Experiences of online Partial Discharge diagnostics on XLPE MVAC and HVAC cables: evaluation of the influence of circuit layout and sensors on the measurement sensitivity and online localization techniques

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ABSTRACT

This work aims at resuming experience from online test experiences from the site, highlighting critical issues that can be found while performing online Partial Discharge (PD) tests on MV and HV cable apparatus. Therefore, a brief guide of best practices and guidelines is proposed to enhance the efficiency and optimize the results of online PD testing.

KEYWORDS

Online, Partial Discharge, Diagnostics, localization, high-frequency current transformer, Phase Resolved PD pattern, Pulse polarity, Time Domain Reflectometry

INTRODUCTION

Maintenance and reliability play a key role in the recent development of grids and industries, the common trend is to minimize the electrical personnel and outsource the majority of the repair and rectification jobs. Under such circumstances, the notification of failure risk and fault prevention is the only tool to mitigate outages.

Partial discharge measurement is one of the diagnostic techniques available and can be integrated into traditional and established maintenance procedures.

PARTIAL DISCHARGE DETECTION

Partial discharge detection is regulated by several standards mainly based on IEC 60270 that can be used in laboratory environments by means of well-defined measuring circuits, acquisition units, and calibration procedures. The scope of the IEC 60270 does not match with online site partial discharge measurement on cable, where the so-called "unconventional" partial discharge measurement techniques are used.

Online tests cannot successfully identify partial discharge phenomena on signal amplitude evaluation and require a deeper level of information to characterize the detected signals and allow an adequate diagnosis, filtering, and analysis tools are necessary to perform a proper data interpretation.

PD Pulses

Partial discharges on cable can be measured by the high-frequency current pulses propagating from the PD sources along the cable in the two directions, such signals are the fundamental brick of the analysis, but on-site there is no control of which high-frequency current signals are detected from the sensor and propagated through the measuring chain. Therefore, such signals must be analysed and characterized using the available information.

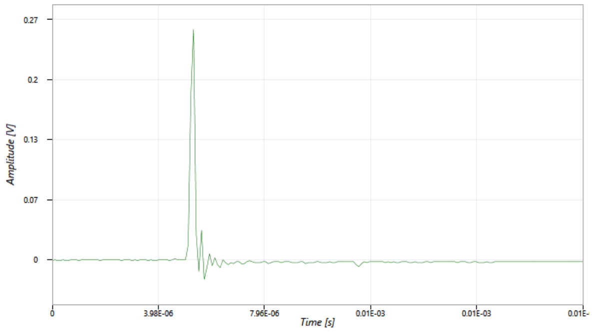

Fig. 1: Recorded PD pulse.

The approach used by the authors uses the analysis of pulses triggered on a minimum amplitude threshold and sampled for a tuneable time duration, saving a portion of the signal before the trigger event, in Fig. 1 recorded PD pulse is reported as an example.

PRPD pattern

The recorded high-frequency pulse magnitudes are therefore plotted in the Phase Resolved Partial Discharge (PRPD) pattern, where the phase reference is the applied voltage reference. An example is reported in Fig. 2.

The PRPD pattern analysis is the most important diagnostic analysis to identify signals originating from an insulation defect from random noises and signals due to PD activities occurring outside of the cable system under test.

Several studies have been performed by universities and research labs to characterize the type of defect with the relevant PRPD patterns, nevertheless, the link between the defect type and the PRPD pattern is not straightforward since minor changes in the defects can lead to significant changes in the PRPD patterns, considering also that the equipment under test may change its materials, layout, and technology based on OEM.

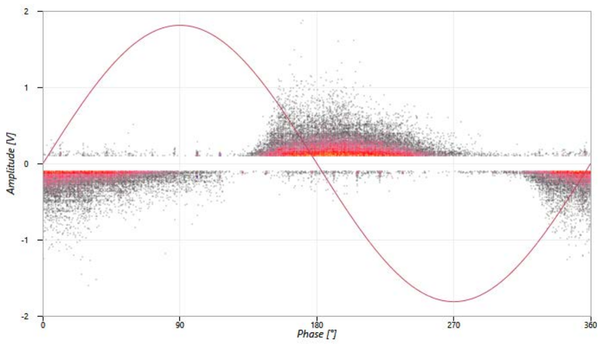

Fig. 2: Recorded PRPD pattern.