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Water treeing detection in 15 kV cables using the thermal step method

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Résumé

Dans ce travail, nous avons appliqué la Méthode de l'Onde Thermique (MOT) sur câble de deux façons : refroidissement par l'extérieur puis par chauffage de l'âme centrale. Nous avons étudié deux tronçons de câble 15kV (un neuf et un après claquage dû aux arborescences d'eau). Cette étude permet de mettre en évidence les différences de profil de charges d'espace entre les deux câbles. Le neuf présente un niveau de charge d'espace plus faible que le câble qui contient des arborescences d'eau. Une telle étude montre que nous pouvons détecter les arborescences d'eau par des mesures de charges d'espace. Les résultats obtenus sur le câble neuf peuvent donner une signature de l'état électrique des câble avant leur utilisation, la M.O.T. devient alors un test prédictif.

Abstract

In this work, we used the two techniques of the Thermal Step Method, the outer cooling technique and the inner heating technique. We were able to apply the T.S.M. directly on two 15kV cable samples (the first one after the very manufacturing process, and the second one after breakdown due to water trees). In fact, these measurements allowed us to detect water trees. We have shown the different profiles of space charges for each cable. The new one presents a lower space charge level than the cable which contained water trees. The results obtained on the new cable could be used as a reference when comparing the different levels of ageing. Therefore, the T.S.M. could be used as a predictive test directly after the fabrication of the cable.

1. INTRODUCTION

It is well known that the electrical properties of insulating materials used with high voltage applications are altered in time. This phenomenon, called "ageing", is strongly related to the external factors acting upon the materials (electric field, temperature etc.) and to the manufacturing process. Over the last decades, considerable efforts have been made to understand and to prevent ageing.

An insulating material is supposed electrically neutral ; however, electric charges can penetrate within the material. It has been shown that the accumulation of electric charges (*space charge*) within insulators, by creating a supplementary internal field (*remnant electric field*), is one of the main causes of ageing. Indeed, it seems that the more an insulation stores space charge, the more its ageing is accelerated by the increase of the global electric field (sum of the applied field and the remnant field). These charges can cause significant field distortion to affect the insulator performance and to reduce its lifetime.

The *Thermal Step Method* (*TSM*) [1-3] is a sensitive method for measuring remnant electric field and space charge density. The principle of the *TSM* consists of applying a thermal step to an insulating material placed in short circuit and of measuring a current response, which is related to the space charge distribution within the material. The response is due to the variation of the sample's capacitance. The *TSM* is a non-destructive measurement method : the space charge located in the bulk of the sample is not removed, and repeated measurements are possible. An electrical survey of the sample can therefore be carried out in order to predict the beginning of the electrical ageing.