Development of a method for the localization of PD-Faults in high voltage cables with UHF-Sensors

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ABSTRACT

This paper reports about investigation on a smart application of UHF-Sensors in combination with computer-aided super-positioning system. The aim is to use simple capacitive UHF-Sensors to monitor the exact position of the partial discharge in a high voltage cable termination. First, the measurement setup and the fault model are described in more detail. After that, the behaviour of the sensors and the location method are explained. Special attention is paid to the curves and their reproducibility and response. Then the measuring system itself is explained and illustrated.

KEYWORDS

Partial discharges, PD measurement, PD localization, UHF-Sensors.

INTRODUCTION

The backbone of the energy supply consists not only on energy generators, but also on the equipment used for energy transmission, such as overhead lines and underground cables. As part of the energy revolution ("Energiewende") and the expansion of renewable energies, underground cables are increasingly being used for energy transmission. Cable terminations are used to connect cables to other equipment. Oil-filled cable terminations are generally used for high-voltage cables. Over time, gas-filled cavities or fibers can form in oil, causing partial discharges and eventually resulting in breakdowns. It is therefore important to detect the partial discharges at an early stage. With conventional PD measurement technology, partial discharges can be detected, but this does not reveal the position of the fault inside a termination.

This paper deals with the development of a smart detection system which detects both the PD in 110 kV cable terminations and the position of the fault. The system is based on simple capacitive UHF sensors. In this paper the measurement setup with the UHF sensors is presented, the sensitivity check is described and a first step towards PD fault detection and location is shown.

MEASUREMENT SETUP

According to IEC 60270, the measurement setup prescribed for partial discharges is used as a back up. This ensures that the measurement setup conforms to the standards, as shown in Figure 1. The transformer supplies the required high voltage $U(t)$, which is measured via the capacitive divider C_H/C_L. The blocking impedance L filters the interference pulses from the transformer or network. The coupling capacitor C_C is used for a sensitive PD measurement. Conventional partial discharges are measured via a coupling quadripole (AKV) and a measuring system.

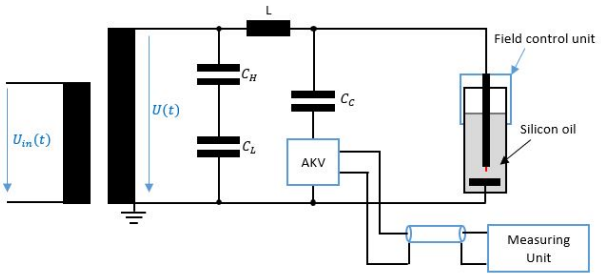

Figure 1: Measurement setup according to IEC 60270

The DUT in this case is an abstract model of a cable termination with an artificial failure inside. In an acrylic cylinder there is a tip-plate arrangement. The tip is at high voltage potential and the rounded electrode is at ground potential. The acrylic cylinder is filled with silicone oil, as shown in Figure 2.

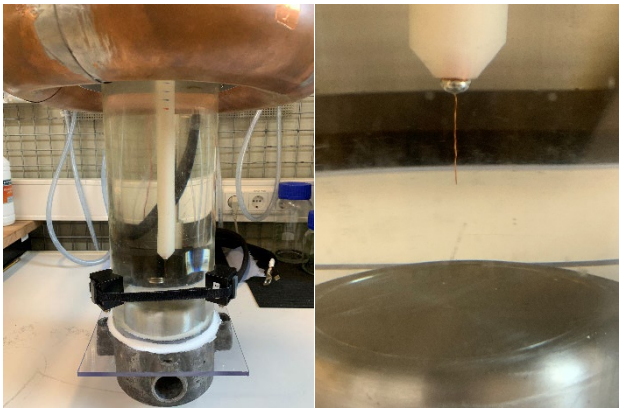

Figure 2: Device under test – Tip-plate-arrangement

In the left picture of Figure 2 a toroid is shown, that serves as a field control unit to minimize sliding discharges on the surface of the silicone oil. The tip is a very fine copper wire with a defined tip radius, which makes the arrangement very inhomogeneous. With this measuring setup, reproducible partial discharges can be generated in the silicone oil. The PD-pattern is shown in Figure 3.