Modeling of the Principal Physical Fields in the Technology of Induction Hardening

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ABSTRACT

Induction heating systems are complex technical objects in which physical processes of different nature take place. In the general case, the mathematical description of such objects is a system of deterministic nonlinear differential and integral equations written for multidimensional and multiply connected domains. Quantitative description of the objects can be obtained using numerical methods.

Computer simulation is a real opportunity not only to explore certain aspects and patterns of electromagnetic, thermal and other effects in induction heating devices, but also to create complex models that take into account the inseparable relationship between electromagnetic and thermal processes in nonlinear and multidimensional loading areas of induction electrothermal devices [1].

Mathematical models of induction melting furnaces comprise computation of electromagnetic, temperature, MHD fields [2].

Effective numerical models of induction heat treatment include two-dimensional modelling of coupling electromagnetic and temperature fields in cylindrical systems [3].These models allow defining structure, hardness, size of grain and other properties of the metallic parts under heat treating. They allow optimizing design and a choice of equipment, a heat treatment mode for the purpose of achievement of the maximum quality and minimization of energy consumption.

Especially for big size rolls and tubes quality assurance of heat treatment needs not only the required hardness along the length of the barrel and the depth of the hardened layer with minimal deviations, but the absence of dangerous thermal and structural stresses leading to the destruction of the rolls and tubes both during the heat treatment and after.

The developed models were used not only for the design of induction heat treatment systems of tubes and rolls, but also for a digital control of these complexes.

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