Investigation of temperature effect on partial discharge patterns in high voltage XLPE insulated cables

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ABSTRACT

In recent years, online partial discharge detection (OLPD) has been used as one of the most important methodologies in condition monitoring particularly beneficial for asset management in high voltage cable systems. Since temperature is an effective factor in changing the PD pattern, the effect of this parameter is analyzed based on laboratory tests on real cable samples on the basis of phase resolved partial discharge (PRPD) methodology. It was shown that the higher temperature of the cable insulation leads to a decrease in the PD pulses amplitude and repetition rate and increase the PDIV but does not have a significant effect on phase of occurrence.

INTRODUCTION

High-voltage and medium-voltage cables play a very basic and significant role in the production, distribution, and transmission of electricity. In fact, if a high-voltage cable is disconnected for no matter what reason, the users or owners of cable networks will suffer huge social and economic losses. Accordingly, it is of great importance to pay attention to the quality and condition assessment tests of such cables. The malfunctioning or problems related to high-voltage cables may occur for a variety of reasons such as the following:

a) Problems associated with the raw materials used in the cables production.
b) Problems occurring in the production process
c) Problems related to storing and transporting the cables
d) Problems happening when installing the cables and accessories (e.g. the joints, the end terminations, etc.)
e) Problems pertaining to installation tests (after installation tests, tests conducted after troubleshooting when cables are in use, etc.)
f) Problems happening when cables are in use or related to aging of insulation

Among the quality tests conducted on high-voltage and medium-voltage cables, partial discharge tests have a very important role in determining the safety of cable insulations. Partial discharge is a slow and long-lasting process which, if it happens, does not necessarily result in an immediate critical condition or fracture in the insulation. What is important in partial discharge is in fact the amount of the energy discharge and the speed of the cable's aging process which is dependent on a variety of factors and is normally not predictable unless regular measurements and tests are done [1].

The resulting electric tensions, due to any one of the reasons mentioned above, can activate partial discharge in defect areas. The scope of partial discharge test covers, diagnoses, and predicts defects from production time until cables installation time. Therefore, partial discharge measurement is the most important factory test and also plays a significant role after installation and when cable are being used in the power network. Hence, how accurately the PD test is conducted and knowing how temperature affects the results of this test are very important in the accurate diagnosis of the defects of the insulation system.

Research Process and Methodology

In the first phase of this study, a 20-meter cable was used with the voltage level of 15 kV containing many small bubbles scattered along the cable and in the XPLE insulation. From now on, we will refer to it as sample 1 (Figure 1).

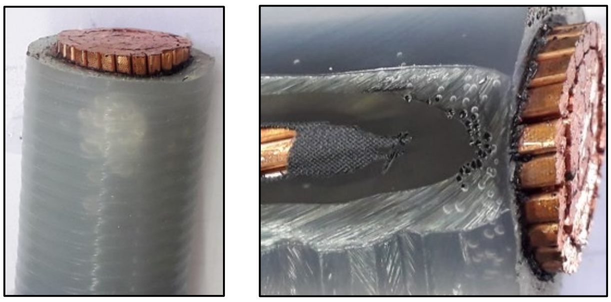

Fig. 1: defected insulation of the scattered bubbles type-Sample 1

The voltage needed to apply to the cable was provided by a 250 kv inductance-resonance PD free transformer. The circuit corresponding to the conducted tests is demonstrated in Figure 2. The frequency of partial discharge measurement in the specified range was selected with ΔF= 300 KHZ and the central frequency of 250 KHZ [2]. In each stage of the sample's temperature change, after 2 hours of stable temperature, the specified voltage was applied and the test was conducted. The patterns of PD were tested and analyzed at ambient temperature, 45 ˚C, 68 ˚C, 90 ˚C.