C5.7

Polymer modified XLPE as insulation in power cables

NILSSON U.H., CAMPUS A., Borealis AB, Stenungsund, Sweden
MONTANARI G.C., University of Bologna, Italy

Résumé
Les PRC modifiés par l'adjonction de copolymères furent introduits dans les années 80 comme isolants de câbles d'énergie. Leur dévelopement a été motivé par le besoin d'améliorer la résistance aux arborescences d'eau du PRC sur base PEBD. Cet article résume les résultats de tests de vieillissement sous champ électrique de ces matériaux sous forme d'échantillons moulés et sur câbles en milieu sec et en présence d'eau. L'accent de cette revue est mis particulièrement sur la résistance aux arborescences d'eau des câbles moyenne tension.

Abstract
Polymer modified crosslinkable polyethylene compounds for power cable insulation were introduced in the 1980's. The reason was their improved resistance to water tree degradation in comparison to low density polyethylene homopolymers. The paper intends to review results from ageing tests of cables and pressmoulded specimens performed in wet and dry surroundings under high electric stress. The emphasis is however on long-term accelerated water treeing tests of medium voltage cables.

1. Introduction

Degradation of polymeric insulation due to water treeing was identified in the early 1970's. Concern for the long-term performance lead to the introduction, in the beginning of the 1980's, of polymer modified crosslinkable polyethylene (XLPE) materials with improved resistance to water treeing. They are blends of polyethylene homopolymer and an EEA (Ethylene ethyl acrylate) or EBA (Ethylene butyl acrylate) copolymer. Since the introduction in Germany, these materials have gained broad acceptance in various countries for fully bonded cable constructions.

This paper will present a summary of laboratory and field experience of these copolymers. Numerous ageing tests involving both pressmoulded specimens, model and full-sized cables have proven the long-life performance of the compounds. The tests include accelerated wet ageing tests of medium voltage cables according to both American and European specifications.

2. Material composition

The materials discussed in this paper are mechanically mixed blends of low density polyethylene homopolymer (LDPE) and EEA or EBA copolymer. An antioxidant is added for stabilisation and the materials are made crosslinkable with the addition of peroxide. In the following these compounds are referred to as XLPE-C in comparison to XLPE-H for the compounds based on LDPE homopolymer.

The morphology of the XLPE-C materials shows a biphasic structure with LDPE as a matrix and the copolymer as a dispersed phase. The copolymer domains are about 0.5 μm in size. The morphology is described in more detail by Nilsson et al [1].

3. Wet ageing properties

3.1 Ageing of short cable samples

The growth of bow-tie trees has been evaluated using short 15 kV cable samples that have been aged at 5 kV/mm for 3000 hours. Tap water was introduced in the cable conductor and the temperature was kept at 90°C for 8 hours each day. After the ageing, the size distribution of the bow-tie trees in the insulation were determined.

Figure 1 compares a standard homopolymer XLPE-H with copolymer XLPE-C. It is evident that the bow-tie trees are significantly fewer and shorter in the copolymer. The longest bow-tie trees were in the range 50-100 μm and 150-200 μm for the XLPE-C and the homopolymer XLPE-H, respectively.