note some generality of their influence upon mechanical and magnetic properties. For example, increase of dislocations concentration (N) in steel is accompanied by increasing of strength characteristics and coercive force value. It should be noted that conventional yield strength $\sigma_{0.2}$ and coercive force H_c are proportional to $\sqrt{N}$. Increase of the level of micro-stresses in steel results in growth of $\sigma_{0.2}$ and H_c. Increase of the volume ($V_п$) of pearlite component in the steel structure is accompanied by increase of H_c and $\sigma_{0.2}$. For pealite of plate-like shape, $H_c \sim V_п$, for pearlite of grainy shape – $H_c \sim V_п^{2/3}$, while value $\sigma_{0.2}$ does not depend on its shape ($\sigma_{0.2} \sim V$). Increase of average grain size (d_{cp}) is accompanied by reduction of both $\sigma_{0.2}$ and H_c; however, $H_c \sim 1/d_{cp}$, while $\sigma_{0.2} \sim 1/\sqrt{d_{cp}}$.

Paper discusses influence of structural parameters of magnetic properties of ferromagnetic materials and possibilities of their use in testing. Special problems can be resolved by means of magnetic methods as well. For example, by measurement of coercive force (H_c), it is proposed to test wear-resistance of heat-hardened articles, to evaluate baking quality of metal powder industry products. Also, magnetic methods has found application for non-destructive testing of manufacturing quality and evaluation of cutting properties of tools of tungsten-cobalt alloys.

Prediction of structural elements service life is one of the topical problems of technogenic safety. Presently, methods for evaluation of macro- and micro-stresses are proposed. Recording of parameters related with displacement of 90° domain borders (magnetoelastic acoustic emission, electromagnetic-acoustic conversion, pyezodynamic magnetization), i.e. with re-distribution of magnetoelastic energy in ferromagnetics, is their fundamental principle. Determination of stresses-strained state of metal by means of magnetic methods makes it possible, using various models of deformable solid mechanics, to approach the problem of predicting the nature of metal mechanical properties variation during deformation and evaluation of the remaining service life. For example, on the basis of model of metals deformation diagram and correlative links between strength and magnetic characteristics, procedure for loading diagram recovery by coercive force measurement was proposed by the way of example of structural steel.

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