Measurement of Leakage Current at the Oil-pressboard Interface during Surface Discharge

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Surface discharge at the oil-pressboard interface is classified as one of the most dangerous fault conditions of large transformers. Surface discharges can be sustained for long periods without surface flashover or breakdown as long as the surface breakdown voltage is not exceeded [1]. Damage at the pressboard surface due to surface discharge is a function of applied voltage and time. If an applied voltage, above the surface partial discharge inception voltage (PDIV) but less than surface flashover voltage persists, the resulting discharges can develop a creeping path due to the drying out of the pressboard by localized heating (forcing oil and water out of the pressboard pores) and the carbonization of the oil and cellulose [1]. The drying of pressboard during the surface discharge process has been observed as the development of white marks on the pressboard surface [1].

A surface discharge experiment using a needle-bar electrode configuration has been developed. A shunt resistor that has been extensively used to measure leakage current for outdoor insulation systems [2] is used in the experiment. The leakage current is also measured using a commercial partial discharge detection system to allow comparison of the leakage current waveform from the oscilloscope against the corresponding phase resolved partial discharge (PRPD) pattern obtained. Figure 1 shows an example of measured leakage current during the occurrence of full-length discharge.

It has been found that after long periods of surface discharge, temporary full-length discharges may occur across the pressboard surface bridging the needle tip and the earth without resulting in complete electrical breakdown. The full-length discharges occur when the white marks have reached the earth bar and travel along the same path as the white marks [3]. The occurrence of this full-length discharge leads to small leakage current (mA range) flowing to earth that is unlikely to trip the earth fault protection relays [3]. Although the currents are relatively small, identifying their presence and relating them to forms of PD activity at the pressboard oil interface is important as it may provide a mechanism for earlier detection of creep stress failure.

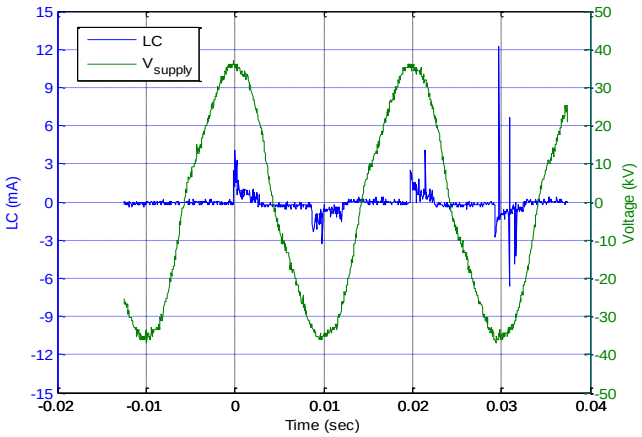

Figure 1: Example of leakage current waveform during full-length discharge at oil-pressboard interface

[1] P.M. Mitchinson, P.L. Lewin, B.D. Strawbridge, P. Jarman, “Tracking and surface discharge at the oil-pressboard interface”, IEEE Electrical Insulation Magazine, vol. 26, pp. 35-41, March/April 2010.

[2] H. Zainuddin, P.M. Mitchinson and P.L. Lewin, “Investigation on the surface discharge phenomenon at the oil-pressboard interface”, *in IEEE International Conference on Dielectric Liquids (ICDL)*, 2011, pp. 1-4.

[3] R. S. Gorur, J. Montesinos, L. Varadadesikan, S. Simmons, and M. Shah, "A laboratory test for tracking and erosion resistance of HV outdoor insulation," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 4, pp. 767-774, 1997.