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#### Study of the effects of the temperature modulation on the lifetime of HV XLPE cables

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**Abstract :** Ageing at constant temperature does not simulate cable operation, since cables are subjected to thermal cycles. Results obtained in 1999 on a 400 kV cable aged at IREQ (Canada) under heat cycles show clearly that this cable has a different behaviour from cables aged recently under constant temperature. In fact, thermal cycles seem to be beneficial to improve cable lifetime, but this aspect remains challenging to be quantified nowadays. The objective of this study is to examine the ranges of temperatures which on the one hand promote the accumulation of space charge which can lead to a potential decrease of the cable lifetime, and on the other hand those ones where space charges release (evacuation) is favoured. It appears that the effect of temperature is very complex, and its consequences for the material are not all unfavourable.

**Keywords :** alternative current, ageing, cables, space charges, thermal cycles;

#### 1. Introduction

Generally, ageing tests on cable systems are mainly cycles to assess the thermal-mechanical aspects. Load cycles are also encountered in the grids. Consequently, existing ageing models (using constant temperature tests) are not representative of reality, as they don't take into account the cycling phenomenon.

J.P. Crine reports that the electrical ageing of polymers under dry conditions is still poorly understood although it has a major influence on the lifetime of extruded dielectric transmission cables [1]. In the perspective of this EPRI report, two questions concern the subject of cable ageing in order to advice at best the operator.

What is the role of polymer morphology under constant and cyclic temperature regimes ?

**Résumé :** Le vieillissement à température constante ne reflète pas le fonctionnement d'un câble en service car les câbles sont soumis à des fluctuations de température. Les résultats obtenus en 1999 pour un câble de 400 kV vieilli à l'IREQ (Canada) avec des cycles thermiques montrent clairement que le câble vieilli a un comportement différent de celui vieilli à température constante. En fait, les cycles thermiques semblent être bénéfiques pour améliorer la durée de vie. Mais la quantification de cet effet est un défi qui demanderait à être quantifiée. L'objectif de cette étude est d'examiner les gammes de températures qui d'un côté favorisent l'accumulation des charges d'espace qui peuvent conduire potentiellement à une diminution de la durée de vie et qui d'un autre côté favorisent leur l'évacuation. L'effet de la température est très complexe et leurs conséquences pour le matériau ne sont pas toujours défavorables.

**Mots clés :** courant alternatif, vieillissement, câble, charges d'espace, cycles thermiques

Morphological measurements performed on well-controlled samples before and after ageing would further improve the ageing model.

How significant are accelerated ageing tests performed at a constant temperature ?

While such tests are useful for comparative purposes, their ability to simulate actual ageing under service conditions with load cycles remains questionable.

Results obtained in 1999 on a 400 kV cable aged at IREQ (Canada) under heat cycles show clearly that this cable has a different behaviour from cables aged recently under constant temperature [1].

It is stated that during the lifetime of an AC cable, space charges may be generated and trapped in an insulation and could influence modifications/ ageing of the product. According to recent investigations with a sensitive space charge measurement method,