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F.6. Emission lumineuse et initiation d'arborescences électriques dans le PRC sous fort champ électrique

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Resumé

Les polymères extrudés utilisés comme isolants dans les câbles haute tension sont le siège de degradation causée par la croissance d'arborescences électriques Ces dernières sont causées par un intense champs électrique local. Durant la phase d'initiation, avant l'apparition de canaux et de décharges partielles, il y a émission de photons par l'isolant. Nous présentons dans ce papier les résultats d'une étude sur l'émission lumineuse dans le PRC. Nous montrons que la quantité de lumière émise est indépendante de la température mais sensible aux gaz dissous dans le polymère.

F.6. Light emission and electrical tree initiation in highly-stressed XLPE cable insulation

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Abstract

Extruded polymers used as insulations for high-voltage cables are susceptible to electrical-tree degradation which initiates at stress enhancements. Light is emitted during the tree-
initiation phase, prior to the formation of channels and partial discharges. This paper presents data on the light emission characteristics for XLPE and shows that the emitted light is independent of temperature but is affected by the gases dissolved in the polymer.

Introduction

Polymers such as low density polyethylene (LDPE) or cross-linked polyethylene (XLPE) are now beginning to be used as insulation for high-voltage transmission-class cables up to 500 kV. Although these materials have excellent electrical properties for cable applications, e.g., low permittitvity, low loss and a high breakdown strength, they are susceptible to electrical ageing when subjected to high electrical stresses [1]. One form of electrical ageing is electrical treeing phenomena originating from local stress enhancements.

Stress enhancements, which can be initiation sites for electrical trees, are considered to be as important as gas-filled cavities for electrical ageing. Possible sources of stress enhancements in extruded cables are protrusions on the semiconducting shield/insulation interfaces or metallic or high permittivity contaminants occluded in the insulation or located at interfaces. Thus, the quality of the interfaces is a very important parameter in determining the electrical performance of extruded cables.

Electrical treeing has 3 phases:

- Initiation phase, i.e. the gradual deterioration of the insulation which occurs prior to channel formation and partial discharges.
- Propagation phase, when the channels initiated at the stress enhancement progress through the insulation due to the action of partial discharges.
- Final breakdown when one or more of the tree channels bridge the insulation and produce insulation failure.

The mechanisms responsible for the deterioration during tree initiation are not clearly understood. The following have been proposed:

- Joule heating [2].
- Impact ionization [3].
- Damage due to hot electrons [4].
- Damage due to ultraviolet (uv) radiation [5].
- Mechanical fatigue due to Maxwell stress [6].

Laboratory studies of tree initiation have usually been performed with metallic needle/plane or needle/needle electrodes to model a stress enhancement. The electrostatic field distribution can be calculated for such a geometry so that observed phenomena can be directly related to the applied