# 3 kHz ACCELERATED GROWTH OF WATER TREES IN MEDIUM VOLTAGE EXTRUDED CABLES

Blandine **HENNUY**, Quentin **DE CLERCK**, Laborelec, (Belgium),
blandine.hennuy@laborelec.com, quentin.declerck@laborelec.com

Alain **FRANCOIS**, Daniel **TENRET**, Ores, (Belgium), alain.francois@ores.net, daniel.tenret@ores.net

Pieter **LEEMANS**, Joachim **MARGINET**, Eandis, (Belgium), pieter.leemans@eandis.be, joachim.marginet@eandis.be

## ABSTRACT

*This paper describes results obtained with a pragmatic method to assess the resistance of medium voltage polymeric cable insulation to water treeing. Water trees (WT) are produced in 14 days in the polyethylene insulation of commercial cable samples by use of a high frequency, high voltage power supply. This method can be used to provide information for asset management and also to check the quality of new cables. A comparison with the 50 Hz (2 years) and 500 Hz (4 months) test for some new cables demonstrates the possible application of the method to a pre-qualification test.*

## INTRODUCTION

The initial objective of the method was to provide information on the remaining lifetime of old cables for asset managers who still have to manage many kilometres of first generation XLPE cables. In order to evaluate the resistance of old cables to water treeing, Laborelec decided to perform accelerated ageing test on cable samples immersed in salt water using a high frequency, high voltage power amplifier. After 14 days the examination of dyed slices allows the assessment of the resistance of real cables to water treeing.

Rapidly the use of this method to assess new cable samples was investigated and it appeared that the test can also be interesting to compare different materials taking into account the manufacturing process. Cables from different origins were tested with sometimes surprising results.

This paper presents the results obtained with the method e.g. a comparison for some new samples with the 50 Hz (2 years) and the 500 Hz (4 months) tests both carried at 3 $U_0$ and 40 ℃, the influence of the type of insulation material and of the impurity content on the water trees growth and the possible use of the test for pre-qualification test or in the framework of a more global quality check of new cables.

## CONTEXT

Water treeing is one of the major causes of premature failure of polyethylene cables. By increasing the insulation losses water treeing can initiate in some cases electrical trees (Figure 1) that lead to breakdown. The water tree issue is considered by most people as solved and indeed due to improvements in the design, the manufacturing process and the insulation compound the growth of water trees in new cables is drastically reduced. Presently two types of water tree retardant insulation material are largely used and are known as copolymer insulation (in fact a mechanical blend of Low Densisty PolyEthylene and ethylene acrylate copolymer) and homopolymer insulation with water tree retardant additives (high molecular weight polymer added in small quantity (< 1%)). Nevertheless the phenomenon of WT growth is not yet fully understood, mostly because of the large number of influencing parameters as voltage stress, frequency, availability of water, presence of contaminants, polymer structure and temperature. Nowadays, unfortunately neither theoretical nor practical models integrating all those parameters are accessible. In order to guarantee a minimum resistance to water treeing, long duration tests are performed during the qualification of new cable designs. The most widespread of these tests is performed at 50 Hz during 2 years (3 $U_0$;40 ℃). The very long duration of this test emphasizes the utility of a test delivering equivalent information in only 14 days.

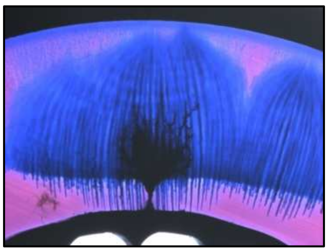

**Figure 1: electrical tree**

## TEST SET-UP

## Description

In order to perform an accelerated test we apply high frequency and high voltage to the insulation placed in a salt solution (Figure 2).

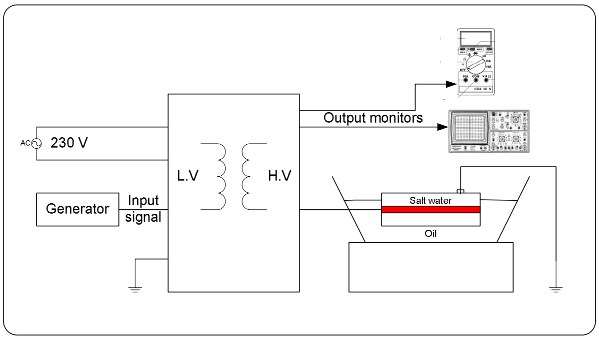


**Figure 2: principle of the test**

The experimental set-up consists in a 30 kV, 5 kHz, 40 mA power amplifier (Figure 3) and a cell containing salt solution immersed in a thermo-regulated oil bath (Figure 4) to avoid any electrical discharge at the connection of the high voltage lead.

**Figure 3: power amplifier**

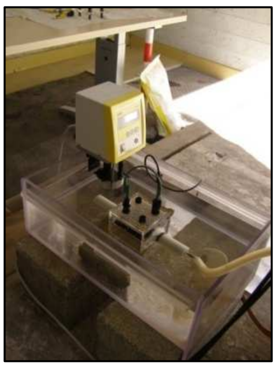

**Figure 4: cable sample in salt water during testing**