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Identifying Prognostic Indicator for Electrical Treeing in Solid Insulation through Pulse Sequence Analysis

Nur Hakimah Aziz*, Martin D. Judd and Victoria M. Catterson
Institute for Energy and Environment, University of Strathclyde, Glasgow, UK
*hakimah.aziz@strath.ac.uk

INTRODUCTION

This research aims to predict the lifetime of solid insulation by experimentally inducing electrical treeing in samples of silicone rubber. Indicators of ageing are features of the partial discharge (PD) plot that correspond to electrical tree growth, and can therefore be used to identify the stage of growth and predict remaining life. In this paper, the pulse sequence analysis (PSA) technique has been applied and shows distinctive features which change with the tree evolution. A prognostic indicator has been identified as the error term when applying linear regression to the PSA plots.

ELECTRICAL TREEING EXPERIMENT

This study employed needle-plane test arrangement on commercially available pre-formed silicone samples as shown in Fig. 1.

PULSE SEQUENCE ANALYSIS (PSA)

The basis of pulse sequence analysis is that strong correlations exist between consecutive discharge pulses due to the influence of local space charge on the ignition of the following discharge pulse [1]. Thus, the characteristic parameters for the discharges are the local electric fields and their changes, which can be represented using only the change in voltage due to the excitation waveform. Fig. 2 shows the basic principle of PSA approach, where the solid circles represent PD pulses within the reference cycle.

DATA ANALYSIS

The data analysis is based on one particular electrical treeing sample that was aged for 9 hours at 9kV. The tree touched the ground plate after 3.5 hours and was still growing after 9 hours of ageing. In order to identify the prognostic indicators, the recorded phase-resolved PD (PRPD) data is transformed into the PSA plot, e.g., u_1 versus u_2, d_1 versus d_2, and u_1 versus d_2. In this paper, only the u_1 versus u_2 plot is discussed in detail. Figures below show a comparison of the data plots at 1.5 hours and 6 hours of tree growth.

CONCLUSION & FUTURE WORK

1. There is evidence of breakdown indicators in PSA for electrical treeing faults, namely the appearance of heavily clustered data points that lie diagonally in the scatter plots of (i) u_1 versus u_2 [2] (ii) d_1 versus d_2 [2, 3]
2. In this paper, a potential prognostic indicator has been identified that is based on the u_1 versus u_2 plot.
3. The other two PSA plots, i.e., d_1 versus d_2 and d_1 versus u_2, also show a clear pattern of electrical tree growth.
4. The next step is to investigate how the RMSE values change with the tree growth.
5. A number of tree samples will be used to investigate the consistency of the result.

REFERENCES