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An analysis of the water treeing resistance of polymer compounds for cable insulation using the two needle method

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Abstract :
The two needle method – which gives the breakdown voltage of specimens containing a single water tree facing a metal needle used as a breakdown initiation site - was applied to compare cable insulating materials. The ranking is in agreement with that obtained from breakdown voltage measurements in model cables. It is shown, however, that measuring the water tree length and opacity coefficient cannot always give the full picture of the vulnerability of the materials to water tree. It is concluded from the work that a new laboratory method is now available to characterize "water tree resistant" materials.

Résumé :
La méthode des deux aiguilles, qui donne la tension de claquage d'éprouvettes contenant une arborescence d'eau unique faisant face à une aiguille métallique servant de site d'amorçage au claquage, est appliquée à la comparaison de matériaux isolants pour câbles. Le classement des matériaux est le même qu'à partir de la mesure de la tension de claquage de câbles modèles. Il apparaît, en revanche, que la mesure de la longueur des arborescences d'eau et celle de leur coefficient d'opacité ne donnent pas toujours une image complète de la vulnérabilité des matériaux. En conclusion de l'étude, on dispose d'une nouvelle méthode pour caractériser les matériaux « résistant aux arborescences d'eau »

1. Introduction

The work presented in this paper deals with the electrical breakdown of cable insulation materials in presence of water trees. For this purpose, we used a method which takes into account two criteria of selection, the water tree length and the breakdown voltage in the presence of the water tree.
The method is based on the study of the influence of a single water tree on the electrical breakdown of the material. The laboratory model used consists of a water needle – at the tip of which a water tree will be grown – and of a facing metal needle which simulates a conducting defect in the material.
The major part of the results presented in this paper relates to thermoplastic materials because the laboratory specimens are easier to manufacture than crosslinked ones. However, some preliminary results concerning crosslinked materials are also presented. Both series of experiments will be compared with the results obtained using the model cable test described by Land and al. [1] on crosslinked compounds.

2. Experimental part

2.1 The two needle method

The method used refers to the so called "two needle test ". It is based on :
a) the determination of the propagation rate of a single water tree growing from a water needle tip.
b) the enhancement of the electric field at a conducting defect (a metal needle in the model) due to the water tree. When applying an increasing voltage to the specimen an electrical failure of the material will eventually occur. This is characterized by the generation of partial discharges at the metallic needle and the breakdown of the material.

2.1.1 Test geometry

The two needle test specimen consists of two parts as shown in figure 1, a reservoir (1) containing the electrolyte solution and an active part (2), thickness 3 mm, containing two needles distant of 1 mm and perfectly aligned.