Contribution ID: **47** Type: **Poster**

Numerical Analysis on the Resistive Overlay Rail of Electromagnetic Launcher using Finite Element Method

Monday 19 June 2017 13:30 (1h 30m)

The gouging phenomenon on the surface of the sliding contact of an electromagnetic launcher is one of the major problems to realize it in practical uses. The resistive overlay is known as one of the solutions to overcome the gouging on the rail surface even though the energy transfer efficiency to the projectile is reduced due to the increase of the rail resistance.

We conducted the launching experiment with a resistive overlay on the copper rail and the result shows that the gouging was not induced with the velocity over 2 kilometer per second using a C-shaped aluminum armature whose bore dimensions are 40 mm by 50 mm. In this paper, the transient velocity skin effect (VSE) is analyzed from the point of view of the current diffusion using two and three dimensional finite element methods (FEM). As the current spreads into the rail and armature, VSE induces the variation of the amount of currents in the inner and outer metals. From the transient variation of current profile, the propulsive inductance gradient obtained from the axial Lorentz force on the armature varies with its movement. Also, the rail inductance gradient is calculated without an armature and compared with the propulsive one. Finally, we conduct the circuit simulation using the calculated inductance gradients and compare the simulation result with the experiment data.

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Session Classification: Poster session I - Pulsed Power Industrial and Bio-Medical Applications

Track Classification: Pulsed Power Industrial and Bio-Medical Applications