Adaptation of Comsol software to the simulation of corona discharge phenomenon

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***Abstract*— The phenomenon of corona discharge has various important applications such as electrostatic precipitation, electrophotography, powder coating, ionization instrumentation, destruction of toxic compounds, generation of ozone, jet printers, indoor air cleaners, and many other industrial processes.**

In the majority of practical situations, the corona model is greatly simplified by neglecting the thickness of the ionisation layer and considering only one ionic species moving with a constant mobility. This is usually justified because of the fact that the strength of the electric field rapidly decreases with distance away from the corona electrode and the ionization zone usually occupies a very thin layer around the corona electrode surface, where both positive and negative ions are generated. In the present work the Finite Element Method (FEM) is used to solve the governing equations for both the electric field and distribution of unipolar charge in Comsol Multiphysics commercial software. The main advantage of present work is that the model could be modified for more accurate 3D simulation, or simulation on time domain.

Boundary conditions for the electrostatic model are relatively simple, as both electrodes (corona and ground) are equipotential, which results in the Dirichlet boundary conditions for V.

The Poisson equation governs the electric potential distribution in the presence of space charge. Assuming negligible diffusion effects, the equation governing charge transport appears to be hyperbolic.

While many different numerical techniques have been effective in solving the charge transport equation, formulation of the boundary conditions for charge density on the corona electrode is the most crucial point. The initial density of the space charge has to be guessed. After the problem is solved the electric field on the electrode surface is compared with Peek's value and the electric charge density updated.

The main issue in the above approach is how to implement an iterative algorithm in the program in order to have the optimum injected charge on the corona electrode. In this study different concepts are used to find the best approach for the initial guess for charge density.

Finally, the basic characteristics of the discharge; including the V/I curve, electric field, and current density distributions are shown. Results from this study are compared with theoretical and experimental results of previous studies.