95 jicable

B.9.1. Les limites des études de vieillissement sur le polyéthylène

DUCHATEAU F. & Co-auteurs,
EDF/DER/ERMEL, Moret-sur-Loing,
France

Résumé

Au cours des années quatre vingts, plusieurs modèles de vieillissement des isolants polyéthylènes de câbles HT/THT basés sur l'évolution des propriétés physico-chimiques du polyéthylène ou la méthode statistique de Weibull ont été proposés. Quelques auteurs ont fait l'hypothèse d'un seuil du champ électrique entraînant un vieillissement irréversible du matériau situé au voisinage de 10-20 kV/mm. Les câbles à isolation synthétique installés en France étant portés à un champ électrique pouvant atteindre 16 kV/mm, un groupe de travail français comprenant des fournisseurs de polyéthylène, des constructeurs de câbles et EDF travaille depuis plusieurs années sur la recherche expériementale d'un traceur du vieillissement intrinsèque des isolants polyéthylènes de câbles HT/THT avec l'objectif de confirmer la validité des hypothéses avancées sur l'existence d'un seuil

Une étude de vieillissement a ensuite été réalisée sur le matériau de base polyéthylène dont le seul additif présent était l'antioxydant, les films de polyéthylène neufs et vieillis étant caractérisés durant le vieillissement.

B.9.1. The limits of an ageing study on polyethylene material

DUCHATEAU F. & Co-authors,
EDF/DER/ERMEL, Moret-sur-Loing,
France

Abstract

In the 80's, several ageing models on high voltage polyethylene (PE) insulation cables based on the evolution of physical and chemical properties of polyethylene or the Weibull statistics method were proposed. Several authors made the hypothesis that the electrical field threshold leading to an irreversible ageing was around 10-20 kV/mm. In France, the electrical field applied to on-line cables can reach 16 kV/mm; a french working group including polyethylene and cable manufacturers and EDF have been carrying out experimental research on the intrinsic ageing tracers of HV/EHV PE insulated cables for several years; the objective was to confirm the validity of the threshold hypothesis.

An ageing study was carried out on the polyethylene raw material in which the only additive was the antioxidant. The fresh and aged polyethylene films were characterized during the ageing step.

1-Introduction

The available evidence suggests that the solid dielectrics used in power cables do not show significant changes in electrical properties as a result of thermal, electrical or chemical ageing, when the influence of partial discharges or the presence of water are excluded [1]. Potential ageing factors can be categorized as either *intrinsic*, those due to physical or chemical changes of the insulation or *extrinsic*, the others. The objective of the study on polyethylene was first to detect any evolution of the intrinsic properties after a thermomechanical ageing, then to initiate the reflexion on mechanisms that could govern the degradation phenomena in extruded insulation cables. First, we carried out the development of analytical methods including electrical, morphological and chemical content : short time dielectric breakdown, Differential Scanning Calorimetry, infrared spectroscopy and moisture measurement [2]. In a second step, polyethylene films have been aged between Rogowski electrodes at room temperature and at 70 °C. The applied fields was in the range 20 kV/mm - 40 kV/mm AC for several thousand hours. Both new and aged materials were submitted to AC breakdown test to check any loss of the dielectric strength.

2-Theorical models on polyethylene ageing

The ageing mechanisms of extruded transmission cables are not fully understood. The features of intrinsic ageing are the following ones :

-Chemical effects such as oxidation and hydrolysis mechanisms;

-Physical effects such as recrystallisation and secondary crystallisation, charge transport and charge trapping.

In fact, both can interact.

Several authors have proposed multistress ageing models either based on the inverse power law for electrical ageing, or Arrhenius law for thermal ageing or Eyring theory for electrical, thermal and mechanical stresses [3] [4] [5] [6] [7].