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Quick method for direct measurements of all important parameters concerning water transport and diffusion in XLPE cables

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Résumé :

Un Cryotome rotatif a été développé pour l'analyse de l'isolation polyéthylène réticulé (PR) de câble. Le Cryotome a été utilisé pour faire des profits de concentration de l'eau dans l'isolation PR de câbles de moyenne tension. De petites sections de câble sont exposées à l'eau trié (eau radioactive) à 50°C pendant une période décidée à l'avance. A cause de la haute sensibilité de l'analyse de détection de l'isotope tritium une période d'exposition typique peut être aussi courte que 3 heures. Les profils de concentration de l'eau triée sont mesurés à –30°C en utilisant la méthode « DSAC » dans un Cryotome rotatif. L'épaisseur des tranches peut être variée. Cette méthode permet d'obtenir très rapidement les paramètres importants suivants en tout point de l'isolation :

- Coefficient de Diffusion (D)
- Solubilité (Cs)
- Coefficient de Perméabilité (P)
- Vitesse de Perméabilité Radiale (J)

Comparé avec l'essai d'imprégnation directe, la méthode « DSAC » donne plus d'information et des résultats exacts 10 à 50 fois plus vite. Des exemples pratiques sont présentés.

Abstract:

A newly developed **Rotational Cryotome** specially designed for cable analysis. is used for measuring **Concentration Profiles of water inside the insulation** polymer of extruded medium voltage cables. Small sections of the insulation are exposed for traceable (tritiated) water at 50° C for a preselected period. Due to the high sensitivity of the detection analysis for tritium a **typical exposure period can be as short as 3 hours**. Here after the samples are cooled to -30°C or lower. Concentration profiles for traceable water are measured at the low temperature using **Depth Slice Analysis Cryotomy (DSAC) in the Rotational Cryotome.** The slicing thickness can be varied.
By the DSAC method the following important parameters can be achieved very rapidly at any point inside the insulation:

- Diffusion Coefficient, (D).
- Saturation Concentration, (Cs).
- The Permeability Coefficient, (P).
- The Radial Permeation Rate, (J). Equal to the radial water tightness.

Compared to Direct Permeation testing, the DSAC method gives much more information and produce accurate results 10 to 50 times faster. Applicational examples are shown.

Introduction.

The presence and movements of water molecules inside any kind of insulation are believed (and to a certain extend proved) to exert great negative influence on the dielectric functionality of especially medium voltage (MV) cables.

Too many km of MV-cables have had an unacceptable short life time in service and it is generally believed that the causes to most malfunctions is troubles with water inside the insulation. Thus minimizing the concentration of water in the extruded type insulation will considerately prolong the life time for MV-cables. Metal foils or metallized tapes wrapped around the cable core do as a fact reduce the intrusion of water considerately leaving the lapped, bonded part of the foil/tape as the only area open for diffusion of water into the insulation.
It is evident that water content and transport in and not least out of extruded polymeric insulation materials are very essential to measure for the control and design of cables.
The aim of this paper is to present a quick and accurate method (DSAC) measuring all the essential parameters concerning water transport and content in polymeric insulation materials and bonded overlaps. The method gives results in a very short time. Conventional permeation tests on a good unprotected MV-cable will take at least 10 days (240 hours) at 50° C before a steady state permeation rate can be deduced. Using this method results are obtained after only 3 hours. Time reduction: 80 times. The DSAC method also works on bonded overlaps.