A.9.1. Performances du polyéthylène réticulé sous fort champ électrique

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A.9.1. Performances of XLPE under high voltages stress

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Résumé

Le travail présenté ici a consisté à caractériser les propriétés électriques et physico-chimiques du PRC avant et après des essais de vieillissement accélérés sur des câbles 90 kV. Une attention particulière a été portée à l'identification de la position radiale et angulaire dans l'isolation des échantillons. En effet, une étude préliminaire a montré que le matériau PRC présente un caractère anisotrope au sein d'un même câble. Si l'on prend en compte cette anisotropie, les résultats montrent que pour la plupart des propriétés analysées, les effets des essais de vieillissement sont inférieurs à la dispersion intrinsèque des propriétés que l'on rencontre même au sein d'une isolation non vieillie.

Abstract

The aim of this study is to characterise XLPE physico-chemical and dielectric properties before and after multistress ageing tests on 90 kV cables. A great care was given to identify the location of any samples before analysis (radial and angular positions in the insulating wall of the cables). A preliminary work showed that, within any cable, the XLPE properties can show some anisotropy. Taking into account this anisotropy, the results show that for most investigated properties, the ageing effects are below the intrinsic dispersion of XLPE properties that one can find even in an unaged cable insulation.

Introduction

Polyethylene and XLPE have been used in France and worldwide for decades. However, at that time, no intrinsic ageing mechanism has been clearly identified. The problem of water penetration into the insulation and the associated water treeing phenomena can be avoided by designing lead or aluminium barrier and is therefore not treated in this study. Since the ageing effects of high electric field are not fully understood, one may wonder what are the factors responsible for breakdown that sometimes occurs into cable insulation. A first hypothesis is that both electric field and high temperature are responsible for irreversible changes of the insulating properties of polyethylene and that these changes therefore help in initiating breakdown. As a second hypothesis, it is assumed that local defects (initially present in PE, generated during processing or due to mechanical damage) such as voids or contaminants are the early sites of partial discharges which lead to treeing and as a consequence to breakdown. The first hypothesis only was taken into account and this study consisted in searching changes of the material properties after accelerated ageing tests on prototypes cables, manufactured for this study.

1. Cables samples and ageing accelerated tests

Three ageing factors are generally considered for cable ageing purposes :

-Thermal cycling stresses which in service conditions are mainly due to cable core heating when a high current is requested. During the accelerated ageing tests, thermal cycles consist in an 8 hours long period at 90°C (core temperature), followed by a 16 hours natural decay of the temperature towards room temperature.

-Electrical field stress due to high voltage application.

-Mechanical stresses due to both field (electrostatic attraction between internal and external semiconductor shields and interaction with charged species) and temperature changes (differential thermal expansion values between the different materials of a cable).

In this study, thermal and electric stresses only were applied to XLPE cables but one must keep in mind that mechanical stresses were superimposed during our tests. Nevertheless, this kind of stress was not directly controlled as an ageing parameter during these tests.

Three different 90 kV XLPE insulated prototypes cables, were investigated. All cables are made with a 630 mm² aluminium core and are insulated with an XLPE wall of 10.5 to 12 mm thickness. Their main characteristics as well as the ageing tests performed on these are given in Table 1. One can notice that cables A and B where thermally pretreated at ≈70°C (to remove gaseous by-products after fabrication) and cable C at ≈90°C. Thus, for cable A, thermal ageing at 90°C also leads to a second annealing process at 90°. This is not the case for cable C whose annealing and ageing temperature are the same. Note also that all the cables were submitted to high electric stress (>24 kV/mm at the internal shield-XLPE interface) and this from 4 months long to 13 months long depending on the type of cable.