CHOICE OF RATIONAL GEOMETRICAL AND REGIME PARAMETERS OF CYLINDRICAL INDUCTOR WHICH IS LOADED BY A BUNDLE OF FERROMAGNETIC PIPES

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The dependence of the energy characteristics of a cylindrical coil downloading as ferromagnetic beam pipes of geometrical and regime parameters of the inductor and installed their relationship.

Inductor, ferromagnetic load, induction heating.

For efficient heating mediums important intermediates branched of surface heat exchange device. The branched surface heat exchange can be realized in a cylindrical inductor which is loaded by a bundle of ferromagnetic pipes along which the passes (runs) material (heat transfer agent), being heated (Fig. 1).

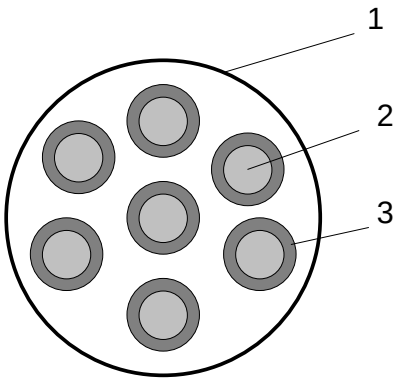

Fig. 1. Cylindrical inductor which is loaded by a bundle of ferromagnetic pipes:
1 - inductor; 2 - material that is heated;
3 - loaded by a bundle of ferromagnetic pipes.

Needed parameters and heating mode can be ensured by selecting the rational geometrical sizes of inductor and cylindrical load elements and installing the required velocity (productivity) of the material along the channel of inductor.

The purpose of research – the definition of energy performance depending of cylindrical inductor with ferromagnetic loading from geometrical and regime parameters of inductor.

Materials and methods research. Electromagnetic calculation of inductors which is loaded by a bundle of ferromagnetic pipes can be realized based on the method described in [1], where the electromagnetic field of cylindrical inductor calculated based on the system Maxwell's equations:

$$rot\mathbf{H} = \mathbf{j},\ div\mathbf{B} = 0,\ rot\mathbf{E} = -\partial\mathbf{B}/\partial t, \qquad (1)$$

considering the material equations:

$$\mathbf{B} = \mu\mathbf{H}, \quad \mathbf{j} = \sigma\mathbf{E}. \qquad (2)$$

where **B, H, E, j** – magnetic induction vector, magnetic field intensity, electric field intensity, current density; σ, μ – conductivity of pipe material, magnetic permeability of pipe material.

Thus, on length of inductor, carried the boundary conditions $A_\varphi\big|_{z=0} = A_\varphi\big|_{z=l} = 0$, that meet the real conditions attenuation of electromagnetic fields at some distance from inductor and the boundary conditions on the boundaries delimitation selection areas, namely equality the normal component of magnetic induction ($B_\rho^- = B_\rho^+$), equality tangential components of the magnetic field intensity on the boundaries where is absent a current layer $H_z^- = H_z^+$, and increasing the magnetic field intensity on the boundary, where is present a current layer $H_z^+ - H_z^- = I_0$.

The solution of electromagnetic problem that goes to the modified Bessel equation for the azimuthal component of the magnetic vector potential allows to find the the current density distribution in the pipe:

$$j_\varphi = -\sigma i\omega A_\varphi. \qquad (3)$$

Given the fact that the magnetic permeability of ferromagnetic pipe nonlinearly depends on the magnetic field intensity, the components of electromagnetic field are defined in the iterative computation process. For this developed method provides determining the parameters of the equivalent consistent circuit, namely:

$$z_{mn} = n\, z_{m1} - z_{xx}(n-1), \qquad (4)$$

Thus, considering resistances on the equivalent circuit, we can determine the energy characteristics of induction installation.

Let us analyze how the energy performance of inductor depends on the geometrical characteristics of pipes (Fig. 2, 3) that are loaded into the inductor, namely the quantity and thickness of the pipe's wall.

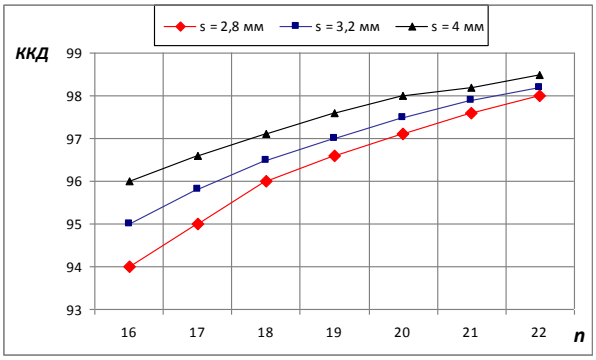

Fig. 2. Efficiency curve of inductor from the quantity of elements loading

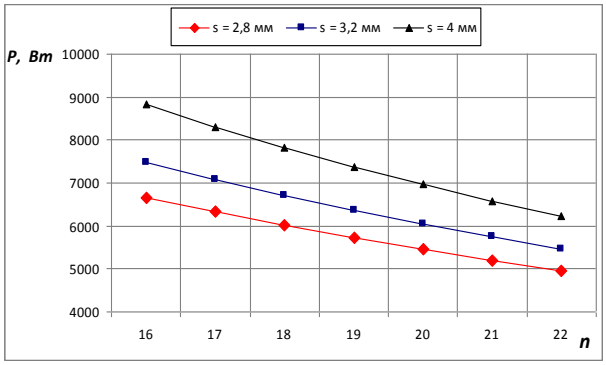

Fig. 3. The curve of power of inductor from the quantity of elements loading

Summary

The dependence of the energy characteristics of cylindrical inductor which is loaded by a bundle of ferromagnetic pipes from the geometrical and regime parameters of inductor has been determined. Proved that the energy performance of cylindrical inductor is strongly dependent on geometry and mode of operation, that is related to nonlinear properties of ferromagnetic download.