Non-contact surface metrology of degraded conductor screens in XLPE cables

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Polymer insulated cables today have an axial water tight design which prevents liquid water from entering the area between the conductor strands. This area is usually filled with swelling powder or strand sealing materials. Thus, liquid water penetrating the area between the strands is less likely, but may happen after a service failure. Liquid water causes corrosion of the Al strands and further initiates environmental stress cracking (ESC) of the conductor screen at the interface. This forms porous structures, so-called Stress Induced Environmental Degradation (SIED), finally bridging the conductor screen radially. Such conditions strongly accelerate vented water tree growth from the conductor screen.

The main purpose of this paper is to present results from non-contact surface metrology characterization of SIED structures in a 12kV cable with stranded conductors filled with artificial salt water for 1 month at 40°C. These measurements were compared to optical microscope examinations at the same surface locations. The bulk morphology was examined using a Scanning Electron Microscope (SEM).

The results showed that after immersing the sample in hot tap water for three hours, the SIED structures were found to be a permanent swelling of the material clearly revealed by the high-resolution 3D imaging. The structure did not change shape or appearance after 2 hours in ambient conditions after wetting. Additional characterization using a Scanning Electron Microscope (SEM) revealed porous structures in the conductive screen with fibrils stretching across the gaps.

Key words: XLPE, aluminium conductor, corrosion, SIED, ESC