COUPLED CONJUGATE HEAT TRANSFER AND ELECTROMAGNETISM ANALYSIS FOR COOLING PROBLEMS

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Key words: Computational Fluid Mechanics, Electromagnetism, Conjugate Heat Transfer, FEM, Coupled problems

Abstract. The aim of this work is to present a framework which can be applied in the solution of coupled problems involving electromagnetism, structural thermal analysis and fluid dynamics. The main application problems are those where a current is applied to some conductive material thus inducing heat. In some industrial applications very high temperatures in the conductor may result in the degradation of the structural parts and therefore a cooling mechanism is needed which involves the circulation of fluid near or inside the conductor. One example of application involves joining and welding using induced heating. The objective of this work is to show how coupling the Navier-Stokes equations and energy equation for the cooling fluid to the energy equation for the structural parts may be used to analyze these complex phenomena. For the current implementation the Maxwell equations in the Eddy current are approximated using a Finite Element Method (FEM) for the conductor and a Boundary Element Method (BEM) for the surrounding air/insulators. For the fluid mechanics problem the Navier-Stokes equations and the energy equation are approximated using a FEM approach. The energy equation for the conductors is also approximated using FEM. The energy equation on the fluid and structural domain are coupled using a monolithic approach by means of linear constraints. Validation and application problems will be presented.