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Condition assessment of triple extruded MV XLPE cables

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Abstract: Water tree degradation of service aged XLPE cables can be detected by measurements of the dielectric response of the insulation. Results from such measurements on triple extruded XLPE cables show that a high sensitivity of the measuring equipment is needed to detect the few and long water trees. Some types of cable joints installed on these cables can give a response as that observed for water trees bridging the insulation.

Keywords: XLPE-Cables, Condition Assessment, Water Treeing, Cable Accessories.

Résumé: Les dégradations par arborescences électrochimiques dans le PRC vieilli en service peuvent être détectées par la mesure de la réponse diélectrique de l'isolation. Les résultats d'une telle mesure effectuée sur des câbles PRC triple extrusion montrent qu'un équipement de mesure de haute sensibilité est nécessaire pour détecter les quelques et longues arborescences. Des jonctions installées sur ces câbles peuvent donner une réponse semblable à celle d'arborescences électrochimiques pontant l'isolation.

Mots clés: XLPE câbles, évaluation conditionnelle, arborescences d'eau, accessoires de câbles.

1. Introduction

Condition assessment of XLPE-cables is becoming increasingly important for the utilities, due to a large number of old cables in service with high probability of failure caused by water tree degradation. The commercial available diagnostic techniques for detection of water tree degradation are generally based upon measurements of the dielectric response, either by measurements in the time or frequency domain [1]. The main purpose of this paper is to present results from diagnostic measurements on water treed XLPE cables with few water trees with different lengths.

2. Experimental methods

2.1 Description of the test samples.

The examined XLPE cables had been in service for approximately 20 years (see table 1). All cables were equipped with strippable insulation screens. The cables were removed from service and the diagnostic testing was performed in the laboratory. After diagnostic testing, the cables were AC breakdown tested, and samples were examined for degree of water treeing by microscopy analysis.

Table 1: Description of the cables

Cable No.	Conductor cross-section [mm^2]	Cable length [m]	Operating voltage [kV]	Year of installation
1	95	140	24	1985
2	240	127	12	1983
3	240	100	12	1980

A heat shrink joint with resistive field grading layer were installed on Cable 2.

2.2 Non-Destructive Testing

Non-destructive testing was performed by measuring the dielectric response in frequency domain, using a method based on measurements of capacitance and dielectric loss tangent (tan δ) in the frequency range from 1 to 0,1 Hz, and voltages up to 2 U_0 [1,3]. In addition time domain dielectric response measurements (polarisation currents) were performed using a DC insulation tester (Megger BM 5010), with a maximum output voltage of 5 kV DC and a current detection limit of 0,1 nA.

2.3 Destructive Testing

After dielectric response measurements of the cables, they were cut into sections of 25 meters. Electric breakdown testing was performed by an AC step test until breakdown occurred. The step test was performed by applying U_o for 5 minutes and subsequently every fifth minute, the voltage was increased by U_o until breakdown occurred ("U_o" is defined as the system voltage divided by $\sqrt{3}$ according to IEC 60 183).

Water tree analysis was performed by microscopy analysis of 0,5mm thick microtomed slices, stained in methylene blue dye solution. In each slice the length of the longest tree was recorded.