

ELECTRO-VORTEX FLOW IN LIQUID METAL BATTERIES

Caroline Nore¹, Pedro Ziebell Ramos¹, Wietze Herreman¹, Loïc Cappanera², Jean-Luc Guermond³ & Norbert Weber⁴

¹*Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, LIMSI, CNRS, Univ. Paris-Sud, Université Paris-Saclay, Bât. 507, Campus Universitaire 91405 Orsay, France*

²*Department of Computational and Applied Mathematics, Rice University, 6100 Main MS-134 Houston, TX 77005, USA*

³*Department of Mathematics, Texas A&M University 3368 TAMU, College Station, TX 77843-3368, USA*

⁴*Helmholtz-Zentrum Dresden - Rossendorf, Bautzner Landstr. 400, 01328 Dresden, Germany*

We study the generation of rotational flows in electrically conducting fluids due to the Electro-Vortex-Flow (EVF) phenomenon, i.e. the interaction of a non-uniform current with the magnetic field it generates. We have been developing a so-called code SFEMaNS since 2001 [2] capable of simulating the nonlinear magnetohydrodynamic (MHD) equations in heterogeneous domains (with electrical conductivity or magnetic permeability jumps) in axisymmetric geometries and with several fluids [1]. Liquid Metal Batteries are composed of three layers of fluids (liquid metal electrode–electrolyte–liquid metal electrode) of different densities lying over each other and stabilized by gravity. These batteries are prone to magnetohydrodynamical instabilities (e.g. the Tayler instability [3], the Metal Pad Roll instability [4], etc.) which may deform the electrode–electrolyte interfaces until the ultimate situation of short circuit when the two metals touch each other.

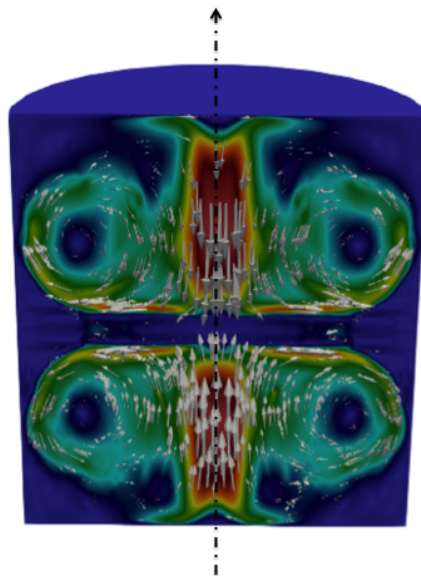


Figure 1. Electro-Vortex Flow created in a Liquid Metal Battery: velocity magnitude (in color) and poloidal vector field in a plane section.

In this talk we first discuss the typical intensity and structure of the axisymmetric flow in a liquid metal column covered by many previous studies. After that, we focus on EVF in liquid metal batteries (see figure 1). We discuss the deformation of the electrolyte-liquid metal interfaces caused by EVF and we characterize how EVF helps in mixing the bottom alloy layer.

References

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