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Investigation of Surface Charge Accumulation and Dissipation Mechanisms Based on Solid Conductivity and Dielectric Relaxation for The Insulator of GIL Under DC Voltage

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Surface charge accumulation on insulator is one of the main restrictive factors of DC gas insulated pipeline transmission line (DC-GIL). The current research on the accumulation and dissipating mechanism of surface charge has the following deficiencies on the solid side. Firstly, the volume conductivity of insulators are usually taken as a fixed value,so the comprehensive effect of electric field intensity and temperature on this parameter is not taken full consideration. Secondly, the calculation models of current density and surface charge density on the solid side ignore the effects of dielectric relaxation, which also affects the calculation of surface charge density. So in this paper, the mathematical model of solid conductivity based on electric field and temperature has been studied, and the model of volume current density and charge density has been reestablished in combination with dielectric relaxation. When the solid side is dominant, the temperature , electric field and dielectric relaxation characteristics of surface charge accumulation and dissipation are simulated and analyzed. The results indicate that the steady state value of surface charge density increases exponentially with the increase of the initial value of electric field and temperature, and the charge saturation time also increased. The increase of the electric field intensity change rate leads to a exponential decrease of the steady state value of surface charge density and the saturation time. The saturation time increases by 3% and the steady state value of surface charge density increases by 0.9% in the influence of dielectric relaxation.Considering only the charge dissipation of the solid side, the higher the temperature, the more favorable for the dissipation of the surface charge. Moreover, the dissipation rate increases exponentially with temperature. The effect of field strength on charge dissipation depends on the initial charge density .Dielectric relaxation slows the dissipation rate by 28%.

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