

Abstract

Electrical stresses that distribution transformers rated 16 kVA up to 2 MVA are subjected to can often cause premature transformer failures. In this study, research related to the development of cost effective bushing embedded sensors that can measure the electrical stresses on the MV side of distribution transformers has been conducted. An embedded screen in a specially designed 24 kV bushing was used for both power frequency and transient voltage measurements. Observed results showed that the screen-based bushing capacitive voltage divider offered results that are consistent with those of a commercial capacitive voltage divider for power frequency voltages as low as 1 kV up to 24 kV. Impulse voltage measurements were consistent with those of a wideband resistive divider for voltages lower than 60 kV. Voltages higher than 60 kV revealed non-linear behaviour which increases as the 150 kV BIL rating of a 22 kV transformer is reached. A nonlinear resistor added to ATPdraw simulations was able to compensate for the observed nonlinearity. PD tests conducted on the prototype bushing showed that the designed prototype had surface discharges which are affected by the positioning of the bushing screen. A Rogowski coil embedded in the same bushing was used for the measurement of both power frequency and transient currents. Measured coil parameters used in ATPdraw simulations produced results that were consistent with the output of the Rogowski coils when measuring 8/20 μ s current impulses. Numerical integration of the Rogowski coil output voltages was successfully used in the recovery of both power frequency and measured impulse currents. The Rogowski coil sensitivity is affected by both coil dimensions and terminating resistance. The designed prototype bushing opens up opportunities for performing stress monitoring on the MV side of distribution transformers.