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On-site TSM measurements on HV cable loops in the frame of the Artemis project

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Identification of aged states of power cables is still a challenge, thus arises significant academic and industrial works... Build-up of space charge within the insulation in both ac and dc conditions is among ageing indicators considered by the electrical engineering community to display physical and, may be, chemical changes. However, these measurements need sensitive and well-defined techniques to reach accurate and reproducible results.

In the frame of the Artemis project, which deals notably with identification of ageing markers of ac high voltage cables, and carried out under the auspices of the EU, on-site space charge measurements had been performed by means of Thermal Step Method (TSM) on 90 kV cables aged under ac voltage in industrial facilities. These measurements were aiming at pointing out a possible evolution of the electrical state of the cables related to the applied ageing conditions.

Two variants of the TSM have been used: the Inner Heating Technique (**IHT**) and the Outer Cooling Technique (**OCT**). **IHT**, which does not require any specific preparation of the cable prior to the measurements, aims at follow-up the evolution of the mean electrical state of the whole cable in relation to applied ageing stresses and duration (measurements performed after ac ageing and consecutive low field dc poling). **OCT** deals with a rather local analysis of the cable (20 cm length areas are considered). In this configuration the heat exchanger can be moved along the cable then enables to point out possible longitudinal differences in space charge build-up in the insulation layer. Thus this technique does not require to cut up the cable into pieces, and can be performed without any dc poling prior to the measurements.

This paper relates some of obtained results, using **IHT** and **OCT** configurations, following several ac ageing steps.

OCT, was used to analyse 5 areas of a cable aged for 6000 hours under 345 kV and 90°C. Differences in electrical state of the cable were displayed, as these areas generated different thermal step responses. By means of Differential Scanning Calorimetry, these variations have been shown to be associated with differences in temperature distribution along the cable loop. In contrast, differences in micro-voids (1 - 10 µm) density and distribution were not found to be significant.

The **IHT** pointed out a trend to increase of the thermal step response with ageing duration (cable aged at 345 kV and 90°C). Through these results, Thermal Step Method response appears to have a strong potential as indicator of the evolution of the electrical state of the insulating system.