6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

High-order accurate time integration methods for electromagnetic-thermal analysis

Tobias Gleim[1⋆] **, Detlef Kuhl**[1]

[1] Institute of Mechanics and Dynamics, University of Kassel, Mönchebergstraße 7, 34109 Kassel, tgleim@uni-kassel.de

Keywords: *MAXWELL equations; inductive heating; high-order accurate time integration schemes*

An important concept in metal forming processes is local heat treatment and cooling that influence local material properties, such as ductility, hardness, yield strength, or impact resistance, cf. [1]. Cold forming methods by means of electromagnetic forces are also of great scientific interest, in order to obtain special shapes and product properties. To make these techniques more effective in industry, or to optimize its application, corresponding numerical simulation tools are needed.

The inductive heating of a metal shaft is influenced by an alternating current inducing a high frequency electromagnetic field, which causes a temperature increase due to the resulting eddy currents. In order to examine this process, the fully coupled electromagnetic Maxwell equations are combined with the temperature field in a monolithic approach. Due to the high frequencies of the applied current and the strongly temperature dependent material parameters, the investigated set of temporal and spatial second order differential equations are strongly nonlinear. The main focus of the talk is the high-order accurate time integration of the semidiscrete, seond order ordinary differential equation. Therefore, high-order accurate Runge-Kutta schemes [2] and discontinuous and continuous Galerkin schemes [3, 4] with an controllable order of accuracy are investigated. Representative examples demonstrate the numerical properties, advantages and disadvantages of the studied integration schemes.

REFERENCES

[1] K. Steinhoff, U. Weidig, N. Saba. *Investigation of Plastic Forming Under the Influence of Locally and Temporally Variable Temperature and Stress States*, Functionally Graded Materials in Industrial Mass Production, 35-52, 2009.

[2] J. C. Butcher. *Implicit Runge-Kutta Processes.* Mathematics of Computation, Vol. 18, 50-64, 1964.

[3] T.J.R. Hughes, G.M. Hulbert. *Space-time finite element methods for elastodynamics: Formulations and error estimates.* Computer Methods in Applied Mechanics and Engineering, 339-363, 1988.

[4] T. Gleim. *Simulation of Manufacturing Sequences of Functionally Graded Structures.* Universitt Kassel, Ph.D. Thesis, 2016.