

Influence of Voltage Type and Polarity on Electric field distribution along a Polymeric Insulator under Contaminated Conditions

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Introduction: Polymeric insulators have been extensively used in power industry since the past few decades. Polymeric insulator behaves differently under AC and DC applied voltage due to charge accumulation under DC voltage. Effect of voltage type and polarity on electric field and potential distribution are investigated in this paper.

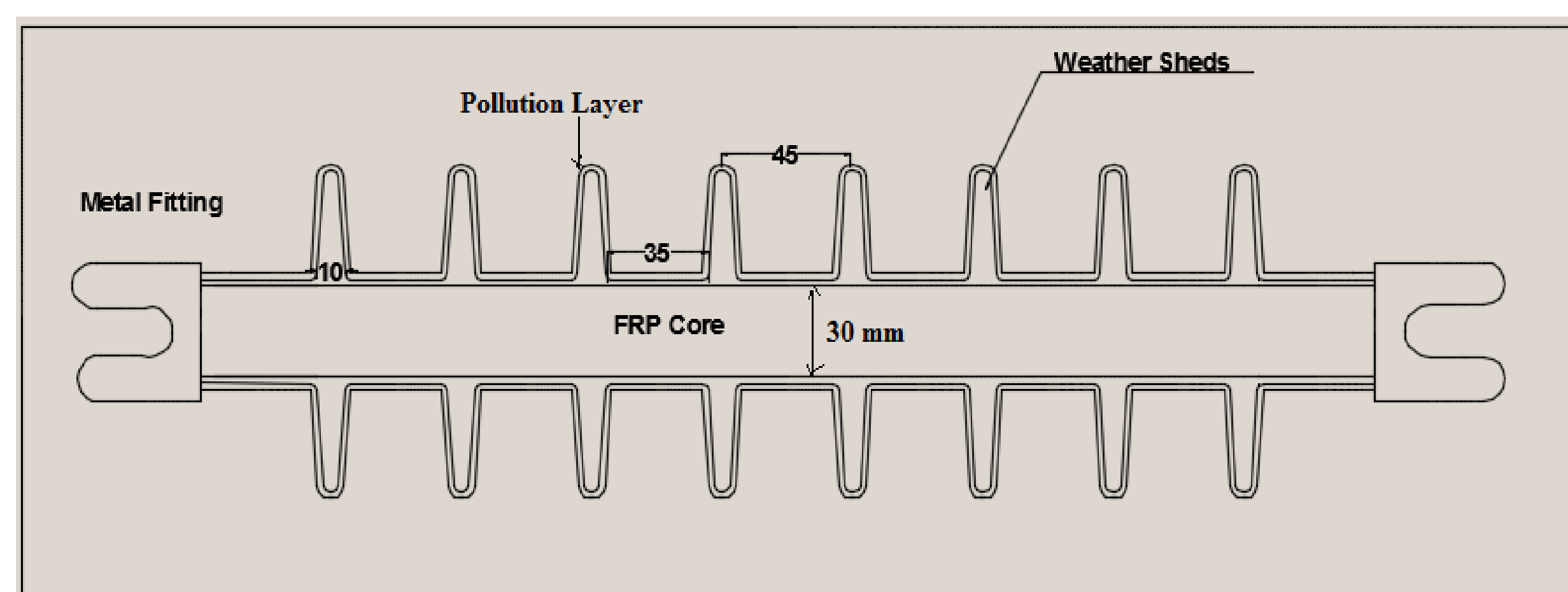


Figure 1. A standard 33 kV polymeric insulator

Computational Methods: Finite element method was used in Comsol Multiphysics to calculate electric field and potential distribution along a standard 33 kV polymeric insulator. The electrostatic formulation was used for simulations. Mathematical equation governing the electric field and potential distribution are as follows:

$$E = -\nabla V \quad (1)$$

$$\nabla E = \frac{\rho}{\epsilon} \quad (2)$$

$$\epsilon \nabla(\nabla E) = 0 \quad (3)$$

$$J = \sigma E \quad (4)$$

Where ρ is the resistivity, ϵ is the dielectric constant, J is the current density and σ is the conductivity of pollution layer.

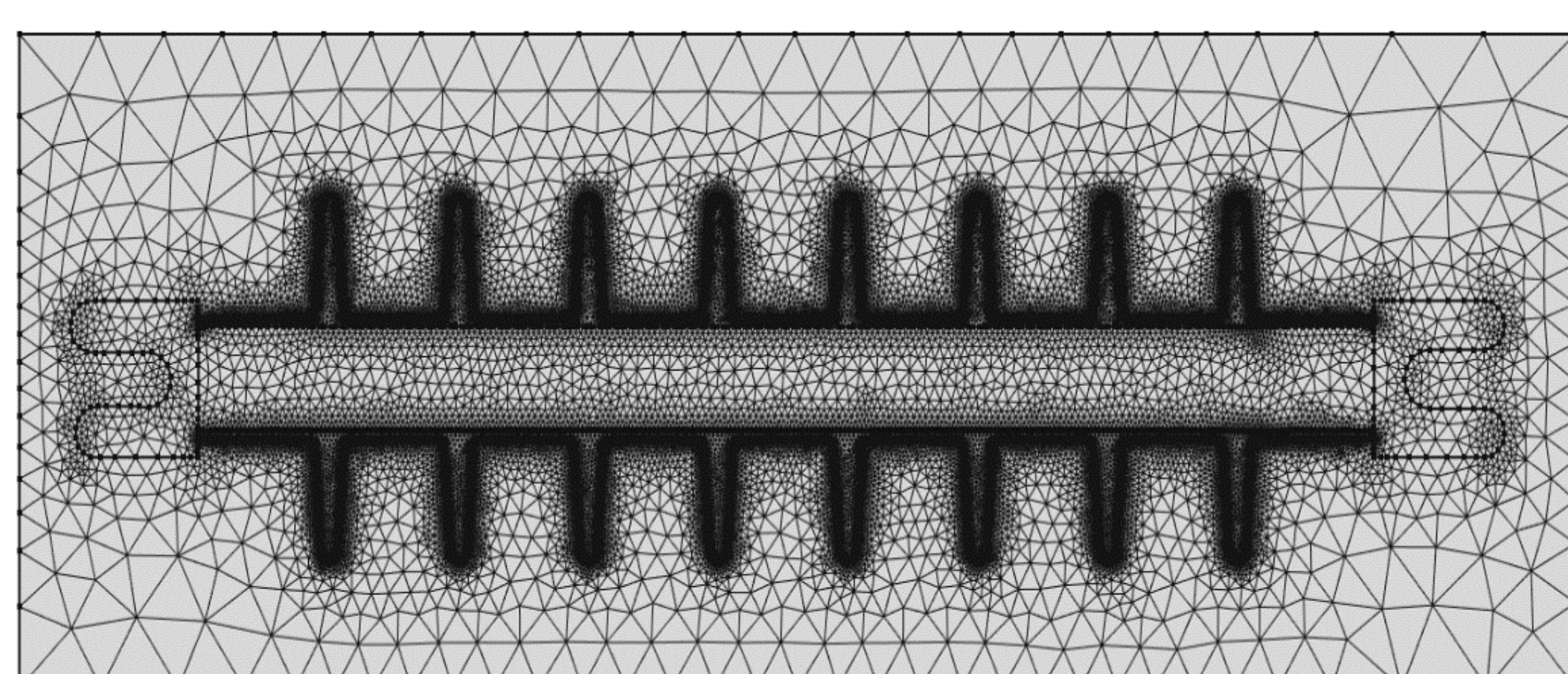


Figure 2. Meshed model of polymeric insulator

Results: Figure 3 and 4 shows the electric field distribution at DC+, DC- and AC applied voltage. At a pollution layer conductivity of 500 uS/cm, the maximum electric field intensity was calculated to be 1.16, 1.14 and 0.79 kV/cm for DC+, DC- and AC respectively.

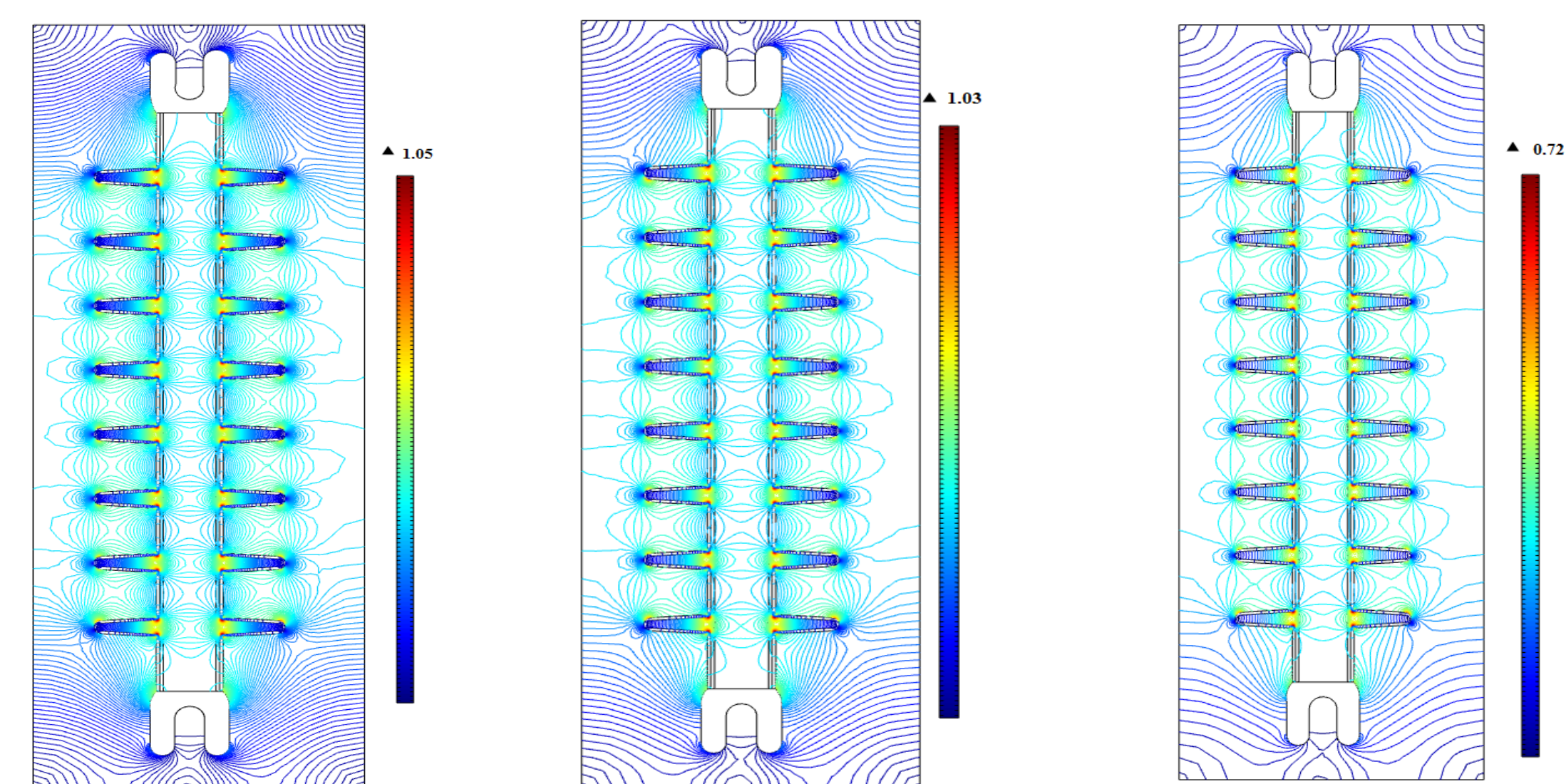


Figure 3. Electric field distribution (a) DC+ (b) DC- (c) AC

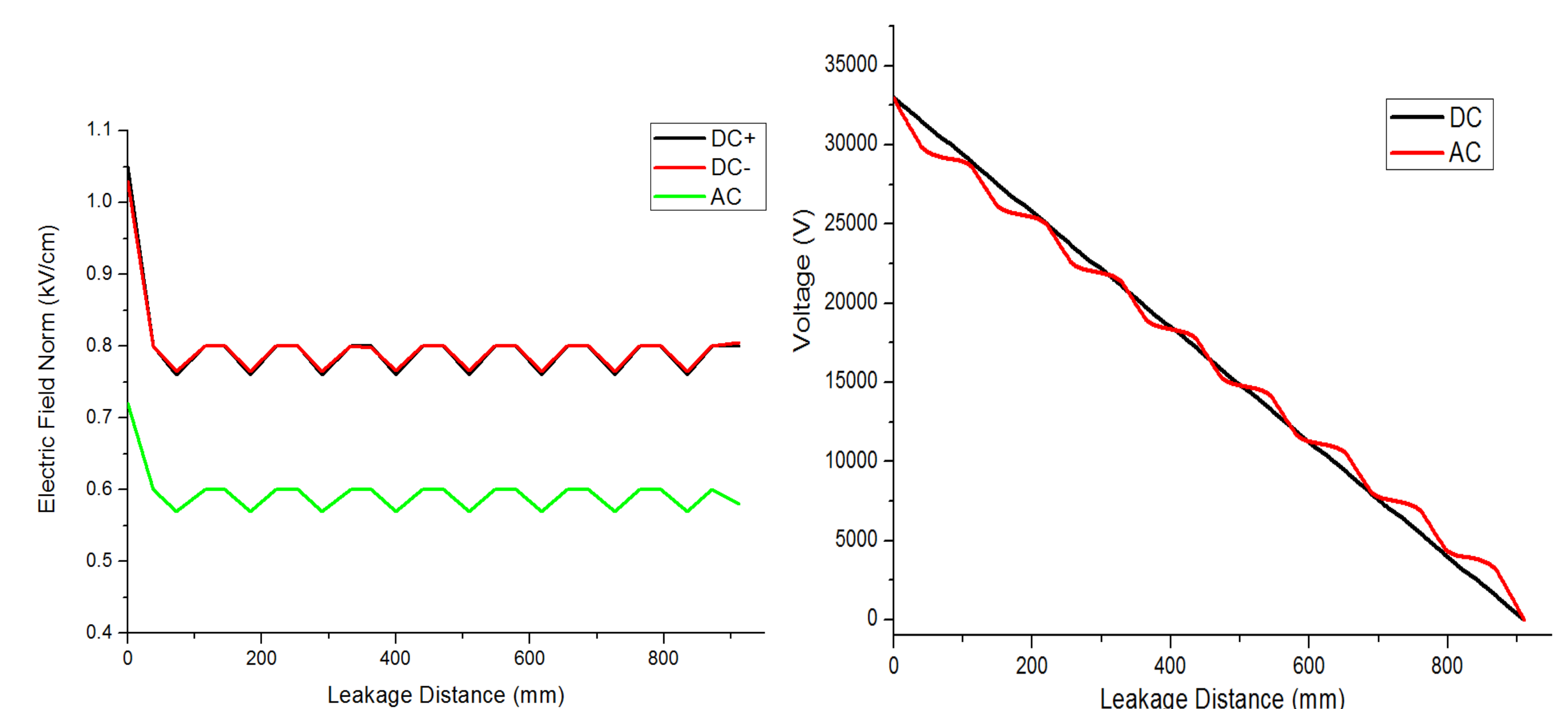


Figure 3. (a) Electric field (b) Potential

Conclusions: It was observed that voltage polarity has very little effect on electric field distribution but voltage type effect electric field and potential distribution. It was also found that electric field is higher in the case of DC applied voltage as compared to AC under similar service conditions.

References:

1. V. M. Moreno, and R. S. Gorur, "Ac and dc performance of polymeric housing materials for HV outdoor insulators", IEEE Transactions on Dielectrics and Electrical Insulation, 6(3), 342-350, 1999.
2. Arshad, A. Nekahi, S.G. McMeekin, and M. Farzaneh, "Effect of Pollution Severity on Electric Field Distribution along a Polymeric Insulator", 11th International Conference on the Properties and Applications of Dielectric Materials (ICPADM) 2015.