INDUCTION HEAT TREATMENT OF THE SHEAR BOLT USED IN REVERSIBLE PLOWS

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Abstract

This paper proposes an analisys of the induction hardening method of the shear bolt with ELTA software. The heating analysis of the shear bolt and other pieces with same structure needs solution in the thermal diffusion problems coupled with eddy currents case. For a better knowledge of the process we need to make more simulation to be sure that the requirements parameter are the same in practice.

Key words: numerical simulation, electromagnetic field coupled with thermal

INTRODUCTION

It is known that in order to avoid deformation of the plows elements we used safety devices to allow passage over of any obstacles of the plow body.

This shear bolt must be have an homogeneous structure to respond of imposed requirements.

Therefore we considered it is necessary to applied a thermal treatment to make a homogeneous internal structure.

We know that the induction hardening simulation method is used for all kinds of geometry types of metal piece. This method consider the change of both parameters like the electromagnetic and thermal parameters. Both parameters is accourding with the temperature.

We must verify that the B-H relation is dependend on temperature, passing from iron-magnetic environment form to air. In this case, we observe that the eddy's current problems and thermal diffusion are strongly coupled in the Curie point zone.

With ELTA software, we can adopt linear pattern (source: ELTA) and the B-H relation. The B-H relation is linear and the magnetic permeability is adjusting according to the highest effective value of the magnetic induction (Leuca et al., 2007).

MATERIAL AND METHOD

The shear bolt has the next dimension:
- The diameter of the shear bolt – 22 mm
- Length – 149 mm
- The diameter of the safety hole – 12 mm.

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

The coupled of thermal diffusion problems with eddy currents is the main problem of every hardening method. For a better analysis of the results we need to find the result of eddy currents problem (power density) and temperature (thermal capacity and thermal conductibility) (Leuca et al., 2002; Leuca, 1997).

RESULTS AND DISCUSSION

The numerical simulation with ELTA software allows to determining accurately any kind of results. The relationship between the used frequencies, the power density, and also the desired treatment depth is very important to make a complete map of the hardening process..

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

The process hardening is shown in Figure 1.

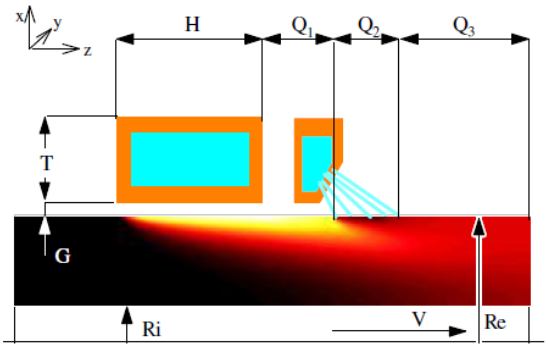
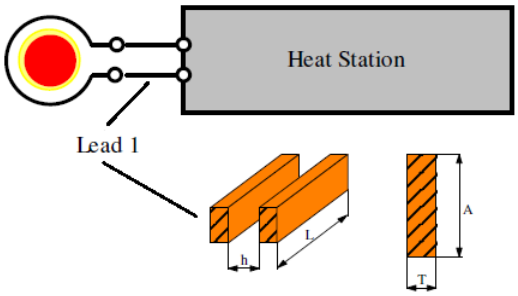


Fig. 1. The model – System configuration (source: ELTA)

We obtain the next result of the simulated process:
- The temperature from hardening zone (Fig. 3)
- The surface specific power (Fig. 4)
- The heat sources density (Fig. 5)
- The cooling diagram (Fig. 6)

- The field strength (Fig. 7)



A =1 cm; T = 0,2 cm; h = 0,3 cm; L = 10 cm

Fig. 2. The circuit model (source: ELTA)

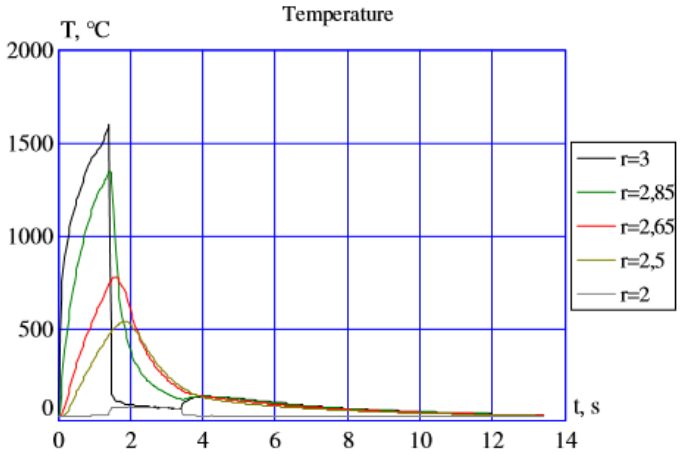


Fig. 3. The temperature from hardening zone

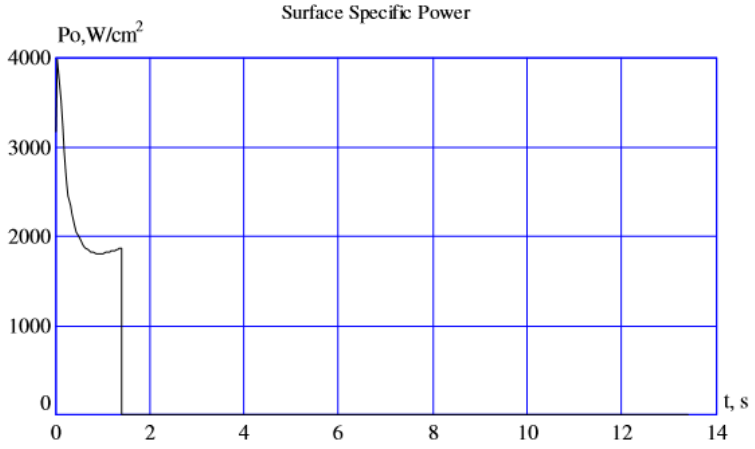


Fig. 4. The surface specific power

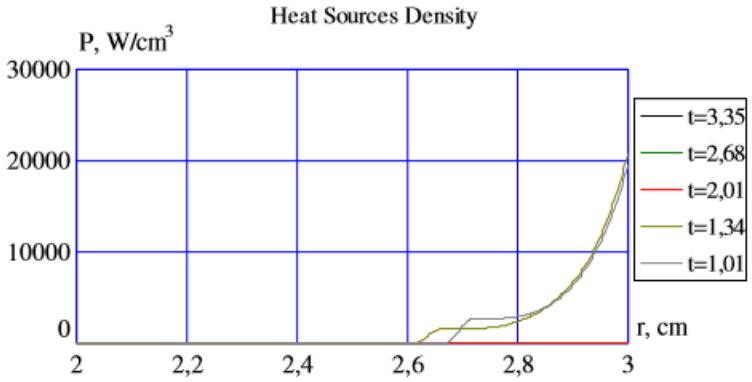


Fig. 5. The heat sources density

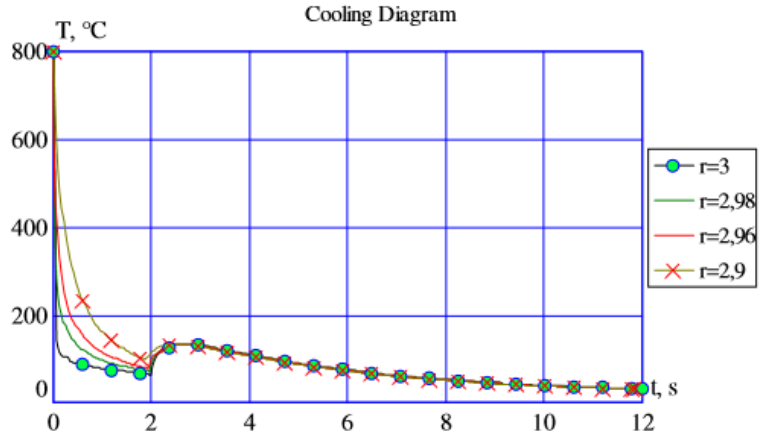


Fig. 6. The cooling diagram

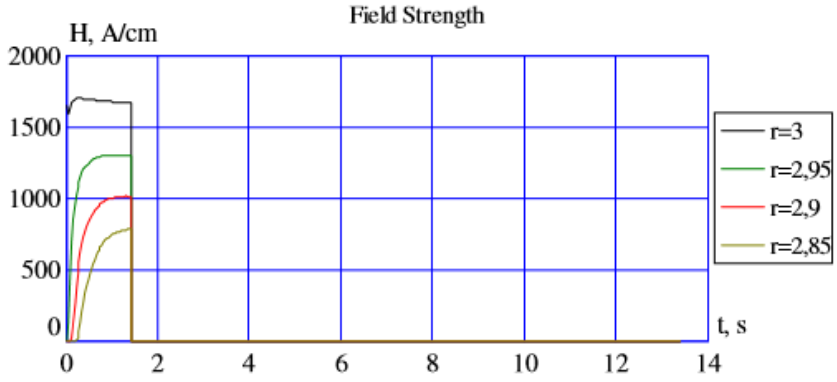


Fig. 7. The field strength

CONCLUSIONS

The numeric simulation of the hardening process is a complex problem.

The non-linear problems of eddy currents is provide from non-linear relation of **B-H** and the non-linear of thermal problem provide from dependence with temperature of thermal parameters [8…19].

After the simulation process we observe that the coupled of two problems result from strong dependence of relation **B-H** with temperature.

The advantage of this simulation method with ELTA software is results from the possibility to have almost similar results in practice.

Through proposed heat treatment we get a homogenous structure for the shear bolt. It will respond promptly to safety requirements of the reversibile plows.

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