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F.1. Effets des radiations UV sur les câbles PE et PR vieillis en milieu humide

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Résumé

Um processus de vieillissement accéléré utilizant le rayonnement UV et une pluie artificielle produite par un "weather-ometer"a été développé pour les câbles recouverts de matériaux isolants.
Des tests mécaniques (dureté Shore A et D) et électriques (facteur de puissance) ont été utilisés pour détecter les modifications de la couverture des câbles.
Les résultats obtenus indiquent un processus de dégradation qui sature à partir d'environ 3000 heures de vieillissement. On peut aussi observer une apparente récupération en surface du matériau vieilli à environ un mois de vieillissement.
Des travaux supplémentaires sont en cours pour étudier ce phénomène et obtenir des modèles pour le processus de vieillissement.

Introduction

Insulating polymeric materials such as polyethylene (PE) and cross-linked polyethylene (XLPE) are being increasingly used for medium voltage power distribution cable network for their low cost, low dielectric constant, desirable mechanical properties and other practical considerations for industrial applications.

A number of experimental work has been done in order to characterise and provide models of solid polymeric material's behaviour submitted to electrical, mechanical and environmental stress [1].

In a tropical country like Brazil these cables are exposed to diverse atmospheric conditions including high humidity, rain, fog, urban pollutant gases, contact with trees and solar radiation (UV).All these adverse conditions produce aging (electrical and mechanical) of these cables.

Particularly, it is known the UV radiation effect on polymeric (plastic and rubber) materials in the presence of oxygen [2]. This effect that increases in humid environment, may lead to their premature failure [3]. As common organic chemical bonds have dissociation energies in the range of the UV radiation, it may be possible to explain the susceptibility to degradation of polymeric materials when exposed to solar radiation.

Studies reported that the exposure of Polyethylene films to the UV radiation in air leads to the uptake of oxygen, formation of carbonyl, hydroxyl and vinyl groups, evolution of acetone, acetaldehyde, water, carbon monoxide and carbon dioxide, increasing brittleness, formation of crosslinks and mechanical failure of the polymer samples. It seems that a competition between chain scission and crosslinking takes place as a result of irradiation on PE in the presence of oxygen. The ratio of scission to crosslinking depends upon oxygen concentration [4].

F.1. Effects of the UV radiation on PE and cross-linked polyethylene (XLPE) cables aged in humid environment

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Abstract

An artificial accelerated aging process for covered cables was developed using UV radiation and artificial rain from a weather-ometer.
Mechanical (Shore A and D Hardness) and electrical (Power Factor) tests were used to detect modifications on the cable's cover.
The results obtained indicate a degradation process that saturates around 3000 hours of aging. It may be observed, also, that there may be a surface recovery of aged material around the first month of aging.
Further work is in progress to study the phenomenon and to provide models for the aging process.

Objective

The objective is to apply accelerated aging process using ultraviolet radiation and artificial rain in an Atlas weather-ometer for different time periods on samples of cables covered with PE and XLPE and to study its effect through mechanical (Shore A and D Hardness) and electrical (Electric Power Factor) tests.

Experimental

The following materials have been investigated:

(i) PE cable (3 phases and 1 neutral), dimensions 2/0 AWG / 67.7mm^2, rating 0.6/1.0kV; aluminium conductor.

(ii) XLPE cable (single phase), dimensions 50mm^2, rating 0.6/1.0kV; copper conductor.

Accelerated aging was generated in a controlled laboratory with the application of UV radiation in humid environment. Following the accelerated aging of the samples, mechanical tests including Hardness Shore A and Shore D were carried out on both the exposed and unexposed areas of the cables. In addition Electrical Power Factor tests at kV were also performed.

In total 200 samples of 100 mm long have been tested. All samples, except the reference materials, were subjected to UV radiation and artificial rain for different time periods, i.e., 216 hrs, 456 hrs, 720 hrs, 1512 hrs, 3546 hrs, and 4623 hrs in an Atlas Weather-Ometer, model CI 65, xenon lamp with approximately 30 w/m2 (± 3) irradiance (340nm) during 120 minutes of continuous irradiation followed by 18 minutes rain at each two hours.

After each time of exposure at least three samples were analysed to establish an acceptable level of repeatability. It was determined Shore A and Shore D hardness with the help of a Microtest 7206-SB Hardness Tester with the correspondent indentation needles, according to the Standard Test Method ASTM D 2240 - 86 [5]. Five measurements in the