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FEA-Based Simulation of Accelerated Ageing in a Power Cable Due to Sustained Partial Discharge Activities in a Spherical Cavity

Abstract

The reliability of electrical assets is greatly influenced by the quality of their insulations. Key power installations such as power cables are manufactured with polymer-based materials as part of their insulation system. However, accelerated ageing of equipment insulations due to manifestation of defect(s), and partial discharges (PDs) can offset the operation of these systems or even lead to breakdowns. In this study, a non-deterministic model to simulate the phenomenon of repetitive discharges in a spherical air-filled cavity within a practical power cable has been investigated. In addition, the work contributes to the understanding of PD behaviour and field distribution under different ageing conditions considering changes in cavity surface conductivity. First, a section of the practical XLPE cable containing the cavity is developed in 2D using COMSOL software, and a finite element analysis (FEA) of the electric field distribution within the cable insulation is performed. The magnitude of the cavity local field, that is enough to ignite a PD, is investigated. Alongside the COMSOL model, the activity of sustained internal PD is simulated in MATLAB by introducing a random sample generating factor and adjusting the model's parameters to obtain something close to the practical results. Furthermore, the impact of continuous PD in the power cable under different cavity dimensions and surface conductivity is likewise investigated, and a phase resolved PD (PRPD) pattern is established. The result shows that the magnitude and number of PDs per cycle increase as the cavity size and its surface conductivity increase. Finally, when the cavity surface conductivity rises, the amplitude of the electric field generated by the surface charge distribution and the number of PDs per cycle approach their maximum values.

Keywords

COMSOL and partial discharge; Cross-linked polyethylene cable; Medium voltage