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An investigation into partial discharge behaviour in impulse aged polymer insulation

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ABSTRACT

The objective of this research work is to investigate the behaviour of partial discharges (PD) in impulse aged solid polymer insulation. The investigation was conducted through studying key partial discharge characteristics such as; PDPRP (partial discharge phase resolved patterns), PD magnitude and PD inception voltage in impulse aged and non-aged insulation. Polymer insulation is widely used in electrical equipment such as motors, generators and power cables for high voltage insulation purposes. The insulation can be inevitably exposed to impulse voltages such as lightning. In this work the experimental investigation was performed on underground shielded power cable insulation. Lightning impulses, generated using a single stage impulse generator, were used to age 11 kV, 1 meter cross-linked polyethylene (XLPE) power cable test samples. Artificial cavity defects were then created in each sample. Subsequently, PD tests were performed using the IEC60270 test setup. Similar cavity defects were created in non-aged cable power samples and similar PD tests were conducted for comparative purposes. PD measurements assessed the effect of impulse ageing on PD phase-resolved patterns, PD magnitude and PD inception voltage. The results revealed that PDPRP had a distinct response to impulse ageing and this manifested as distinct changes in PD magnitude peak profiles of positive and negative half cycle patterns. PDPRP of non-aged samples contained a characteristic positive half cycle peak PD magnitude that is smaller than that of negative half cycle peak PD magnitude. The converse applied to the case of aged samples where the PDPRP negative peak magnitude was either larger or equal to the positive peak magnitude. Generally, PD magnitudes of non-aged test samples were larger and varied over a wider range than those in aged samples. PD inception voltage of the aged samples was slightly lower than that of non-aged test samples. The findings on the influence of impulse ageing of insulation on PD characteristics can be interpreted using conventional knowledge on PD mechanisms. These findings can be useful in PD diagnosis technology, for example; during continuous online PD monitoring changes in PD patterns could infer increased exposure of equipment under test to lightning voltage surges.