3D-Simulation of Electromagnetic and Temperature Fields in the Continuous Induction Heaters

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ABSTRACT

One of the basic areas, where the induction heating is widely applied, is the through induction heating of metals before forging, rolling, pressing, etc. Usually the aim of the heating is achievement of the given temperature with the certain allowable non-uniformity in the volume of the product. For the complete description of the temperature field in a heated up body it is necessary to know as temperature distribution in the cross section, as along the length of the billet. Usually continuous inline induction heaters are used for heating of metal with high production rate. The power of these installations can reach 10-15 MW and accurate prediction of the electromagnetic and temperature field's distributions in the billets is very important at the design stage of installation as well for the control of the induction heaters.

In order to provide an acceptable computation accuracy for design induction heaters, contemporary software for analyzing induction heating should take into consideration a few features of the process. Most important is interrelation of electromagnetic and heat transfer phenomena. Induction heating is a complex combination of electromagnetic, heat transfer and metallurgical phenomena. Heat transfer and electromagnetic are tightly interrelated because some physical properties of heated materials depend strongly on both magnetic field intensity and temperature. One of the major difficulties in the electromagnetic field and heat transfer computation is the nonlinearity of material properties. This exists because the thermal conductivity, specific heat, and electrical conductivity of metals are functions of the temperature, while magnetic permeability is a function of both magnetic field intensity and temperature. Inappropriate handling of a nonlinear feature of material properties by taking into consideration their average values can lead to essential design errors.

A unique numerical calculation technique has been developed and used to provide fast and reliable computation [1]. The main advantages of using this software:

- Software is designed especially for induction heating applications and it realizes essential coupling of electromagnetic and temperature fields during computations that provides great accuracy
- Most important features of the induction heating installations are taken into account, including characteristics of power sources and possibility to change power, voltage, current and frequency during the process as well as possibility to simulate stages of holding billets in the inductor and its transport.
- Software can be used in the control systems in the real time. It is easy to implement procedures of optimal design and optimal control of the induction heating installations.

REFERENCES

[1] Demidovitch V. "Special Software IndHeat for Modelling Induction Heating Processes", Proceedings of 3rd International Workshop on ELECTRIC AND MAGNETIC FIELDS EMF'96, Liege, Belgium, pp. 273-278. (1996)