The influence of arrangement of pernament magnets to rotation heating of ferromagnetic shrink-fit

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Abstract **Several arrangements of pernament magnets forming a magnetic circuit for rotation heating are presented. The problem is solved as hard–coupled model described by three coupled partial differential equations (for the distribution of electromagnetic field, temperature field and field of thermoelastic displacements). The results from the arrangements are compared together and discussed. One of them was built and measured and it verifies the results from the numerical solution.**

Keywords **Rotation heating, shrink-fit, ferromagnetic clamping head, numerical analysis, higher-order finite element method.**

I. Introduction

This paper deals with the finding a suitable geometry of the magnetic circuit rotating induction heating of the thermoelasic clamping head. [1] [2]

II. Arrangements of magnetic circuit

Fig. 1. shows considered and simulated arrangements of magnetic circuits. They differ among themselves primarily in the count, size, location and in one example in the shape of the pernament magnets. The size of the air gap is also variable in the arrangements. The results are depicted in Fig. 2.

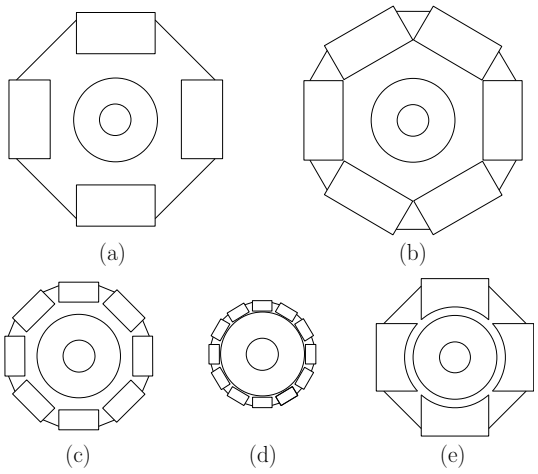

Fig. 1. (a) The first arrangement (the same configuration as the measured), includes 4 pernament magnets of the size $20 \times 10\,\mathrm{mm}$ with the air gap of $6.25\,\mathrm{mm}$. The next arrangements are with (b) 6 pernament magnets (size $20 \times 10\,\mathrm{mm}$, air gap $7.1\,\mathrm{mm}$), (c) 8 pernament magnets (half size $10 \times 5\,\mathrm{mm}$ and half air gap $3.12\,\mathrm{mm}$), (d) 12 pernament magnets (size $5 \times 2.5\,\mathrm{mm}$ and air gap $0.4\,\mathrm{mm}$) and finally (e) the arrangement with arc shape of pernament magnets (basic size $17 \times 10\,\mathrm{mm}$ and air gap $2.1\,\mathrm{mm}$.

III. Numerical solution

The numerical solutions of the problem are realized by a fully adaptive higher-order finite element method implemented into codes Hermes [3] and Agros2D [4]. Both codes have been developed in our group for a couple of years. More information can be found on their webpages.

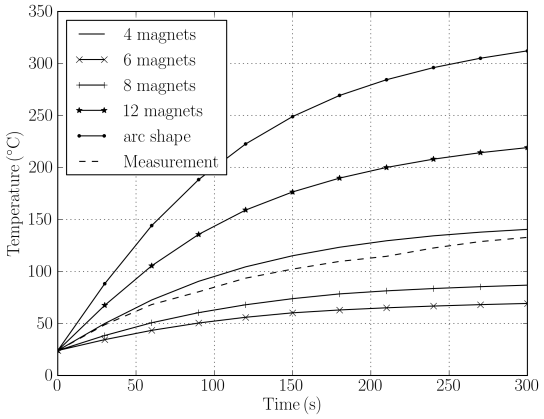

Fig. 2. Temperature evolution of the clamping head for the several arrangements and comparison with the experimental measurement.

IV. Conclusion

The presented results shows the dependence of the arrangement and the shape of pernament magnets to the heating process of clamping head in time. The geometries with 6 or 8 magnets are according to the simulations unsuitable. The chart of time-dependent temperature shows that the improvements could be done in general with the decreasing of the air gap. It could be done with an arrangement containing many smaller pernament magnets or by choosing the magnets with nontypical shape. The limitation of the air gap size is a requirement for the safe operation at high speeds of the rotational induction heating.

V. Acknowledgements

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References

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