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Cross-linked polyethylene materials for DC power cables

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Résumé

En vue du dévelopement d'un système isolant PRC pour cables à courant continu (CC), une étude importante a été entreprise pour identifier des matériaux minimisant le niveau de charges d'espace lorsqu'exposés à un champ CC. L'importance des couches isolantes et semi-conductrices est démontrée sur base de tests utilisant des échantillons moulés et des cables modèles. Les résultats de cette étude montrent qu'il est possible en modifiant le système d'isolation de réduire d'une façon significative le niveau de charges d'espace dans l'isolant tel qu'observé pour les systèmes PRC utilisés dans les cables de puissance courant alternatif.

Abstract

The paper presents results from a major work to develop peroxide cross-linked polyethylene material systems with improved space charge behavior under DC stress. The importance of both the insulating and semiconductive materials is demonstrated using press moulded plaques and model cables. It is shown that modifications of the materials make it possible to very significantly reduce the space charge accumulation normally associated with XLPE material systems for AC power cable applications.

1. Introduction

Polymeric cables have to a great extent replaced fluid-filled cables in AC distribution and partly in AC transmission systems up to 500 kV. The situation is different in HVDC transmission systems since initial tests with polymeric cables were not successful due to build-up of space charges in the insulation. However, the work to find polymeric alternatives has been intensified with the introduction of new techniques for determination of space charge distribution in dielectrics.

This paper presents results from an on-going project to develop polyethylene-based HVDC materials. The DC electrical properties of the new materials are compared to those of present XLPE products for AC applications. The properties of the new materials allow production of peroxide cross-linked HVDC cables on conventional extrusion lines [1]. The work is in this paper focused on the space charge accumulation which is one main factor regarding DC insulation.

A PEA (Pulsed Electro Acoustic) system has been used to study the space charge accumulation in cross-linked plaques and cables. The space charge accumulation has been measured under a number of conditions in order to identify possible weaknesses. Additional knowledge has been obtained by measurements of electric conductivity on thin plaques.

The work has shown that both the insulating and semiconductive layers are influencing the space charge build-up. A new material system showing very insignificant space charge accumulation has been developed and is currently being evaluated using various DC cable designs.

2. Materials

The paper covers results obtained with three insulating materials (A, B and C) and three semiconductive compounds (1, 2 and 3).

The insulating compounds A, B and C are all peroxide crosslinkable materials based on high pressure polyethylene resin. A is a standard XLPE grade used for AC distribution and transmission systems, while B and C are new compounds with improved properties.

The semiconductive material 1 is, in the same way, a standard carbon black-based grade for conductor and insulating shielding of AC power cables. Compounds 2 and 3 are new materials that have been identified as potential candidates for HVDC polymeric power cables.

The non-electrical properties of all these materials allow production of peroxide cross-linked cables on conventional extrusion lines.