STUDY OF THERMALLY AND WATER TREE AGED POLYETHYLENE BY INFRARED SPECTROSCOPY, ABSORPTION CURRENTS AND SPACE CHARGE MEASUREMENTS

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ABSTRACT

The paper deals with thermal and water tree ageing of polyethylene insulation used for medium voltage cables. Laboratory-made flat polyethylene samples have been aged thermally and under the effect of water and ac electric field, at high frequency (5 kHz). Absorption/resorption currents and infrared spectroscopy measurements have been performed before and after ageing. The evolution of the electric charge trapped in the water treed samples has also been monitored. The results are analyzed in view of correlating the water tree ageing of the materials with the evolution of the electric charge in the insulation, in order to elaborate a non destructive methodology for estimating the treeing degree of a cable.

KEYWORDS

Power cable – Ageing – Water tree – Space charge – Absorption currents

INTRODUCTION

Power cable insulations are submitted during service to permanent and accidental stresses (electrical, thermal, mechanical, water, radiations etc.). Under the effect of these stresses, the insulations suffer different degradation processes, which lead both to the decrease of physical properties and to the reduction of lifetime [1]. As heat, oxygen and moisture are considered as main ageing agents, heat-resistant (cross-linked) polyethylene, oxygen-resistant polyethylene (with anti-oxidants) and water-tree resistant polyethylene (containing water-tree retardants) have been manufactured [2-3]. Moreover, the cable manufacturers provide the cables with barriers against moisture and water trees. However, most of the operating medium voltage cables are not equipped with barrier against water penetration, and their insulations do not contain water tree retardants. Tests allowing to detect the water trees' presence in cable insulation and to estimate the insulation ageing state and the remaining life are therefore needed. Several methods, from which ones are already used whilst the others are still being experimented, have been proposed for this purpose [4-6].
The present work is concerned with experiments carried out for analyzing the water tree growth in unaged and thermally aged low density polyethylene samples, which have also been characterized by infrared spectroscopy, space charge measurement and absorption / resorption currents. The aim is to follow the modification of the values of space charge and of the absorption/resorption currents in the water treed polyethylene samples in view of using these results for assessing the state of cable insulation.

EXPERIMENTAL SET UP

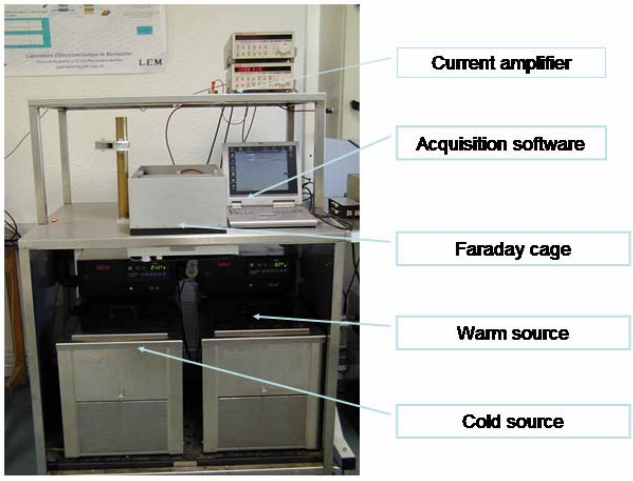

Figure 1 : Thermal step method bench for space charge measurements in flat samples [7]

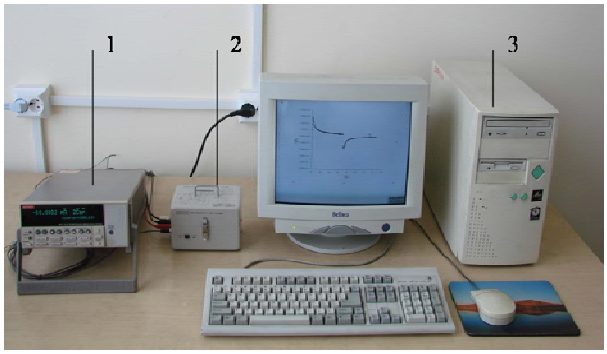

Figure 2 : Experimental set up for measuring absorption/resorption currents : 1- Keitlhey 6517 electrometer, 2- Keithley 8009 measurement cell, 3- computer.

Squared plaques with a surface of 150x150 mm^2 and of thickness d = 0.5 mm have been manufactured from low density polyethylene pellets by pressmoulding at 200 bars, 145°C. The plaques have been submitted to a first thermal conditioning at 50°C during 2 days, then disks with a diameter D = 60 mm have been cut from the plaques. Then, the disks have been provided with graphite electrodes (with a diameter of 50 mm) and subjected to space charge and absorption/resorption currents measurements. The space charge measurements were performed with the thermal step