Numerical Simulation of Compressible Magnetohydrodynamic Plasma Flow in a Circuit Breaker

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Abstract: The main function of a circuit breaker is to switch off the electric current safely, in case of fault current. A mechanical force separates the contacts, and an arc starts to burn between the two contacts. This plasma is described by the resistive Magnetohydrodynamics (MHD) equations. The emphasis is on very high currents (10kA-200kA) and relatively high conductivity. Radiation is incorporated by adding a Stefan's radiation. To simulate the plasma in the arc the Nektar code developed by Brown University is adapted and extended. It is based on the Discontinuous Galerkin(DG) methods allowing for triangular or quadrilateral meshes in 2d and hexagonal or tetrahedral meshes in 3d. GID is used for mesh generation. The code is extended to include Runge-Kutta time stepping, various accurate Riemann solvers for MHD, slope limiters and SF_6 gas data. It operates on both serial and parallel computers with arbitrary number of processors.The suitability of this Runge-Kutta Discontinuous Galerkin (RKDG) methods is analysed. In particular different numerical fluxes, different Riemann solvers and limiters, low and high order approximations on smooth ad non-smooth solutions are investigated. Numerical results are given. This work has been performed by Patrick Huguenot and Harish Kumar in their Ph.D. theses and by Vincent Wheatley.

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