

Abstract

The increasing demand for electrical power energy comes with a challenge to design power transformers with optimised dimensions at the same time meeting the energy requirements. The dimension of a power transformer is influence by the insulation system. The use of composite insulation comprising of transformer oil and cellulose (paper and pressboard) is still currently the most economical insulation technology allowing for dimension reduction. Although over the years, there have been developments of alternative insulation systems; the conventional insulation type is still predominant due to various reasons. The main disadvantage with the conventional composite insulation system is relative permittivity mismatch of the different material, which leads to localised electrical stresses at their interface. The localised electrical stress causes surface discharge on solid insulation material at normal operating voltage thereby slowly developing into a permanent conduction path, which leads to dielectric failure. It is known that about 25% to 30% of major dielectric failures of power transformers are due to switching and lightning impulses associated with solid insulation ageing and contamination. The objective of this dissertation is to study the effect of surface discharge on the lightning impulse (LI) breakdown voltage of oil-impregnated pressboard used in power transformers. Needles placed at an acute angle on the surface of an oil-impregnated pressboard sample to plane electrode geometry were used to age 24 pressboard samples with surface discharge. The electrode gap distance was set at an optimised distance of 45 mm. The test samples were continuously aged by surface discharge at a constant supply voltage of 30 kV. The ageing experiment was performed in an array of 12 test samples set simultaneously aged for a period of 3 hours and another set for 7 hours. A set of 6 out of the 12 aged samples were tested for positive and another set for negative LI breakdown voltage. The experimental findings are that surface discharge reduces the LI breakdown voltage of oil-impregnated pressboard and this is a function of exposure period to surface discharge. Furthermore, although negative LI breakdown voltage of pressboard is higher than positive LI breakdown voltage, the former is affected relatively more by surface discharge ageing. The presence of any surface discharge in power transformers should therefore not be tolerated.