

**B7.7****The stability of mass-impregnated paper AC cables operated at DC voltage**

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Abstract

In this paper, a study on the stability of ac mass impregnated paper cables operated at dc voltage is presented. Two stability criteria are proposed based on partial discharge analysis during load cycles. In order to find an objective parameter for making the distinction between "stable" and "unstable", Weibull analysis was used. The underlying physical behavior of the PD patterns that were detected is discussed in terms of the electric field distribution and the formation of cavities due to local pressure changes in the insulation.

Résumé

Dans ce papier, une étude est menée sur la stabilité de câbles AC à papier imprégné opérant sous tension continue. Deux critères de stabilité sont présentés basés sur des analyses de décharges partielles pendant des cycles de charge. Afin de trouver un paramètre fiable pour distinguer la stabilité de l'instabilité, la statistique de Weibull est utilisée. Le comportement physique pressenti correspondant aux empreintes des décharges partielles détectées, est discuté en terme de distribution de champ électrique et de formation de cavités dues à des modifications locales de pression au sein de l'isolant.

Introduction

The yearly increase of the consumption of electrical energy makes an expansion of the medium voltage grid unavoidable. Especially in urban areas, this may be a costly operation. Another approach would be to operate (part of) the existing medium voltage grid at dc voltage. This has several advantages:

- For given operating voltage, the transmission rating can be raised by at least a factor $\sqrt{2}$.
- A significant reduction of losses.
- A lower susceptibility to partial discharges.

Since the beginning of the century, ac voltage has been used for distribution and transmission of electrical energy. At present, dc voltage is mainly used for long distance or submarine transport at 400 kV and higher. The price of conversion between ac and dc voltage was up to now one of the reasons why dc was not used for distribution at lower voltages. Huge progress has been made in recent years and converters can now be made cheaper and more robust [1]. In transmission systems, we already observe the conversion of ac power lines to dc.

A large part of the Dutch medium voltage grid consists of belted type mass-impregnated paper cables. Compared with XLPE cables they were considered to be the best choice for conversion because of the expected absence of problems related to space charge.

The study presented in this paper was therefore aimed at medium voltage mass-impregnated paper cables. More in particular, the goal was to find a test criterion for a safe conversion to dc voltage. No attention was given to the stability of cable accessories. Complete cable systems will be studied in a follow-up of this study.

The most important question to be answered is how far we can increase the operating voltage compared to ac. Therefore, a number of studies should be performed:

- Study of the partial discharge (PD) behavior during operating conditions of the cable and definition of criteria for the evaluation of PD activity.
- Stability testing.