Discharge Inception Voltage In Insulation: Verification Of The Niemeyer Model Using COMSOL & MATLAB

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Abstract

The Partial Discharge Inception Voltage (PDIV) is a critical parameter in the design and evaluation of electrical insulation systems. Accurate prediction of PDIV is essential for ensuring long-term reliability and operational safety of high-voltage equipment. Among the various prediction models developed for this purpose, the Lutz-Niemeyer model is one of the most widely recognized and applied for calculating the PDIV in gas-filled voids within solid insulation materials.

This study presents a numerical verification of the Niemeyer model using the finite element simulation platform COMSOL Multiphysics, in conjunction with COMSOL LiveLink for MATLAB. The Niemeyer model was implemented to determine the inception conditions for partial discharges in voids for varying geometries and material configurations by using the calculated/simulated electric field distribution from COMSOL without partial discharges.

The simulation results were validated against experimental measurements, demonstrating a high degree of correlation between the predicted and observed PDIV values. The combination of COMSOL and MATLAB via Livelink enabled a flexible and automated workflow for parameter variation, sensitivity analysis, and post-processing of the electric field data.

The findings confirm the applicability of the Niemeyer model for practical insulation design and highlight the advantages of combining numerical simulation with experimental validation. This approach provides a robust framework for optimizing insulation systems and assessing the risk of partial discharge under different operating conditions.

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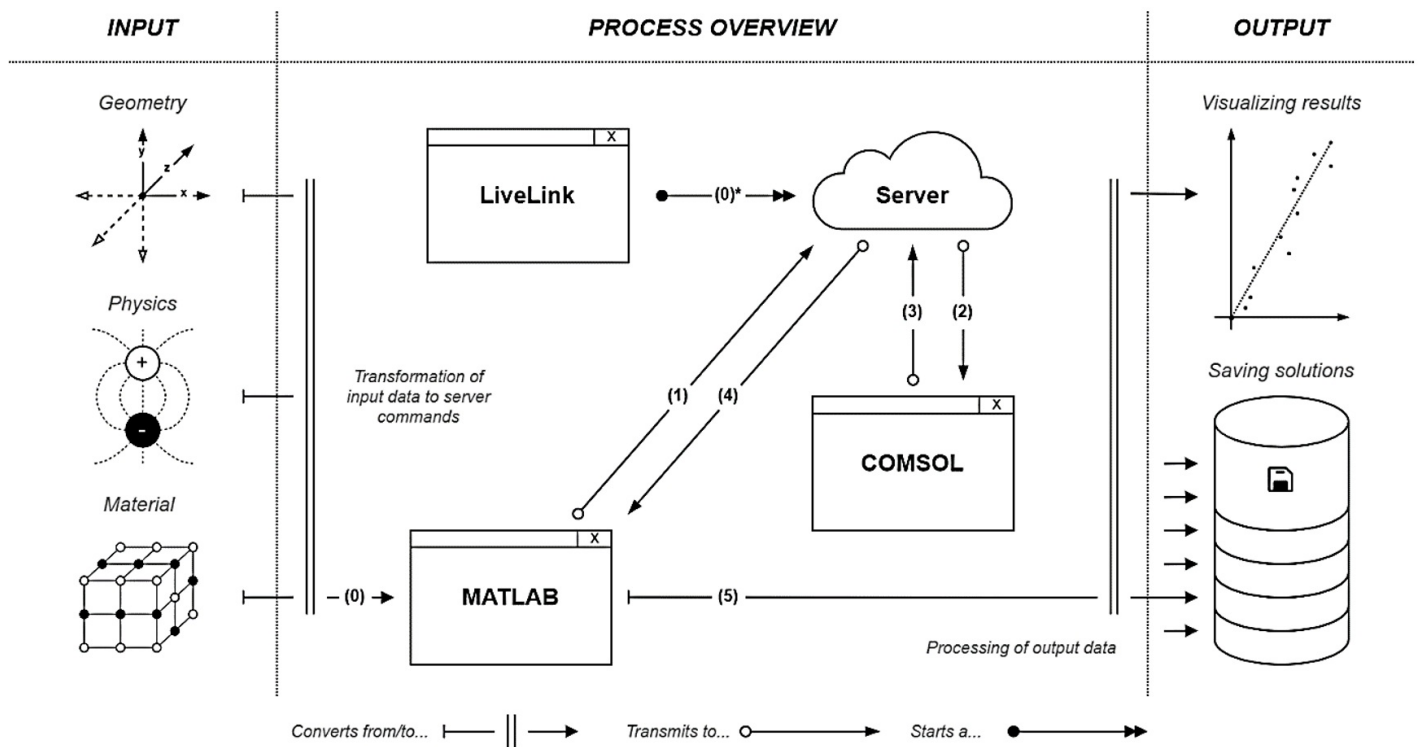
Figures used in the abstract

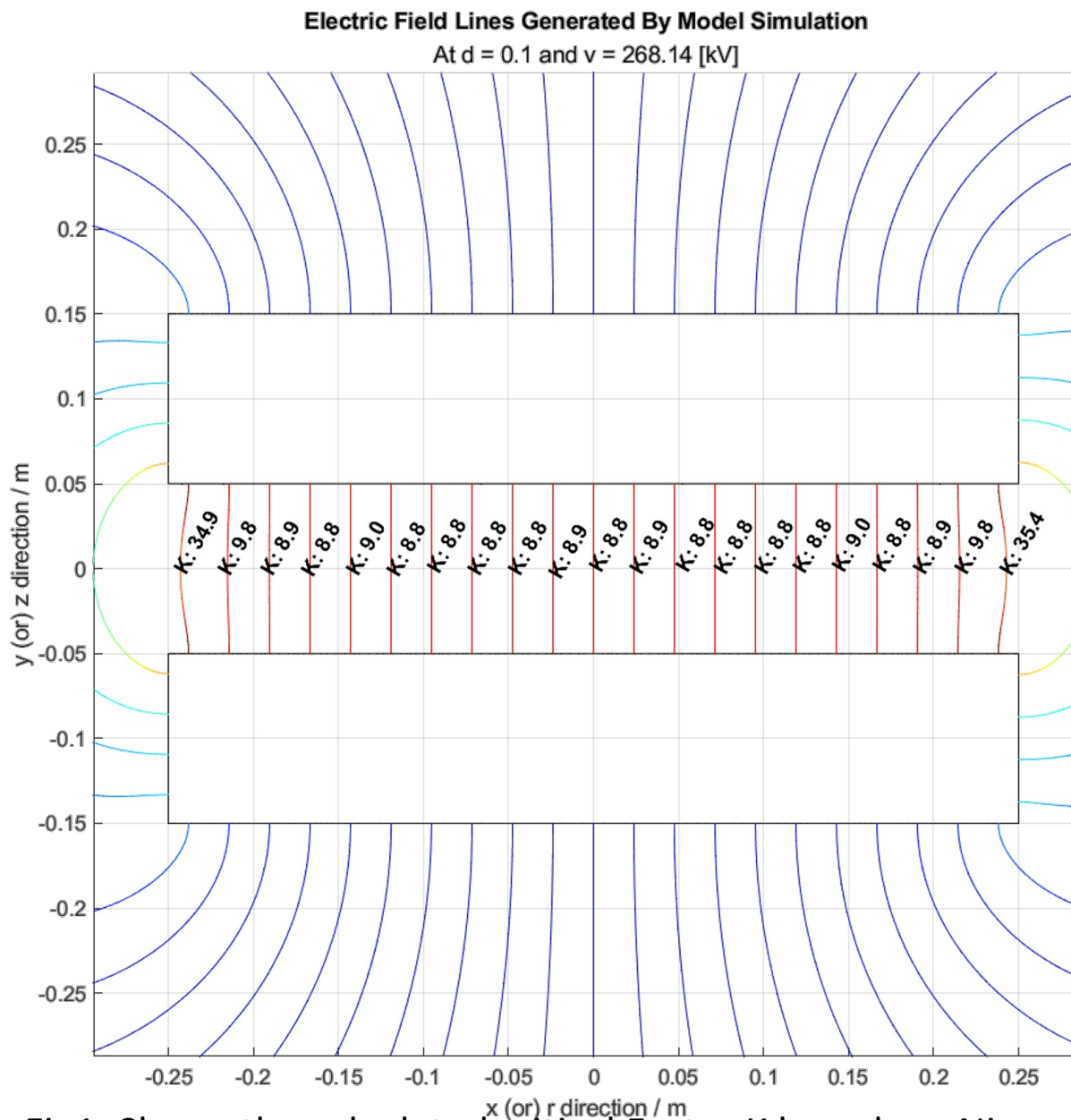**Figure 1** : Process diagram of numerical solution process. Enumerated and with given legend.

Fig1: Shows the calculated critical Factor K based on Niemeyer's equation to verify the inception voltage of the partial discharge

Figure 2 : Shows the calculated critical Factor K based on Niemeyer's equation to verify the inception voltage of the partial discharge