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## Study of AC Electrical and Thermal Ageing of XLPE Polyethylene by Space Charge Measurements

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The aim of the present study was to follow the space charge formation under ac field (50Hz) in polyethylene (XLPE) in order to better understand the AC "ageing" phenomena in real HV cables.

As the dielectric phenomena are in general weak under AC ageing, this work was done on so-called EFI-type standard samples (Rogowski profile) with semiconducting carbon black electrodes as in HV cables. Our study was performed for two levels of poling electric fields (30 and 40 kV/mm rms) and at an environmental temperature of 60°C (temperature representative of the power cable operating conditions and considered as critical with regard to the accumulation of the space charges in PE). The use of thin insulating layers in this work (around 0.7 mm of PE) allowed us to reach values of applied electric fields close to the maximum service conditions of the underground power cables (around 30 kV/mm rms - values which are very difficult to reach on a cable length in a laboratory environment).

Measurements were carried out after five durations of thermal and electrical poling: 15 days, 1 month, 2 months, 4 months and 8 months and for the two levels of the applied electric field. For these tests, and for each duration of poling, three Rogowski-samples were necessary: two were maintained under poling (ac electric field and 60°C temperature) and the third (called "reference" cup) was only maintained at the poling temperature without applied electric stress. After each stage of ageing, the cups were measured by the Thermal Step Method (TSM) to evaluate the residual levels of electric fields and space charges. The study has put in evidence the following results:

- The application of the 50 Hz ac stress for duration of few months allowed us to observe a polyethylene particular structure modification. This "ageing" could be revealed by a process of "re-poling" under weak dc electric field performed at ambient temperature (evidence of defects created by the ac mode). After statistical treatments of the results, the observed structure modification was confirmed by the tests carried out on the only thermically aged cups.
- The increase of the ac poling electric field also seems to be at the origin of a more significant "ageing" of the Rogowski cups. The calibrating process performed on these cups indicated us that values of intern residual fields did not exceed 0.11 kV/mm.
- The increase in the duration of ac conditioning (up to 8 months) did not allow us to detect a real "ageing" evolution from a statistical point of view. The TSM signals measured after ac and ac+dc poling, as well as measurements of decrease of the TSM current (cups maintained in short circuit conditions at ambient temperature) did not clearly confirm this evolution.

The results obtained in this study confirm that the XLPE structure modification (may be abusively called ageing) revealed by a process of "re-poling" submitted to a 50 Hz alternative constraint, are phenomena governed by a particularly slow dynamics.