Influence of heat-shrink joints and terminations on Tan delta values of a medium voltage cable installation at very low frequency.

Theresa **JOUBERT** (1), Jerry **WALKER** (2)

1 Vaal University of Technology, Vanderbijlpark, South Africa, theresa@vut.ac.za
2 Walmet Technologies (Pty) Ltd, Vereeniging, South Africa, jerrywalker@walmet.co.za

Medium voltage cables and the accessories (joints and terminations) form a critical part of the power delivery system. While progress has been made in understanding the processes in the accessories of power cables during diagnostic testing with power frequencies, the processes during testing with other frequencies are not known yet and this necessitates that several aspects require considerable investigations to obtain further information.

High voltage testing of cables are done to verify the integrity of the accessories after installation on a new cable system and as a control measure of the jointing process on a service aged cable and its accessories following a failure. It is an accepted practice to perform the tests with a low frequency supply due to the constraints of testing at power frequency and thus field testing of Medium Voltage cables are done at very low frequency (0.1 Hz) and it has also been incorporated into the National Standards of many countries (SANS 10198-13). It has further become very popular to also incorporate diagnostic testing and evaluation of the cable systems at very low frequency and partial discharge and Tan delta evaluation are the two popular methods.

It has been shown in a number of publications that the Tan delta value of a heat shrink joint and termination are not a direct function of the frequency as is the case with a single layer of insulation like an XLPE cable. In a multi-layer insulation system like a joint and / or termination the polarization characteristics of the different materials play a significant role at very low frequencies having a significant effect again on the Tan delta value. Therefore, cable accessories should be treated quite differently from the cables itself as the joint in a cable system is a complex multi-layer insulation system whilst the cable can be seen as a homogeneous insulation system.

Most standard tests ignore the effect of the frequencies and wave shape on the accessories of a complex multi-layer insulation system. The differences of the permittivity and volume resistivity of the materials of the different layers have the effect that the combination of materials (three layers and two layers) will respond differently to varying frequencies as the mechanisms involved to determine the stress distribution in a joint, is totally different to a cable which is a single layer insulation system.

It is therefore necessary to understand the behaviour of multi-layer insulation systems when a test is performed at a frequency lower than the rated frequency in order to do a sound evaluation of the condition of the insulation.

Finite Element Simulations has been used to determine the theoretical Tan delta values of Cables, joints and terminations in isolation. This paper combines all the previous simulation results to show the influence of joints and terminations as a function of the length of the cable system and the number of joints in the cable system.