Partial Discharge measurements during AC voltage test: a fast and effective method for the site commissioning of long EHV XLPE cable systems

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ABSTRACT

The aim of the present work is to describe the process and procedures used in a Partial Discharge (PD) investigation on a full cable system during the AC withstand test. The analysis of the results, the comparison of the PD data in the detection points and the final outcome will be presented. The PD measurements have been carried out on the cable accessories, each one having an inductive sensor permanently installed on it by design. Such measurements provide information related not only to the current status of the insulation system but also to the defects that could lead to failure, even time after the final commissioning.

KEYWORDS

EHVAC cable, partial discharges, quality assurance, simultaneous measurements, AC withstand test.

INTRODUCTION

Once manufactured, cables and cable parts for Extra High Voltage AC (EHVAC) XLPE extruded cable systems are thoroughly tested in the factory for quality assurance purposes. In order to guarantee the absence of defects related to manufacturing, multiple different electrical and non-electrical tests are carried out during the end-of-line process [1]. The more precise and accurate the quality assurance, the more significant the reduction of the infantile mortality of the parts when the cable system is put in service.

Nevertheless, factory quality assurance cannot take care of defects related to the field installation of the cable systems. Cable handling and laying, joints and terminations manufacturing in the field are just the main operations that could lead to the introduction of weaknesses and defects in the cable system [1]. As a consequence, additional quality assurance tests are commonly required at the final stage of the commissioning of the cable circuits and they are carried out according to the procedures defined in International Standards for EHVAC cable systems [2-3]. The most important field tests are the ones investigating the insulation system: dielectric tests, voltage withstand and PD detection. The latter is becoming a common practice due to the amount of useful information that it provides.

Despite the fact that a cable is a relatively simple electrical asset, PD measurements during the AC withstand test require expert operators and proper instrumentation [4] in order to execute a correct analysis and the consequent reliable evaluation of the status of the insulation system after the final manufacturing in the field [5-9]. Such analysis can support the quality assurance and avoid early failures of the cable system during the initial stages of the exercise.

In the following, an experience of a quality assurance test performed in the field on a cable system for commissioning purposes will be discussed.

Tab. 1: main characteristics of the cable system under evaluation.

Rated voltage	230kV
Rated frequency	50Hz
Cables under test	3 x 2 circuits
Insulation technology	extruded XLPE
Embedded capacitive sensor	RFCT permanently installed
Sectionalized or straight	Both
Total number of accessories	198 (12 OT+186 Joints)
Total length	16.1 km

EHVAC CABLE SYSTEM

The cable system that has been evaluated is a three-phase 230kV double circuit, 16.1km long. Tab. 1 shows the main characteristics of the cable system.

PD sensors are embedded inductive Radio Frequency Current Transformers (RFCT) permanently installed on each cable accessory. Joints are either sectionalized or straight depending on the configuration set in the cross-bonding box.

The single cable circuit is depicted in Fig. 1. At both Side 1 and 2, the cable is terminated through outdoor terminations and then the joints are installed at about every 500÷600m. The two cable circuits constituting the cable system are identical and both were commissioned by means of the same procedures and testing.

The voltage source for the AC and the PD tests was a Resonant Test System (RTS) connected on the Side 1 of each of the phases.

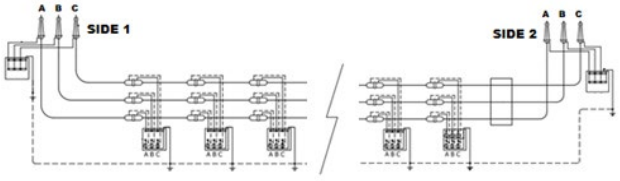

Fig. 1: schematization of one cable circuits.

PD TEST SETUP

The cable system is equipped with permanently installed state-of-art commercial RFCT PD sensors that are wrapped around the grounding leads of the terminations and around the bonding leads of the joints. PD sensors are terminated in derivation boxes, where the acquisition boxes are connected to. Fig. 2 shows the installation of the measuring system (A) on the outdoor terminations and (B) in the joint bays.