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ELECTROMAGNETIC THERMAL METALLURGICAL MODELS FOR INDUCTION HARDENING

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Abstract

It is well known that hardening is a very complex process that involves different physical phenomena. Numerical simulation can be an useful tool to design this kind of processes, but, at the present, an experimental approach is still preferred for several reasons, e.g. simulations require very high computation time, obtained results describe only partially the real life process.
A complete description of the process should include not only the solution of the thermal transient during the heating but also a proper simulation of the cooling step in order to correctly predict the metallurgic properties and the residual mechanical stress in the workpiece. Consequently, a complete simulation requires a multi physics approach. The heating step is described through a non linear electromagnetic solution coupled with a non linear thermal transient one; the cooling step, when the piece is quickly cooled by a quenching system, should be obtained as the solution of a fluid dynamic problem, to properly describe the heating exchange characteristics of different cooling media and, finally, the whole computed thermal process is used to determine the thermal stress in the piece and the final distribution of the different phases of the steel (austenite, martensite, perlite).
Another difficult is related to the complexity of the geometry of the pieces to harden. In the paper a methodology to obtain a complete simulation of the hardening process will be presented in a simple axi-simmetric geometry to verify the feasibility of the proposed method.

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