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Flux 3D application package for the analysis of thermal fields in an induction heater for cylindrical charges

Streszczenie. *W pracy przedstawiono wyniki obliczeń pola temperatury w procesie nagrzewania indukcyjnego wsadów cylindrycznych od wewnątrz. Wykonano obliczenia w programie FLUX 3D metodą elementów skończonych. Obliczenia parametrów pola temperatury wykonano dla trzech różnych czasów nagrzewania. Rozkład temperatury wyznaczony został dla prądu o wartości skutecznej 2kA i częstotliwości 10 kHz.* ***(Zastosowanie programu FLUX 3D do analizy pola termicznego nagrzewnicy indukcyjnej wsadów cylindrycznych)***

Abstract. *The paper encloses the results of the numerical analysis of temperature in the induction heating device for cylindrical charges. Numerical simulation was made for three different value of the times. Temperature in the charge was calculated for current I=2 kA and frequency f=10 kHz. The heating process was simulated and analyzed in the FLUX 3D program by using of finite element method.*

Słowa kluczowe: Pole temperatury, nagrzewanie indukcyjne, hartowanie indukcyjne, pola sprzężone.
Keywords: Temperature field, induction heating, induction hardening, coupled fields.

Introduction

Induction heating is often used in many production processes such as the automotive industry. An example may be hardening, which means hardened from the center of various types of bushings. For the individual needs of the chosen process parameters of inductors and power sources to achieve the proper temperature on the surface of the load. Figure 1 shows a cross section of the pipe-hardened from the inside. Inside the pipe is five spiral inductor.

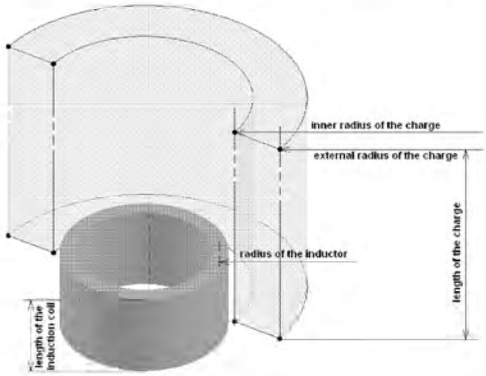

Fig.1. Cross-section of the charge of internal inductors.

Construction of mathematical model

Source temperature field is a guide through which the flowing current generates Joule heat. Calculation of heat flow density and heat fluxes can designate the Fourier law. More complex cases and particularly the issue of transients require the use of a heat conduction equation of Fourier-Kirchhoff [1]. The study determined the temperature distribution in the feed cylinder formed as a result of thermal conductivity. Assuming isotropy of the material and the constant pressure to give a differential equation of thermal conductivity in the form of spatial coordinates:

$$\rho c_p \frac{\partial T}{\mathrm{d}t} = \mathrm{div}(\lambda \cdot \mathbf{grad}T) + p_v \quad (1)$$

were λ denotes the specific heat conduction of the material, ρ - material density (specific mass), $T = T(r,t)$ - temperature, c_p - specific heat at constant pressure, p_v - power density of induced currents in the feed (specific average Joule losses $p_v = \gamma\omega^2|\underline{A}|^2$)

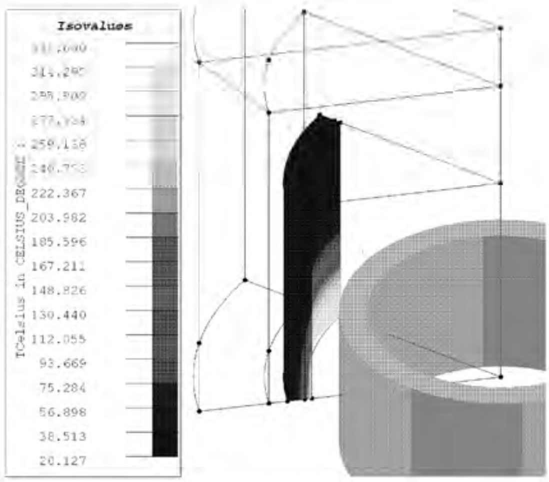

Fig.2 Charge temperature distribution after 0.5 s.

Conclusions

Using multi-variant calculations performed FLUX of temperature field. This paper presents the distribution of charge temperature after 0.5 s.

The presented research shows advantages using computer program like FLUX 3D for calculating of distribution of the temperature in the induction heating device for cylindrical charges.

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