PD Testing and Monitoring of HV Cable Systems

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ABSTRACT

In the paper, a versatile PD testing and monitoring system is described, which is applicable to different types of the cables and can be connected to a vast range of PD sensors. The examples of the PD measurements performed with the high frequency current transformers and ultra-high frequency sensors on cross-linked polyethylene and on internal pressure cables are given. The temporary monitoring solution is proposed to check the insulation integrity of selected accessories of the cable line in an underground tunnel. Multi-channel techniques are successfully used to increase the sensitivity of PD measurements. The case studies show that incipient failures can be early detected and their evolution can be monitored.

KEYWORDS

HV Cable, Condition Based Maintenance, Partial Discharge Measurements, Testing and Monitoring

INTRODUCTION

Partial discharge (PD) testing and monitoring is nowadays a worldwide accepted method for the condition based assessment of the high voltage (HV) cable insulation and a required part of acceptance testing on-site. Different solutions for sensors and acquisition techniques have been recommended, applied and lately acknowledged by international standards and technical bodies [1-4].

As a result, utilities have to be educated continuously on different technologies and sometimes they are dependent on external expertise for advanced data interpretation. Therefore, there is a strong need for a versatile PD testing and monitoring equipment that is applicable for different types of the cables and that can be connected to a wide range of PD sensors. Moreover, the system should be able to provide all information requested in the relevant international documents.

In this paper, examples are shown of the PD measurements performed with the high frequency current transformers (HFCTs) and ultra-high frequency (UHF) sensors on cross-linked polyethylene (XLPE) and on 110 kV internal gas pressure cables.

For the cable systems in operation, the on-line tests are the most requested tests. Intermittent PD signals detected during periodic measurements have to be observed over a longer period of time. As a result, systems that enable temporary monitoring are frequently requested. Such a temporary monitoring is in general performed on selected accessories of the cable line, such as terminations or joint groups. The access to the link boxes can be difficult for buried cables and in many cases, an inductive power supply is required to energize the PD monitoring system.

For PD data evaluation, the synchronous measurements on consecutive elements of the cable system are recommended for sensitive detection and precise localization of insulation defects. Such measurements require a fiber optic connection between the acquisition units that can be easily provided for short link cables or for the cables in underground tunnels. In this paper, the example is given of a PD system installed for the temporary monitoring of two consecutive join groups of 230 kV XLPE cable laid in the tunnel.

The sensitivity of the PD measurements on-site is strongly limited by the high noise level. The recommended systems should provide the hardware and software features able to diminish the noise influence on tests results. Multi-channel techniques (e.g. 3PARD) are used to increase the sensitivity of PD measurements [1,5]. The case studies included in this paper show that incipient failures can be detected early and their evolution can be monitored.

PD TESTING OF 110 KV INTERNAL GAS PRESSURE CABLE SYSTEM

The test object was a 110 kV three-phase internal gas pressure cable already in service for 42 years. The cable has a length of 1914 m and connects a GIS with an air-insulated substation. The main purposes of the measurements were to check the condition of cable insulation as well as to compare the performances of HFCT and UHF type sensors.

The PD measurements were performed in sequence at both ends of the cable, at a GIS and later at overhead line (OHL) terminations. The HFCT sensors were installed at the GIS termination. At the OHL location, a six-channel synchronous PD measuring system was used and three HFCT and three UHF sensors were connected to the grounding shield of the cables (Figure 1). The measurements were performed at different frequencies.

Figure 1. Sensors installation at the GIS and OHL cable terminations

PD measurement with HFCTs is the most commonly applied method for on-line PD detection at cables and their accessories [3]. In this particular case, the HFCTs working at the characteristic frequency range from 50 kHz to 14 MHz, were used. For comparison and better data evaluation, the measurements with UHF sensors working in the frequency range from 100 MHz to 1 GHz were performed in parallel at the OHL terminations.