# ABOUT THE THERMAL TREATMENT OF METAL PIECES

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***Abstract***
*This paper proposesa thermal treatment or a metal pieces. For that case we use the eddy current treatment method of gear used in a conveyor by using an inductor with circular section. We have some problems like: thermal diffusion coupled with eddy currents. The problems was solve with FLUX 2D software package.*

**Key words** Electromagnetic field coupled with thermal, numerical simulation.

## INTRODUCTION

A mathematical model of the eddy current treatment involves some difficulties:

- a coupled thermic-electromagnetic problem,
- the constitutive relationship B-H is nonlinear and strong dependent on the temperature,
- the surface region must be heated higher then Courier point,
- the heating must be done quickly enough so that the high temperature remains on the surface,

The method can be used for all kinds of geometry types. They can consider the change of both the electromagnetic and thermal parameters accourding to temperature. All numerical methods warn a kind of instability when is solving the problem. Branded programs, adopt the linear pattern [1], where the B-H relation is linear, the magnetic permeability is adjusting according to the highest effective value of the magnetic induction [8]. The pattern allows adopting the sinusoidal regime and the images too for the sizes of the electromagnetic field and its equations. The results are acceptable for the specialists. The recommended solutions are analysed with FLUX-2D package programme.

## MATERIAL AND METHODS

In this case we have an electromagnetic problem with a parallel – plane structure. The coupled of thermal diffusion problems with eddy currents is the main problem in heat treatment. The material parameters from eddy currents problem (B-H characteristic and resistivity) depend from temperature, in time material parameters from thermal problem depend from the result of eddy currents problem (power density) and temperature (thermal capacity and thermal conductibility) [3], [4]. Each adopt time steps for thermal problem, it return to eddy currents and diffusion problem. If the correction is not significant, we go to the next time step. If its signalize instability in time, then the time step must reduce.

## RESULTS AND DISCUSSION

The numerical simulation allows to determining accurately the relationship between the frequencies used, the power density and 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 at 8 kHz using a circular coil as shown in figure 1.

The inductor is dimensioned in order to assure a distribution of the currents in the piece which implies the optimal heat treatment.

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

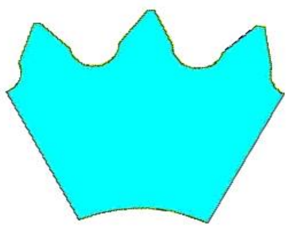

Figure 1. The model of transmission gear used in a conveyor

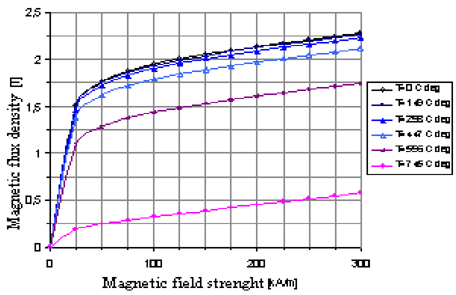


Figure 2. The magnetic flux density depencence with the magnetic field strength and temperature of the steel

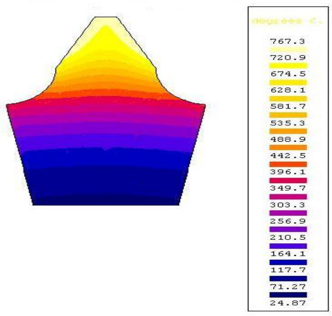


Figure 3. The map of the thermal field distribution into the tooth of the conveyor gear at time 21.28 sec

**CONCLUSIONS**

The numeric simulation of eddy current treatment is a complex problem, where are resolve simultaneous two field one non-linear problems and 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 [8…20].

The parameters are:

- thermal conductibility,
- thermal capacity,
- thermal transfer coefficient on surface

The coupled of two problems result from strong dependence of relation **B-H** with temperature, in electromagnetic field problem and thermal field source, given by Joule lost, in thermal diffusion problem.

The advantage of this method is results from the possibility to adopt the sinusoidal regime and complex image, the numeric form of field equation leading to one algebric equation system with complex coefficient.

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