MHD Electrolyte Flow Within an Inter-electrode Gap Driven By a Sinusoidal Electric Field and Constant Magnetic Field

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Abstract

This research presents an inter-electrode gap (IEG) that is typical of pulsed electrochemical machining (PECM). Within the IEG there is a constant magnetic field that interacts with a pulsed electric field to create a magnetohydrodynamic force on the electrolyte. The magnetohydrodynamic force that results from the Lorentz Force is often used to assist PECM where this force is used to increase machining performance. PECM reactions are often mass transport limited and require additional mixing to increase the reaction rate. In this study, the electrolyte flow is used as a metric for potential machining improvements. The small IEG used in PECM precludes the measurement of the velocity field within the gap directly making simulation necessary. The simulation consists of two electrodes, the workpiece and tool, with an electrolyte that fills the IEG between them. The COMSOL® AC/DC module solves the Maxwell equations to determine the electric field in the IEG while the COMSOL Multiphysics® laminar flow module solves the Navier-Stokes equation for the incompressible fluid. The magnetic field is assumed as a constant throughout the simulation domain and the Lorentz force is the cross product of the current density and magnetic field. The force is directly added as a volume force in the laminar flow. The simulation is then run over a range of magnetic flux densities and PECM frequencies. The results can then be used to help determine better operating parameters for PECM based of electrolyte flow.

Figures used in the abstract

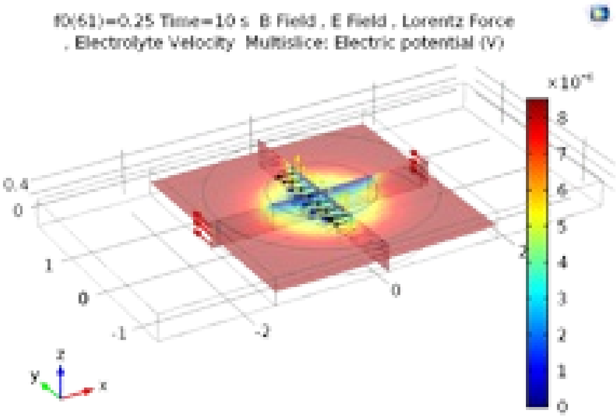

Figure 1: Electrolyte velocity resulting from the volumetric Lorentz force as a result of the magnetic and electric fields shown