Investigation of temperature dependence of dc diagnostic tests on LV PVC insulated cables

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ABSTRACT

In this study, the conductive and polarisation processes were investigated by voltage response measurement because this technique enables to examine the conductive and polarisation processes separately. The measurements were carried out on new and thermally aged LV PVC insulated cable samples and the temperature dependence of conductive and polarisation processes were investigated. Comparing the results of the measurements on new and aged cables more precise temperature correction factors are recommended for dc diagnostic tests.

KEYWORDS

polyvinyl chloride, voltage response, temperature correction, dielectric processes, conductivity, polarisation conductivity, thermal degradation, correction factor

INTRODUCTION

The temperature dependence of the insulation resistance measurement on PVC insulated cables is well known. Several standards and recommendations describe this relationship and provide correction factors to normalize the results of measurements at different temperatures. The insulation resistance test measures the sum of the currents of conductive and polarisation processes therefore these temperature correction factors characterize the sum of these two processes.

Previous studies have revealed that the temperature dependence of conductive and polarisation processes are different and they are also dependent on the thermal degradation of the PVC insulation **Erreur ! Source du renvoi introuvable.**, **Erreur ! Source du renvoi introuvable.**. The results of previous studies suggest that the temperature correction factors are not independent of the degradation of insulation therefore the correction factors cannot be used for all cases.
The aim of this study is to recommend more precise temperature correction factors for dc diagnostic tests.

VOLTAGE RESPONSE METHOD

The voltage response method enables to separate the investigation of conductive and slow polarisation processes, furthermore to distinguish polarisations by time constant from 1s to 1000s or more. To achieve this, decay and return voltages are used.
The timing diagram of the measurement can be seen in Fig. 1. After long duration charging (t_{ch}) with dc voltage (V_{ch}) and disconnecting the voltage source from the insulation decay voltage ($V_d(t)$) can be measured in insulations. In case of lossless voltmeter usage, the decay voltage curve shows self-discharging process of insulation.
When the insulation is charged, after few seconds of short-circuiting (t_{dch}) the return voltage ($V_r(t)$) can be measured. To investigate polarisations in higher time constant range this measuring algorithm is repeated with increased discharging times (t_{dch}).

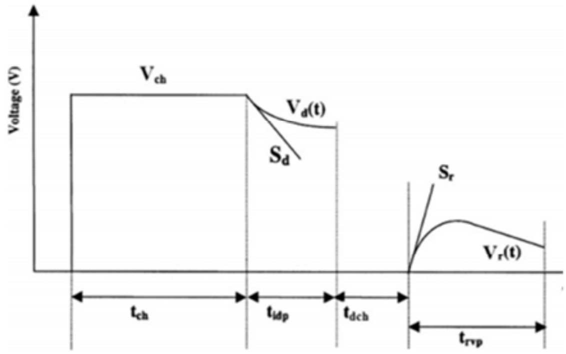

Fig. 1.: Timing diagram of voltage response method

The decay ($V_d(t)$) and return ($V_r(t)$) voltages are measured so as to determine the initial slopes of the decay (S_d) and return (S_r) voltages. Researches have revealed that the initial slope of the decay voltage is directly proportional to the conductivity of the insulation material and the initial slope of the return voltage is directly proportional to the polarisation conductivity of the material **Erreur ! Source du renvoi introuvable.**, **Erreur ! Source du renvoi introuvable.**, **Erreur ! Source du renvoi introuvable.**. Hence:

$$S_d = \sigma V / \varepsilon \qquad [1]$$

$$S_r = \beta V / \varepsilon \qquad [2]$$

where V is the measuring voltage, σ is the conductivity, β is the polarisation conductivity and ε is the permittivity of the material.

A considerable advantage is that the S_d and S_r values are independent of any properties of the insulation hence these values are independent of the volume or the shape of the insulation.

SAMPLES AND MEASUREMENT

The laboratory test were carried out in three different low voltage (0.6/1 kV) cables which were prepared from one three-core cable specimen. Three solid aluminium conductors of cable are covered by core insulations, which were prepared from coloured PVC material. The cables have blue, red and white cores and split neutral conductors. This structure is coated by a PVC jacket. Each cable specimen was two meters long.

To open the door to examine the dielectric properties in various degradation levels a 900-hour-long thermal ageing process was carried out. The temperature of the ageing process was 110°C. Voltage response measurements were carried out before and after ageing