PARTIAL DISCHARGE DETECTION AND 3D-LOCALIZATION AT 110-KV-CABLE TERMINATIONS USING UHF-SENSORS

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ABSTRACT

The aim of this paper is to show the detection and localization of partial discharges at 110-kV-cable terminations using UHF-sensors. For this purpose six service aged 110-kV-cable terminations are tested. These six cable terminations have been in use from 1994 to early 2022 to bypass existing cable systems or overhead lines for a limited period of time during construction work, maintenance and repair. Each cable termination is tested at service voltage and if PD are present the 3D-localization with the UHF-sensor system is performed. The paper shows the test setup, the methodology of the localization procedure and the achieved results.

KEYWORDS

Partial Discharge; UHF; Detection; 3D-Localization; Cable Termination.

INTRODUCTION

Partial discharge (PD) measurement is now used in the testing and diagnosis of high-voltage cable systems as one of the most important methods for assessing the condition of the insulating medium of an electrical system. Both conventional partial discharge measurement according to IEC 60270 and unconventional methods such as partial discharge measurement with ultra-high frequency (UHF) sensors have already proven their reliability. The second method is already being used successfully in gasinsulated switchgear and power transformers.

For high-voltage cable accessories, the partial discharge measurement is performed more frequently via conventional line-based systems or unconventionally via HFCTs which are installed in the shielding area of the cable joint or the cable termination. If partial discharges occur due to a fault in the equipment, it is a challenge, especially with cable terminations, to distinguish whether this fault is in the cable itself or in the cable termination because of its vicinity to the reflection point. According to the cigré study TB 815 of 2020, the fault rate has increased drastically in recent years, especially in cable terminations [1]. Additionally, the risk potential of PD in terminations is much higher compared to PD inside the cable insulation. Therefore, it is essential to detect potential faults in cable terminations as early and reliably as possible and, above all, to localize them.

The aim of this paper is to show how reliable detection and localization of partial discharges in cable terminations can be realized using UHF-sensors. The methodology behind the detection and 3D-localization with the UHF-sensors is explained and will be tested on six service aged 110-kV-cable terminations. These six cable terminations have been in use from 1994 to early 2022 to bypass existing energy connection systems (OHL or cable) for a limited period of time during construction work, maintenance and repair. The cable terminations were sorted out on the basis of visually detected defects and are now being examined in the laboratory. For this purpose, each cable termination is operated separately at service voltage and investigated for its partial discharge behaviour using the UHF-PD-measuring system. If partial discharges are present in the terminations, the exact position of the PD-fault location is determined by a 3D-localization. This is performed for all 6 cable terminations. The cable terminations are then cut open and the localized fault location is investigated. This serves as a check for the accuracy and reliability of the UHF-PD-measurement system.

TEST SETUP AND TEST PROCEDURE

The six cable terminations of the XLPE-cables (S2XS2YFuG 1x120 RM/25 64/110 kV) were replaced due to visual defects. Figure 1 shows an example of one of these defects:

Figure 1: Example of visual defect at the cable terminations

No information is available about the internal structure of the cable terminations. The cable terminations were prepared so that approx. 8 m of cable remained at each cable termination. The cable ends on the other side of the termination were peeled off and field control elements from the manufacturer TE Connectivity (HVCA-XHVT145-SCONE) were used for field control. This was done according to the instructions so that the geometric field