Finite Element Simulation of Impulse Arc Discharge

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Abstract

Damages caused by lightning overvoltages remains to be an important issue for electrical industry, putting limitations for efficiency of transmission and distribution of electrical energy. Modern solutions for lightning protection such as multichamber arresters (MCA) for overhead powerlines (OHL) and surge protection devices (SPD) for electrical equipment are aimed to interrupt gid current initiated by lightning overvoltage. Such devices usually contain spark gap aimed to pass both lightning current and power grid current when the overvoltage is occured and after-breakdown conducting channel is formed. In order to develop the optimal construction and provide reliable operation understanding of impulse arc discharge phenomena is of great importance. In this article we discuss development of impulse arc's physical model based on single fluid MHD equations. Due to large lightning current magnitude and rapid rise rate high pressures are regularly encountered in arresters and as a consequence shock wave formation and radiation losses are of great importance. In order to resolve shock fronts additional stabilization methods are employed. Influence of radiation is assesed using conventional radiation trasnport equation (RTE) for two-band model. The first frequency band has a wavelength starting from zero up to 120 nm and an absorption coefficient of 2000 m-1, the second band starts from 120nm up to 1mm with 50 m-1. Described physoical model is implemented in COMSOL Multiphysics® using coupled AC/DC, CFD and Heat Transfer interfaces. High Mach Number Flow (HMNF) was applied to resolute shock front, solution of for two frequency bands RTE was performed with Radiation in Participating Media (RPM) module. Smothed aggregation Algebraic Multigrid (AMG) solver was chosen in order to tackle the strong nonlinearity if the problem. Obtained preliminary results of impulse arc simulation are in acceptable agreement with experimental data. Possibility of application of developed model for designing new prospective protection devices is assesed.

Figures used in the abstract

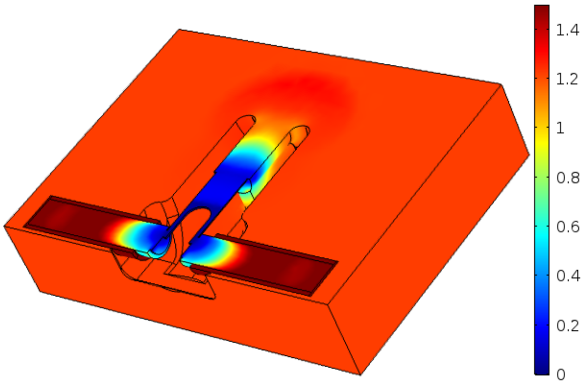

Figure 1: Distribution of density in discharge chamber.