PPC 2017 Brighton, UK
June 18-22, 2017

Contribution ID: **407** Type: **Oral**

Magnetic Field Diffusion in Medium-Walled Conductors Using Finite Element Method (FEM)

Thursday 22 June 2017 11:15 (15 minutes)

The diffusion of a magnetic field through the walls of a hollow conductor is a problem that eludes analytical description with a few exceptions only. For instance, some solutions exist for cylindrical geometries in the limiting cases that the skin depth is much larger than or much smaller than the wall thickness. However, in pulsed applications, where the transient skin depth may be similar to conductor thickness, the underlying simplifications to the thin wall solution begin to breakdown. Electromagnetic simulations using the finite element method (FEM) are conducted for various 2-D and 3 D geometries focused on the medium-walled case, which is considered to be of great importance in a variety of pulsed power applications, from shielding sensitive electronics to obtaining accurate diagnostics.

Even in simplified geometries, the development of complex eddy current distributions gives rise to a finite delay time observed in the diffused field inside the shielded volume vs. the applied field. Further, for transient sinusoidal excitation, the dB/dt magnitude at its first half-wave peak decreases initially over-exponentially with the wall thickness. This dependence changes to a simple exponential relationship for wall thicknesses beyond the skin depth. For instance, for a wall thickness equal to about one transient skin depth, simulation reveals a reduction in dB/dt magnitude by roughly one order of magnitude over the unshielded case (skin depth ˜ 0.86 mm for Al T6061 at the given frequency of 7.1 kHz). However, to achieve an additional order of magnitude reduction in dB/dt peak magnitude, a wall thickness of approximately seven times the skin depth (˜ 6 mm) is required.

In more detail, the effects of material parameters such as conductivity and permeability on the diffusion process are examined. Simulation accuracy is verified through comparison with simple-geometry, high-frequency-limit analytical solutions and results from pulsed high-magnetic field experiments.

Author: COLLIER, Landon (Texas Tech University)

Co-authors: BUNTIN, Tyler (Texas Tech University); DICKENS, James (Texas Tech University); Prof. MANKOWSKI, John (Texas Tech University); NEUBER, Andreas (Texas Tech University); WALTER, John (Raytheon Company)

Presenter: COLLIER, Landon (Texas Tech University)

Session Classification: Oral session 19 - Numerical Modelling - Session Chair : Aled Jones

Track Classification: Pulsed Power Physics and Technology, Components and HV Insulation