Comparative Investigations of PD-Behaviour on an Artificial Accessory Failure under medium Voltage AC and Damped AC (DAC)

Robert **Bach**, Daniel **Müller**, South Westphalia University of Applied Sciences - Soest, Germany, mueller.daniel1@fh-swf.de, bach.robert@fh-swf.de
Christian **Walter**, E.on. S.E. - Bayreuth, Germany, Christian.walter@bayernwerk.de

ABSTRACT

To evaluate a real accessory failure, a reproducible surface discharge arrangement is created by omitting a field control tube at one end of an MV cable and stressing the arrangement with two different voltages (AC and DAC). Since these arrangements correspond to a real failure type and may occur, e.g. in the case of bad workmanship, it is of considerable interest to prove the detectability of this failure type by AC- and DAC-Test Voltage. The focus of this investigation is laid on the reproducibility and the partial discharge characteristics under AC and DAC stress.

KEYWORDS

Damped AC, Artificial Accessory Failure, Partial Discharges, Surface Discharges, Medium Voltage Cable, On-Site-Voltage Test

AUTHOR NAMES & AFFILIATIONS

Daniel MÜLLER, Robert BACH, University of Applied Sciences – Soest (Germany), Mueller.daniel1@fh-swf.de, Bach.Robert@fh-swf.de

Christian WALTER, E.on. S.E. – Bayreuth (Germany), Christian.Walter@bayernwerk.de

INTRODUCTION

Commissioning tests for high-voltage XLPE cables after installation are still a challenge for the used test voltage source. The high reactive power demand of the cable capacitance leaves only a few options to test the cable insulation with an appropriate voltage level and AC-field distribution [1, 2, 3]. Testing a power cable with the AC resonant technique is widely accepted and a lot field experience was gained in past. Nevertheless even this technique can only be performed with great effort on-site due to the mechanical characteristics of the testing device. To decrease the testing effort, methods like DAC can be an appropriate option due to its simpler assembly process and light weight and less space consuming properties. In the past, many field experiences with this technique have been gained, leading to an acceptance of this method [4, 5]. The ability of DAC to detect service endangering defects was approved in several laboratory investigations by applying a needle defect in insulation material [6]. These laboratory investigations compared the results of 50-Hz-AC and DAC voltage application on a precisely inserted needle in a full scale HV and MV XLPE cable insulation. The focus of this investigation was to clarify whether DAC can detect or breakdown a needle failure in an appropriate time of voltage application compared to AC tests. PD characteristics, such as PD-inception level, ET growth rate and PRPDA showed, that the DAC test voltage can be used for MV and HV on-site tests.

Known that needle defect represents only the worst case of inhomogeneities inside the insultation and lead to basic conclusions of the usability of DAC for on-site tests, it is important to investigate the ability of DAC to also detect the most frequently occurring defects on site.

Statistical Investigations of real failures on cable on site, where a breakdown occurred during service, showed, that most cable defects were initiated by bad workmanship of cable accessory assembly [7]. Thus, real practical failures can mainly be led back to three basic mechanisms:

(1) misplaced or undefined field control (e.g. by disregarding the measures for stripping the semi-conductive layer, etc.), the penetration of water and
(2) inhomogeneities inside the cable accessory at earth or high-voltage potential (e.g. due to no-deburring of the connector, damaged conductor, etc.),

Since the previous investigated needle defect in the laboratory experiments is the most extreme variant of an inhomogeneity inside a cable accessory but it does not represent the most likely defect. The other failure mechanisms need to be taken into account. Since mechanism (2) does not often initiate PD in the beginning for this purpose here a surface discharge setup was choosen: at a cable end (failure mechanism (1) misplaced or undefined field control) is created by omitting the field control tube. The surface discharge setup was used to investigate the behavior of surface discharges under 50-Hz-AC and DAC voltage application. Main focus shall be laid on reproducibility, PD-characteristics and comparability. For further investigations on MV and later HV cable samples, this work can be used as a knowledge basis.

SURFACE DISCHARGE ARRANGEMENT

The main target of this investigation is to gain further knowledge about surface discharge arrangements at cable terminations without, or misplaced field control. To simplify the test setup, the edge of the outer semi-conductive layer will remain uncontrolled under air conditions. This investigation shall give insight on surface discharge behaviour under DAC testing to be compared with 50-Hz-AC. In a later stage other artificial accessory failure will be investigated as well. The used cable samples for the medium voltage investigations are XLPE insulated power cables for 12 / 20 kV (A2X(FL)2Y 1 x 240 mm²). Later also 110 kV cable samples shall be taken for further investigations.

The cable samples used had a length of appr. 1.2 m. One end was prepared with a field control tube to avoid PD there.