(Internal Proposal of Student Project)

Project Title: Magnetohydrodynamic Simulation of Electromagnetic Pump in TC-1

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Introduction

The pilot molten lead-bismuth target circuit (TC-1) in university of Nevada Las Vegas (UNLV) was designed for beam power of 1 MW accelerator driven system (ADS). The TC-1 is a liquid lead-bismuth eutectic (LBE) circulation loop. Circulation of the liquid alloy is driven by an annular linear induction pump (ALIP). Experimental measurements of system parameters have yielded a surprisingly low pump efficiency of less than 1%. A numerical study of the pump efficiency is being conducted to determine which operational parameters are responsible for this low efficiency and to give insight into future EM pump design. The numerical study will first entail calculating the EM phenomena such as the induced current distribution, magnetic field and electromagnetic body forces using both analytic and numerical methods. These calculated EM forces will be incorporated into fluid flow calculations using a commercial code such as FEMLab and/or Fluent. Parametric studies of the EM and fluid flow phenomena in the pump will be carried out.

Tasks and Timeline

The tasks for this project can be split into 1) EM calculations and 2) fluid flow calculations. Specific subtasks involved with the EM calculations will be:

1) Analytic modeling of MHD equations using a symbolic mathematics package (e.g. Mathematica, Maple, or Matlab) and C to identify the significant, operational parameters.
2) Numerical modeling of MHD equations using the in-house code 3DEM and FEMlab.
3) Perform a parametric study of EM phenomena using analytic and numerical models.

Specific subtasks involved with the fluid flow calculations will be:

1) Incorporating EM body forces into commercial CFD code (i.e. FEMlab, Fluent).
2) Perform 2-d, axi-symmetric calculations of fluid flow in side channels of EM pump.
3) Parametric study of EM effects on fluid flow in side channels of EM pump.
4) Incorporate end effects into EM pump model.
5) Parametric study on entire EM pump including end regions.

One year: April 1, 2006- March 31, 2007

Milestones and Deliverable

The major milestones for this project will be the three parametric studies listed above. These studies will indicate the pertinent operational parameters for the current EM pump and design parameters for future EM pumps. The results from this project will be published in two conference papers and one journal paper.