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Modeling Of Corona Partial Discharge Under Various Electrode Types With Finite Element Analysis

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Abstract

INTRODUCTION:

Partial discharge (PD) is the most unwanted phenomenon in high voltage insulation system. It causes degradation to the equipment insulation leading eventually to the breakdown and system failure. One type of PD, called corona discharge, occurs due to the ionization of the air between high voltage electrode and the ground or at any sharp point under high voltage stress. In this work, the electric field (EF) distribution was simulated using finite element analysis (FEA) to study the influence of EF on corona discharges due to different electrode geometries.

USE OF COMSOL MULTIPHYSICS:

In this study, COMSOL Multiphysics software was used to model the corona PD under different electrode geometries (sharp, flat and sphere). Two dimensional (2D) axial symmetric model have been built to study the electric filed distribution and its influence on corona PD occurring. Figure 1 shows sphere electrode model as example for others two electrodes (sharp and flat). 'Electric current physics' was used to study the electric field distribution between high voltage electrode and the ground. In order to obtain more accurate result, an extremely fine element size was used in physics controlled mesh. Time dependent study was used to solve the model to calculate the electric field distribution.

RESULTS:

Figure 2 shows the simulation of electric field distribution from different electrode types under applied high voltage while Figure 3 shows the respective electric field magnitude along the symmetry axis of the model. The high voltage electrode is made of stainless steel and was assigned with a high conductivity value, while the surrounding is air. The top electrode was applied with high voltage while the bottom plate was grounded.

Comparing Figure 3a, 3b and 3c, the electric field magnitude at the tip of the sharp electrodes is the highest, followed by the flat and sphere electrodes. This is the reason why the inception field of corona discharge under sharp electrode is the lowest compared to under flat and sphere electrodes. When the electric field is lower, higher applied voltage magnitude is needed for a corona discharge to occur

It was found that the maximum charge magnitude is the highest under sharp electrode, followed by the flat and sphere electrode. This is again due to the electric field magnitude is the highest at the tip of the

sharp electrode compared to the flat and sphere electrodes. When the electric field magnitude is higher, more ionizations can take place, resulting in a longer streamer formation. Hence, the maximum charge magnitude becomes higher.

CONCLUSION:

The electrical field distribution for all types of the electrodes was successfully simulated using COMSOL Multiphysics software. It was shown that the electric field magnitude surrounding the tip of the electrode under high applied voltage influences the PD characteristics.

Reference

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3. H. Illias, G. Chen, and P. L. Lewin, "Modeling of partial discharge activity in spherical cavities within a dielectric material," IEEE Electrical Insulation Magazine, vol. 27, pp. 38-45, 2011.

Figures used in the abstract

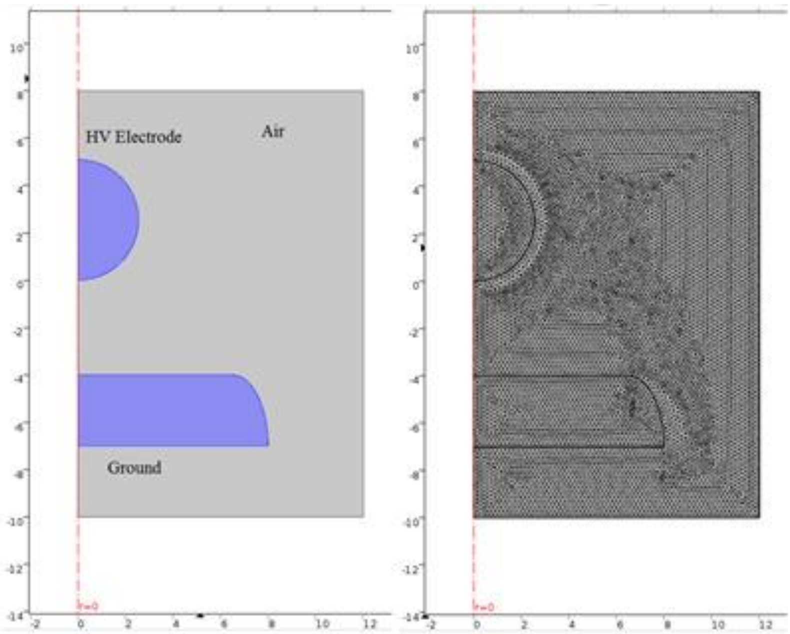

Figure 1: Sphere electrode model

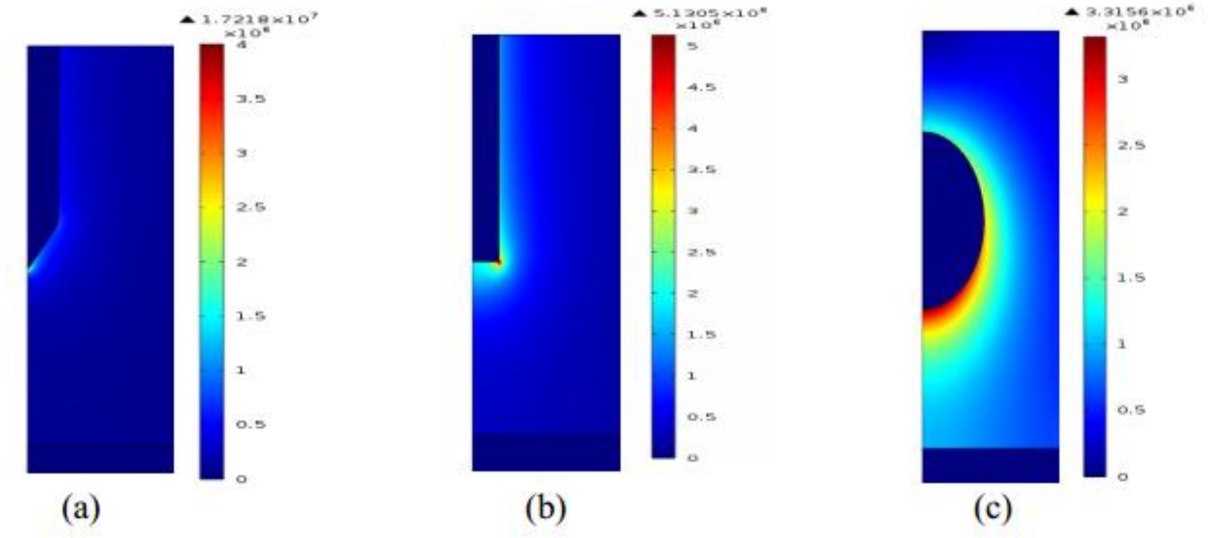

Figure 2: Simulation of electric field distribution from different electrode; (a) sharp, (b) flat and (c) sphere electrodes under 20 kV applied voltage

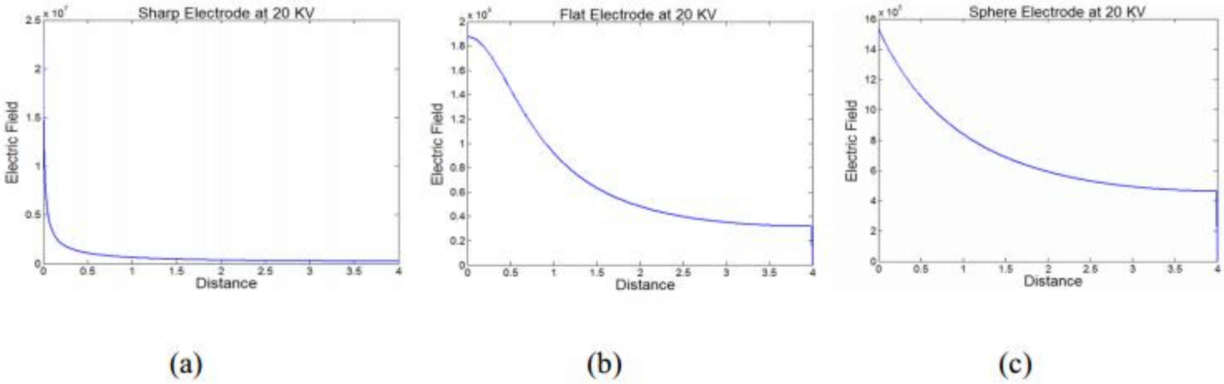

Figure 3: Electric field magnitude along the symmetry axis of the model; (a) sharp, (b) flat and (c) sphere electrodes under 20 kV applied voltage