E.3. Mesure des charges d'espace dans des câbles HT et THT à isolation PR soumis à des vieillissements sous fort gradient

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Résumé:

L'étude du vieillissement consiste, en autre, à suivre l'évolution des propriétés électriques du câble qui pourrait se traduire par une perte des performances du matériel sur site. La mise en évidence des effets du vieillissement a été réalisée par des mesures de charges d'espace. Dans le cadre de cette étude, nous avons poussé à un fort gradient, 27 kV/mm pendant 3000 heures, un échantillon de câble afin de simuler une contrainte équivalente à plusieurs années de mise en service. La comparaison avec un échantillon non vieilli nous a permis de quantifier la variation des propriétés diélectriques en fonction du vieillissement. L'étude radialement et angulairement du polyéthylène dans le câble, nous a permis ensuite de montrer le comportement particulier de certaines zones de l'isolation morphologiquement différentes.

E.3. Space charge measurement of HV and EHV XLPE cables submitted to ageing under high stress

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Abstract

The ageing study can consist to follow the evolution of electrical parameters of the cable. This evolution could be a falling of intrinsic properties of the insulation and lead to lost of performance of the cable in situ.

We choose to study this evolution by the space charge measurement on two samples of HV cable : the first one was aged under an electrical stress of 27 kV/mm during 3000 hours, the second one was unaged. The study of radial and angular share in the aged sample permitted to show a particular behaviour of certain morphologically different part of the insulation.

I. Introduction:

The electric characterization of insulating material show these last years the development of different methods allowing to give remaining space charges distributions[1,2,3]. This information characterizes the electric comportment of the synthetic insulation and permits their improvement. Since 1987, a collaboration between Cables Pirelli and the Laboratoire d'Electrotechnique de Montpellier (LEM) lead to perfect a non destructive method, "the Thermal Step Method", by many validations [4] and optimizations [5]. We use this tool to determine the origin of these charges, to explain by theoretical models their kinetic [6], and to relate special investigation on cable making [7] as we show in this paper. An apparatus has been developed to make measurement in cylindrical samples like cables. In this new system, it is possible to create a thermal gradient from the outer or from the inner conductor. We proceed to a comparative study of two identical HV cables. One has been aged by an high electric stress 27 kV/mm during 3000 hours. After, in order to characterize the homogeneity of the extruded cable insulation, we use the thermal step method to observe the insulation ageing of particular zones.

II. Experimental procedure :

The principle of the thermal step method has been already described in many papers [4,5]. In the case of the cable, two types of stimuli can be created: external cooling or internal heating. The difference is in the form of the temperature gradient. In the first case the stimulus is a thermal step (from 20°C to -25°C) which keeps the reached temperature constant during the measurement. The second case is a thermal wave created by the circulation of an high current in the conductor before the start of the measurement. So, we play with the time of heating to explore all the insulator thickness [8]. The experience is described in figure 1. After the acquisition of the current inherent of the variation of dilatation and permittivity by the thermal wave, we proceed to the deconvolution of the current to obtain the distributions of the electric field and the space charges distributions.

III. Results:

III.1. Comparatives measurements in aged and non aged cables :

We take from an aged HV cable of (3000 hours, 27 kV/mm and temperature cycling) a sample named "A". On an other identical HV cable, non aged, we take a sample named "B". After about 6 months without stress, the samples have a very low level of space charges. In order to compare them we proceed to an heating at 80°C during 12 hours in short-circuit.

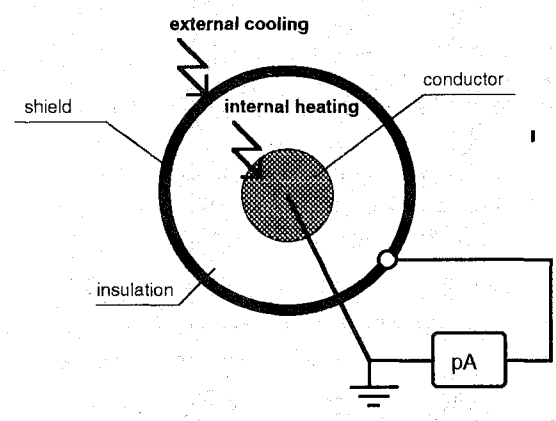

Figure 1 : Experimental scheme

Then after controlling the absence of charges, we submit them to identical stress (60 kV DC, 70°C, 20 hours) and we measure space charges. As we can observe in figure 2, the distributions of space charges of the sample "A" show a greater injection at the cathode (external semiconductor). This injection induced an higher level of residual electric field (8kV/mm). . The differences of the two distributions are not important enough to conclude with an irreversible damage of the cable "A". After these first considerations, we proceed to a partial heating at 70°C during 1 hour , and after during 2 hours more. Like this we can observed the different kinetic of the charge in the sample "A" and "B". In figure 3 and figure 4, we see that the two distributions of space charges are very closed. This fact could be proved that the differences with the first space charges distribution (fig 1) are due to creation of low energy levels traps because these charges disappear after at "low temperature" 70°C.