



B.6.3.

Study of AC electrical and thermal ageing of XLPE polyethylene by space charge measurements

AGNEL S., TOUREILLE A., LEM Montpellier, France
PLATBROOD G., Laborelec, Belgium

Abstract: The aim of this study was to follow the space charge formation under ac field (50 Hz) 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 semi conducting carbon black electrodes as in HV cables (poling electric fields 30 and 40 kV/mm rms, and at a temperature of 60°C). Measurements were carried out after four durations of electrical and thermal poling and for the two levels of the applied electric field. 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 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.

Keywords: alternative current, ageing, cable, space charge

Résumé: Le but de cette étude était de détecter la formation des charges d'espace sous champ électrique AC (50 Hz) dans le polyéthylène (PRC) afin de mieux comprendre les phénomènes du vieillissement en AC dans les câbles HT réels.

Comme les phénomènes diélectriques sont en général faibles sous courant alternatif, ce travail a été effectué avec des échantillons standards de type EFI (profil Rogowski) avec des électrodes semi-conductrices chargées de carbone (champ électrique de conditionnement de 30 et 40 kV/mm rms et à une température de 60°C). Les mesures ont été effectuées après four durées de conditionnement (électrique et/ou thermique) et pour deux niveaux de champ électrique. Après chaque étape de vieillissement, les tasses ont été mesurées par la Méthode de l'Onde Thermique (MOT) pour évaluer les champs électriques et les charges d'espace résiduels. Les résultats obtenus dans cette étude confirment que les modifications de structure du polyéthylène réticulé chimiquement mises en évidence par une contrainte alternative 50 Hz sont des phénomènes régis par des dynamiques faibles.

Mots clés : courant alternatif, vieillissement, câble, charges d'espace

1. Introduction

Polymers used as electrical insulation in high voltage underground power cables can be susceptible to long term deterioration due to the application of high electrical stress. The use of thin insulating layers in this work (Rogowski cups with 0.7 mm of polyethylene) 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). The differences between the study of the insulation in ac conditions on cables and on Rogowski cups can be summarised in Table 1. Even though the conditions are not identical, the interest of this work is to study an insulation/electrode couple by using Rogowski cups and therefore to create a model for

the insulation/semiconductor couple. However, the heterogeneities (radial, longitudinal) in a cable after manufacturing have to be taken into account in any technical measurements in order to have a representative measurement of the cable [1]. The heterogeneity between the real samples explains the complexity of the approach still more if we think to a model of ageing.

Another paper [2] in this session explains the importance of morphological measurements performed on well-controlled samples before and after ageing in order to better understand the ageing model.

The aim of this work is to show that the accumulation of space charge is possible when these samples are submitted to an ac electrical and thermal ageing. The injection of electrons is strongly depends on the