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Study by simulation the influence of temperature on the formation of space charge in the dielectric multilayer Under DC Electric stress

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Abstract: Multidielectric polyethylene is a material that is generally employed as insulation for the HVDC isolations. In this paper, the influence of temperature on space charge dynamics has been studied, low-density polyethylene (LDPE) and Fluorinated Ethylene Propylene (FEP) sandwiched between two electrodes were subjected to voltage application of 5kV (14.3 kV/mm) for extended duration of time and the space charge measurements were taken using bipolar model is one-dimensional, taking into account trapping, detrapping and the rencommbinaison in order to determine the charge density and electric field of the sample depending on the thickness. The simulation was carried out at three different temperatures (20, 40, and 60°C). The results of this model going to compare with experimental space charge measurements . Finally, simulation results demonstrated that the temperature has many effects on the dynamic space charge and of influences the charge injection, charge mobility, electrical conduction, trapping and detrapping.

Keywords: Space Charge, Temperature, LDPE, FEP, Numerical Model.

1 Introduction

MULTILAYER polymeric insulation has been used in HVDC equipment for a long period time because it has economical cost and desirable electrical and physical properties. however, it degrades below a combined stress of thermal, electrical, mechanical, and chemical stresses during regular operations [1, 2]. When a direct-current (DC) voltage is applied to a polymer insulator lead to the presence of space charge formed in the bulk insulation inside the dielectric causes electric field distortions and may affect the degradation of the insulation system [3]. Therefore, a better understanding of space charge dynamics, in accordance with the particular variation of the space charge distribution in dielectric multilayer insulation becomes increasingly important and needs a careful investigation [4], we have taken the example of combination of two dielectrics Polyethylene Low Density (LDPE) and Fluorinated Ethylene Propylene (FEP) have been generally found in cable accessories between the insulation of the cable and that of the accessory in the high voltage (joints and termination) [5, 6].

However, the majority of the literature work has conducted at DC electric stress and at room temperature, especially, in a useful HVDC cable system [2], the operational temperature of HVDC cable is not constant, especially in countries where the climatic situation changes significantly during diffrent times of the year [7, 8]. For it becomes essential to study and attempt to understand space charge dynamics in the charge transport system of "sandwich" type LDPE-FEP under various temperatures under electric stress DC voltages. We have found much research to measure the dynamic of space charge in the dielectrics based on measuring systems such as the PWP, LIPP, and PEA methods [6-9]. For this selection, we have led to measure, understand and simulate the phenomenon of space charge in the dielectric multilayer at different temperatures. So we used a very complex model allows simulating the charge transport system of "sandwich" type LDPE-FEP. The purpose of this work is developed a numerical model based of the previous models [10-12], able to simulating the different experimental measures that describe the dynamic behavior of the space charge in the polyethylene insulation sandwich LDPE-FEP for the different temperature under stress 14.4 KV, based and compared with model [13], and investigated the effect of temperature on formation and stability of shallow trap at a dielectric interface of the multilayer under high DC electric field using the pulsed electroacoustic (PEA) technique, her results show that temperature plays a vital role in the space-charge dynamics at the dielectric interface, the applied DC voltage mainly effect the amount of space charge. For the calculation of the space charge and the electric field

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