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Survey of space charge evolution in high voltage cables submitted to AC voltage as part of the Artemis project

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Abstract:

In recent years, links have been made between the decrease of performance of XLPE-insulated power cables and the electric charge accumulated within the insulation under dc and ac conditions (space charge).

The aim of the present work was to investigate space charge evolution in cable insulation and to correlate it to ac ageing. An experimental set up based on the the thermal step method has been employed to survey the evolution of the charge in 90 kV power cables during ac ageing. The principle used for the experimental bench (namely the "outer cooling technique") consists of applying, by a cold liquid, a thermal step on the outer semicon of the cable and to measure a capacitive current response which is a function of the electric charge contained in the cable insulation. The measurements were performed on cable pieces taken periodically from cable loops subjected, in industrial facilities, to ac fields between 14 and 30 kV/mm rms at room temperature and at 90°C during 14 months. The evolution of the charge trapped in the cables was found to be dependent on the ageing conditions. A trend of the amount of trapped charge to increase with the ageing time, field and temperature has been observed, despite a low level of ageing of the samples. The obtained results give further evidence that space charge accumulation can be regarded as an indicator of the evolution of the electrical state of the cable insulation.

Keywords: alternative current, ageing, cable, space charge

1. Introduction

The comprehension of the fundamental mechanisms involved in the decrease with time of the dielectric properties of cross-linked polyethylene (XLPE) cable insulation, and thus the identification of the parameters related to its electrical and thermal ageing, is of considerable interest for predicting the long-term behavior of new and installed high voltage cables. On the basis of correlations which have been

Résumé:

Des études récentes ont montré l'existence de liens entre la diminution des propriétés électriques des câbles isolés au polyéthylène et la charge électrique susceptible de s'accumuler dans l'isolation sous fortes contraintes électriques et thermiques (charge d'espace).

L'objectif de ce travail a été de mesurer l'évolution des charges d'espace dans l'isolation de câbles haute tension et de la relier au vieillissement. Les mesures de charges d'espace, effectuées à l'aide d'une mise en œuvre expérimentale basée sur la méthode de l'onde thermique, ont porté sur des tronçons de câbles 90 kV prélevés périodiquement dans des boucles vieilles pendant 14 mois sous champs alternatifs sur sites industriels. Les contraintes électriques appliquées lors du vieillissement ont été comprises entre 14 et 30 kV/mm efficaces, pour des températures de 20°C et 90°C. L'évolution des charges piégées dans les câbles s'est montrée dépendante des conditions de vieillissement. Une tendance à l'augmentation de la quantité de charge piégée profondément avec le temps, le champ électrique et la température a été mise en évidence, malgré un faible niveau de vieillissement des échantillons. Les résultats obtenus amènent des preuves supplémentaires au service de l'utilisation de l'accumulation de charges d'espace comme indicateur de l'état de l'isolation d'un câble.

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

made during the last ten years between degradation of XLPE and electric charge accumulated in its bulk (space charge) [1-2], a european project (ARTEMIS) involving industry and academic researchers was launched, with the goal of developing a Diagnosis System for high voltage ac power cables [3]. The aim of the present work, which is a part of the ARTEMIS project, was to investigate space charge evolution in the insulation of cables submitted to