Effect of Pollution Layer Conductivity and Thickness on Electric Field Distribution along a Polymeric Insulator

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Introduction: Electric field distributions along a polymeric insulator under wet and contaminated conditions were studied in this paper. Pollution layer was modelled as a conductive water layer and conductivity was varied from 10-6 to 10-3 S/m. Similarly, thickness of pollution layer was varied from 0.5 to 2 mm in steps of 0.5.

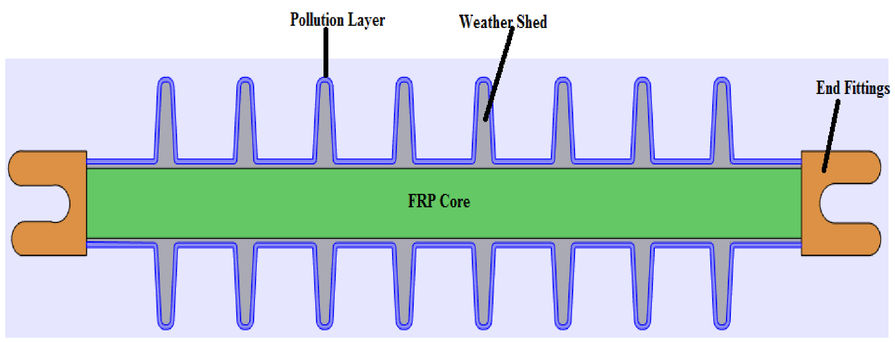

Figure 1. Regular shed polymeric insulator

Computational Methods: Electric currents formulation was used to study the effect of pollution conductivity on the electric field distribution. The equation governing the electric field computation is Comsol is given below [10].

$$\nabla . J = Q_j \quad (1)$$

$$J = (\sigma + j\omega\varepsilon_o\varepsilon_r + J_e) \quad (2)$$

$$\nabla E = \frac{\rho}{\varepsilon} \quad (3)$$

$$\varepsilon\nabla(\nabla E) = 0 \quad (4)$$

No. of Sheds	8
Leakage Distance	900 mm
Shed Diameter	105 mm
Sheath Diameter	30 mm
SIR Relative Permittivity	4.3
FRP Relative Permittivity	7.2
Water Relative Permittivity	81
Service Voltage	33 kV

Table 1. Insulator and simulation parameters

Results: Electric field intensity along the insulator surface was greatly influenced by pollution layer thickness and conductivity. As the pollution layer thickness was changed from 0.5 to 2 mm, the electric field increase from 1.12 to 1.65 kV/cm. In the case of pollution layer conductivity highest electric field stress was calculated for layer conductivity of 10-3 S/m. Pollution layer thickness was kept constant at 1 mm in this case.

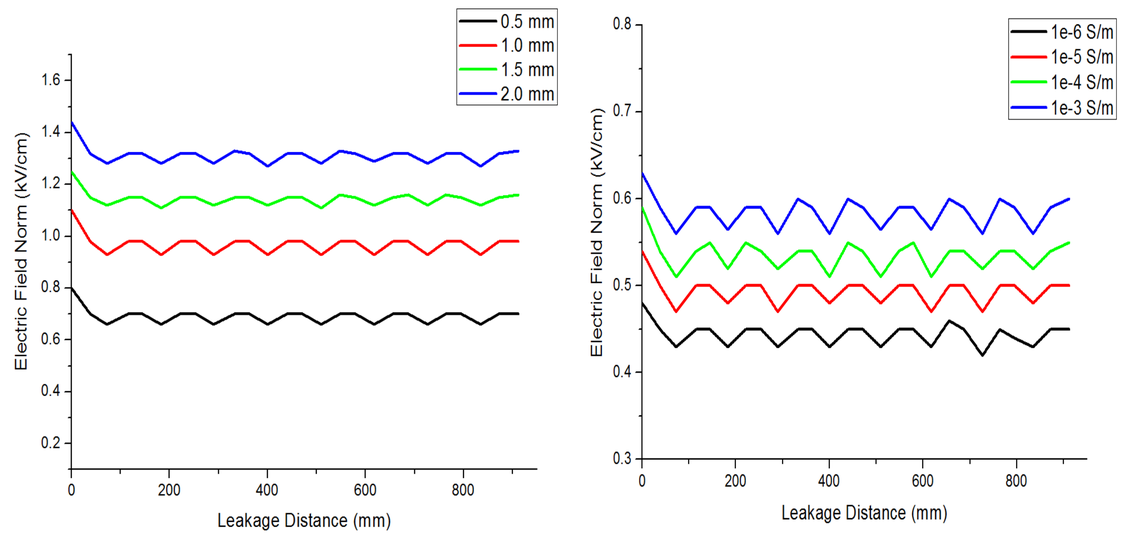

Figure 2. Electric field distribution at various (a) Layer thickness (b) Conductivities

Conclusions: Based on the simulation results it was concluded that electric field is greatly influenced by pollution layer conductivity and thickness. As the pollution layer conductivity and thickness increases, electric field intensity increases. The highest electric field was observed to be 1.65 kV/cm in the case of a 2-mm thick pollution layer.

References:

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2. T. Doshi, R. S. Gorur, and J. Hunt, “Electric field computation of composite line insulators up to 1200 kV AC” IEEE Transactions on Dielectrics and Electrical Insulation, 18(3), 861-867, 2011.