ON-SITE VHF PARTIAL DISCHARGE DETECTION ON POWER CABLE ACCESSORIES

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ABSTRACT

During the on-site installation of power cables, mistakes in installing cable accessories can occur. If this results in insulation defects, partial discharges (PD) can occur. These PD will erode the insulation, can bridge the distance between both conductors which will result in a complete breakdown and failure of the cable system. It is known that PD pulses consists of energy frequencies up to hundreds of MHz. Therefore a VHF/UHF PD detection system is applied to detect partial discharges in a non-conventional way. Aspects that need to be considered during the development of such a system such as detection method, sensor type and location, calibration etc. are presented and discussed in this contribution.

KEYWORDS

Partial Discharges, VHF/UHF PD detection, Non-conventional PD detection.

INTRODUCTION

To achieve high quality of power cable accessory installation in transmission power cables, partial discharge detection during the on-site acceptance test is becoming an important issue. In particular, to search in the cable accessories for the presence of discharging insulation defects, on-site the cable is subjected to an AC test voltage. To be able during this voltage test to detect simultaneously partial discharges in all accessories the joints and terminations are equipped with VHF/UHF PD detectors.

Partial discharges in a power cable system can occur due to different insulation defects: such as at a gas-filled cavity, a protrusion in a semi conductive layer, or conversion of a water tree by a lightning or switching over-voltage etc. [1]. If allowed to continue, partial discharges will erode the insulation, usually forming a tree-shaped pattern of deterioration (electrical tree) which will grow through the dielectric and eventually bridge the conductors resulting in a complete breakdown and failure of the cable or accessory.

In this paper the results of after-laying testing of transmission power cable accessories using a non-conventional technique are being presented. The non-conventional system is based on the detection of high frequency signals being emitted by the discharge. Therefore, each power cable accessory is equipped with either an internal or external sensor to decouple the partial discharge signals. The partial discharge detection system uses narrow-band detector, in this case a spectrum analyzer. Laboratory experiments are presented on artificial defects to show its applicability.

PARTIAL DISCHARGE DETECTION

PD pulses as occurring in the cable insulation can contain frequencies of up to several hundreds of MHz. However, especially the higher frequencies tend to attenuate rapidly with the distance, see figure 1. As is shown in this figure, below 10 MHz, the attenuation is negligible, however, above this frequency the attenuation increases rapidly with the frequency at which the PD signals propagate. As a result, picking up the higher frequency components is only likely when the sensor is close to the discharging site. Therefore, to be selective during the after-laying test in which the accessories are of main interest, selecting higher measuring frequencies will ensure that only PD activity present in the accessories will be detected. In this way, discrimination between PD in the cable itself and the accessory is effectively achieved.

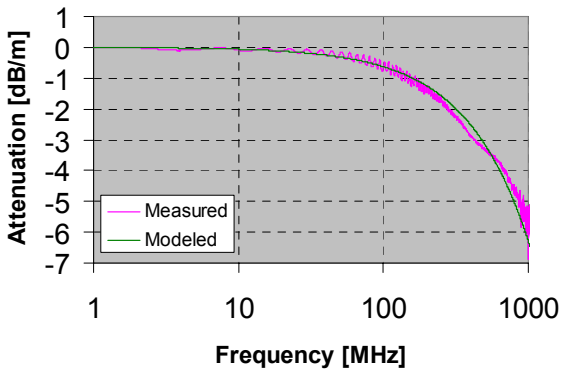

Figure 1: Measured (pink line) and modeled (green line) attenuation of high-frequency signals propagating inside a 380 kV XLPE power cable.

So, the HF/VHF/UHF PD detection system is applied locally on the power cable accessories [2, 3]. Figure 2 represents two stand-alone systems diagnosing different cable accessories. The diagnostic HF/VHF/UHF (PD) detection systems consist mainly of four parts:

1. a detection part that acquires information about possible PD in an accessory (red: sensor, amplifier),