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A new test method to evaluate the water treeing resistance of polymers for cable insulation

FILIPPINI C., LEMD CNRS, France
RADU I., LEMD, France
NOTINGHER P., Politehnica University, Bucharest, Romania
CAMPUS A., Borealis Polymers NV, Belgium

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Abstract : The proposed test method is based on the use of laboratory specimens including two needles. One of them is a water needle at the tip of which a water tree will be grown during the ageing stage of the test. The other is a metal needle simulating a material defect at which partial discharges will appear during the breakdown stage of the test. The resistance of the material to water treeing is characterized by the inception voltage of partial discharges and by the breakdown voltage of the specimen. Theoretical and experimental justifications of the method are given.

Résumé : La méthode d'essai proposée est fondée sur l'utilisation d'éprouvettes de laboratoire à deux aiguilles. L'une d'elles est une aiguille d'eau à l'extrémité de laquelle on fera pousser une arborescence d'eau pendant la première phase du test. L'autre est une aiguille métallique simulant un défaut du matériau sur lequel des décharges partielles vont apparaître lors de la deuxième phase. On caractérise la résistance du matériau aux arborescences d'eau par la tension d'apparition des décharges partielles et par la tension de claquage de l'éprouvette. On donne des justifications théoriques et expérimentales.

1. Introduction

Tests on real cables being expensive and time consuming, laboratory tests are usually performed prior to cable tests to evaluate the water tree resistance of materials. Two classes of laboratory tests can be distinguished : (i) tests in uniform or quasi-uniform field geometry with plate-like specimens or miniature cables, in which the essential criterion is the breakdown voltage after ageing ; (ii) tests in divergent field geometry with plates containing sharp, water-filled indentations, so-called water needles, where the criterion is the water tree size after ageing, sometimes combined with the water tree opacity.

A better knowledge of the causes of insulation breakdown induced by water treeing leads us to propose a new method, belonging to the second class of laboratory tests in which the criterion is the breakdown voltage of specimens containing an unique water tree. The new method is based on the remark that breakdown is generally initiated at a defect of the material and that a neighbouring water tree can increase the electric field on the defect, thus triggering the breakdown process. The laboratory model used in the proposed test consists of a water needle – at the tip of which a water tree will be grown – an of a facing metal needle which simulates a defect of the material. In the first part of the paper we examine the breakdown mechanism which our method is based on. The work includes the presentation of the model, theoretical considerations with results of calculations and experimental results supporting the proposed model. The test method is presented in the last part of the work as well as an example of comparison between two materials.

2. Breakdown model

2.1 Origin of water treeing -induced breakdown