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Diagnosis on power cables for determination of remaining lifetime : Experiences with oscillating wave test

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Abstract

Currently there are various methods in discussion for the diagnosis of medium voltage cables regarding the ageing status and the remaining life-time. Most frequent measurements are performed on an integral basis, that means, that the general overall condition of the cable's insulation is determined. These results in general are not very precise. The disadvantage of most of these methods is, that even major singular defects are not detected. Diagnosis on integral basis with cable circuits consisting of different types of cables is in most of the cases impossible.
The Oscillating Wave Test is based on PD measurement, thus in general a detection of singular defects is possible.
In order to obtain more experience with this method and for further development, an experimental setup in the lab was made. Experiments are ongoing.

Résumé

On présente différentes méthodes pour établir un diagnostic des câbles à moyenne tension en ce qui concerne leur état de vieillissement et durée résiduelle de vie. La plupart des mesures sont faites à base intégrale. Ce qui veut dire que l'état général de l'isolation du câble est défini. Les résultats ont montré qu'ils ne sont pas très précis. Le désavantage de la plupart de ces méthodes est que même des plus grands défauts singuliers ne sont pas découverts. En particulier le diagnostic à base intégrale pour circuits composés de différents types de câbles n'est pas possible dans la plupart des cas.
Le Oscillating Wave Test System se base sur la mesure de PD, ce qui rend possible la détection des défauts singuliers. Pour gagner plus d'expériences avec cette méthode et pour le développement ultérieur on fait des essais de laboratoire. Les expériences continuent.

Introduction

Currently there are various methods in discussion for the diagnosis of medium voltage cables regarding the ageing status and the remaining life-time.
In [1] an overview is given over the existing diagnosis systems:

- Voltage test according to DIN VDE 0298 Part 1
- FGH-Steptest
- IRC-Analysis
- Returning voltage measurement
- Very Low Frequency (VLF) - Loss factor measurement
- Complex Discharge Analyzing (CDA), PD measurement
- PD measurement with Oscillating Wave Test System (OWTS)

A regional energy supplier in Southern Hessen, Germany, performed a study [2] about the diagnosis systems IRC-Analysis, Returning voltage measurement and VLF-Loss factor diagnosis. Several Energy Power Suppliers asked for a comparative investigation about the current different known diagnosis systems [3].
Most of the diagnosis systems are performed on an integral basis, that means, that the general overall condition of the cable's insulation is determined. Their results in general are not very precise. The disadvantage of most of these methods is, that even major singular defects are not detected. A diagnosis on integral basis with cable circuits consisting of different types of cables is in most of the cases impossible.
The main conclusions of those studies are the same: The current state of the diagnosis systems do not permit a real and secure prediction about the remaining life-time of cables in operation. However, it is the wish of the industrial users to have a diagnosis system which allows for very precise data about the remaining life-time of power cables; with the aim to plan and to optimize maintenance events and to improve the overall availability of eletrical energy by preventing unexpected power failures.
Among the above mentioned quoted diagnosis systems the Oscillating Wave Test System (OWTS) offers a way to detect singular defects. The OWTS works as follows: The capacity of the cable sample is charged with DC voltage to U_r (rated voltage) within several seconds. Then the cable capacity is short-circuited with an inductance L_{res}, thereby a series resonance circuit is created. Due to the very low losses in the cable insulation the sinusoidal resonance oscillation has a very slow decay. The value of the inductance L_{res} is chosen in order to receive a resonance frequency of some hundred Hertz, i.e. in the same magnitude as the normal operation frequency of