ABOUT USING INDUCTION HARDENING METHOD TO A METAL PIECE

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Abstract

This paper proposes induction hardening method to a metal piece. The heating analysis in this case needs solution, the thermal diffusion problems coupled with eddy currents. The experiments number in designing process can be decreased for a better knowledge of the process.

Key words: Numerical simulation, Electromagnetic field coupled with thermal.

INTRODUCTION

The induction hardening method can be used for all kinds of geometry types. They can consider the change of both parameters like: the electromagnetic parameter and thermal parameter. Both parameters is accourding to temperature. The B-H relation very dependend on temperature, passing from iron-magnetic environment form to air. Regarding to this reason, the eddy's current problems and thermal diffusion are strongly coupled in the Curie point zone. In this zone all numerical methods warn a kind of instability when is solving the problem.

Branded programs like the FLUX package, adopt the linear pattern (Cingoski V., 1996), where the B-H relation is linear, the magnetic permeability is adjusting according to the highest effective value of the magnetic induction (Leuca T. et al., 2007).

The solutions are analysed with FLUX-2D package programme.

MATERIAL AND METHODS

In this case of electromagnetic problem we have a parallel – plane structure. The magnetic field problem can be reduced to the determination of a potential vector with a single component, which verifies an similar equation with that of the scalar potential.

The coupled of thermal diffusion problems with eddy currents is the main problem of every hardening method. The material parameters from eddy currents problem (B-H characteristic and resistivity) depend from

temperature and material parameters. For a better analysis of the results we need the result of eddy currents problem (power density) and temperature (thermal capacity and thermal conductibility) (Leuca T. et al., 2002; Leuca T., 1997).

RESULTS AND DISCUSSION

The numerical simulation allows to determining accurately the relationship between the used frequencies, and the power density, and also the desired treatment depth.

The optimal frequency can be estimated by the penetration depth of induced currents.

The process consists in performing a single hardening as shown in figure 1.

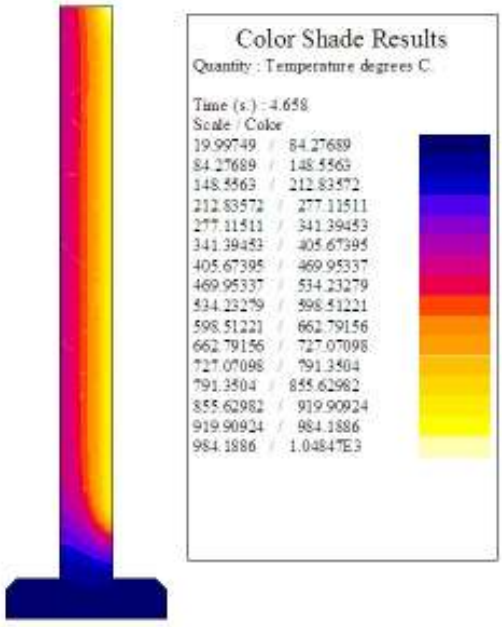

Fig. 1. The model

The magnetic flux density depencence with the magnetic field strength and temperature of the steel is shown in figure 2.

In the figures 2-6 we present the result of:

- The temperature from hardening zone;
- The debited current from the source;
- The rezistivity dependence with the temperature of the steel;
- The thermal conductivity depencence with the temperature of the steel;

- The equivalent transfer heat coefficient dependence with the temperature;
- The thermal field distribution.

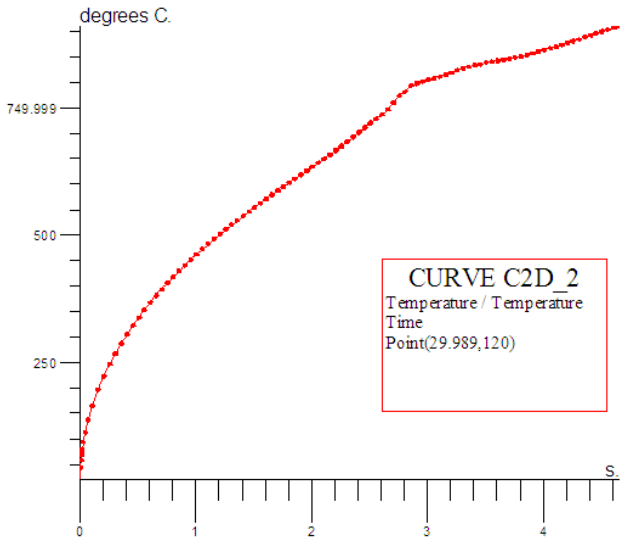

Fig. 2. The temperature from hardening zone

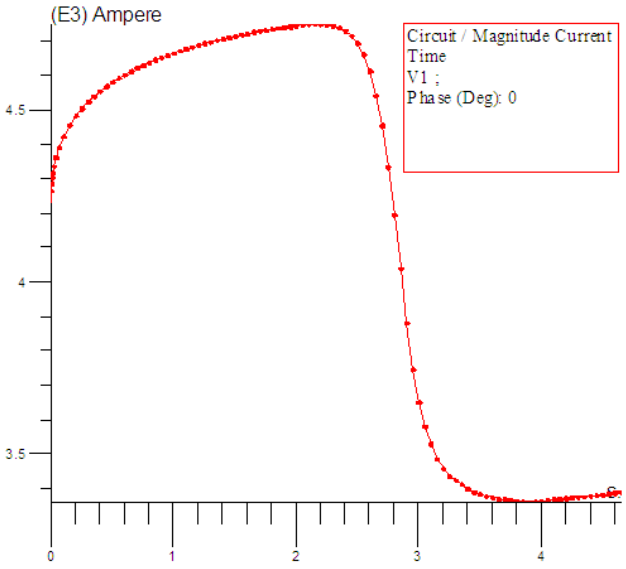

Fig. 3. The debited current from the source

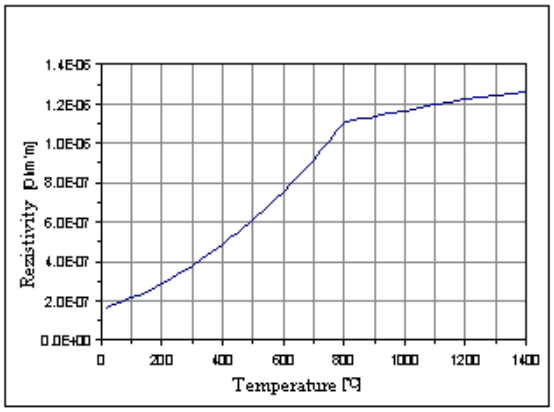

Fig. 4. The rezistivity dependence with the temperature of the steel

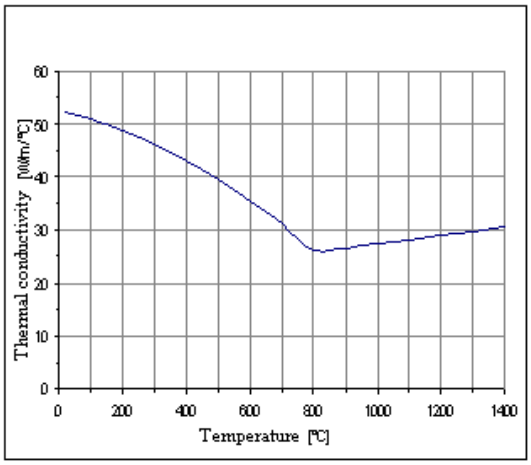

Fig. 5. The thermal conductivity depencence with the temperature of the steel

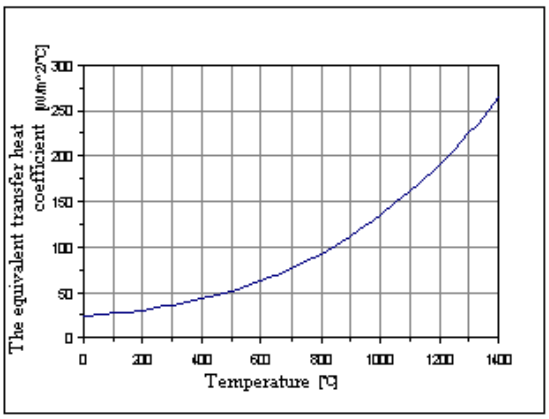

Fig. 6. The equivalent transfer heat coefficient dependence with the temperature

CONCLUSIONS

The numeric simulation of the hardening process is a complex problem. We must solve simultaneous two field non-linear problems one of eddy currents and thermal diffusion. The non-linear problems of eddy currents is provide from non-linear relation of **B-H**, in time the non-linear of thermal problem provide from dependence with temperature of thermal parameters (Leuca T. et al., 2007; Cheregi G., Arion M., 2008; Cheregi G. et al., 2008; Arion M., Cheregi G., 2008; Leuca T., Cheregi G., 2009; Cheregi G., Arion M., 2010; Maricaru M. et al., 2011; Hănţilă F.I. et al., 2012; Arion M. et al., 2012; Burca A., Cheregi G., 2012; Burca A. et al., 2012; Burca A. et al., 2013; Burca A., 2014).

The coupled of two problems result from strong dependence of relation **B-H** with temperature.

In electromagnetic field problem and thermal field source, the result is given by Joule lost..

The advantage of this method is results from the possibility to have similar results in practice.

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