Contribution ID: **278** Type: **Poster Presentation**

Evolution of Partial Discharge of Oil-paper insulation under Long-term AC Voltage

Friday 8 July 2016 17:15 (15 minutes)

Internal insulation defects of oil-immersed transformers are common because of flaws in both manufacturing and transportation process. Partial discharge (PD) activity caused by insulation defects may occur at rated voltage condition, leading to deterioration of material, which results in breakdown of insulation. Feature parameters of PD are closely related to the performance of insulation materials. Therefore, the parameter changes under long-term AC voltage due to the decrease in electrical properties of material. It is effective to acquire insulation condition of materials by analyzing changes in the parameters of PD.

The present thesis studied partial discharge in insulation defect of oil-paper insulation under long-term AC voltage. The PD tests were performed on specimens of 1 mm thickness which was placed between the needle-to-plane electrodes in an oil cup. The specimen was impregnated with oil in vacuum with treatment of hot air drying in order to remove moisture. Feature parameters of PD, such as phase-resolved partial discharge analysis and average discharge magnitude, were recorded during the test process. When the feature parameters of PD are significantly changed, some specimens were removed. The surface appearance of these specimens was studied by scanning electron microscope and infrared spectrometer, and the insulation parameters such as surface resistivity was also measured. These measurements provide a theoretical basis for the analysis of the changes in the feature parameters of PD, which is helpful for the estimation of remaining life of insulation material.

Test results indicate that as the AC voltage applied, cellulose depolymerisation continuously happened at the surface of paper. Cellulose in some area is carbonized by PD, and particulates are created. The surface resistivity of paper decreases, resulting in a higher repetition rate of PD. As the PD developed, the discharge magnitude is increased at the beginning while decreased rapidly just before breakdown of the paper, and the distribution phase of discharges is almost unchanged.

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Session Classification: Oral 11

Track Classification: Dielectrics, Insulation, and Breakdown