B5.6

The return voltage method, a diagnostic tool to assess water tree damage in PE- and XLPE cables, and the experiences from the method in Romania

KAMENKA D., Hagenuk KMT, Radeburg, Germany
PISPIRIS C, Icemenerg SA, Bucarest, Romania

Abstract
For an ideal cable the maximum return voltage is a linear function on charge voltage. The non-linearity observed gives a good indication of the aging/ damaging condition of a PE/XLPE cable. The form and maximum of return voltage curves allow to clearly distinguish different effects like water in the cable, water in the joints or polluted terminals which is a diagnosis of dielectric and of the complete system of laid cable.
This is illustrated by measurements carried out in-situ and in laboratory in Romania on XLPE as well as paper and oil-insulated cables.

Résumé
Pour un câble idéal le maximum du voltage de retour est une fonction linéaire de chargement. La non-linéarité observée donne une bonne indication d'état du câble PE / VPE. La forme et le maximum du voltage de retour permettent de distinguer les effets d'eaux dans le câble, d'eaux dans les jonctions ou extrémités sales et donc de diagnostiquer le diélectrique et le système de câble posé.
Ces résultats sont illustrés par des mesures faites in situ et en laboratoire en Roumanie par des câbles PE/ VPE et des câbles isolés à papier.

Introduction

The aging and damaging conditions in PE and XLPE cables are especially characterized by growth of water trees in the dielectric. These water trees according to their number and characteristics result in a typical dimension and slope of return voltage curve as a function of time. Therefore this curve can be used as a characteristic to evaluate aging and damaging condition of PE and XLPE cables. The procedure is described in the part 1, chapters 1 to 4. In part 2, chapters 5 and 6, experiences from applying this method in Romania are described.

1. Equivalent Circuit and Basic Principal

The cable can be represented by a simplified equivalent circuit diagram (figure 1), in which Ri is the insulation resistance of the solid dielectric and Cc the capacitive resistance of the cable. Cp and Rp are simplified representations of polar components within the solid dielectric. It has been established that in service aged XLPE cables the polar components in service aged XLPE cables are directly related to the presence of water trees in the solid dielectric. R-C combinations, which represent water trees from an equivalent circuit point of view, have different time constants depending on the progression of the water tree.

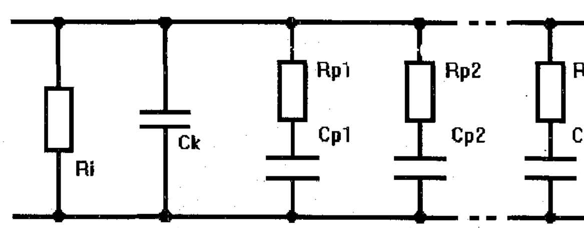

Figure 1. Cable: Simplified Equivalent Circuit

The cable is charged for several minutes by applying a DC high voltage. This step is followed by a "soft" discharge via a resistor for several seconds. During the third step the return voltage is measured, which results from the discharge of the polar components (figure 2). The shape of the return voltage curve is characterized by the different time constants.
Each three-step cycle - charging, discharging, measurements - is repeated at four different charging voltage levels, 0.5Uo, 1.0Uo, 1.5Uo,