

Results of 10 years after installation tests combined with PD detection on MV cable systems

Frank DE VRIES, Jacco SMIT, Liandon B.V., Alkmaar, the Netherlands, frank.de.vries@alliander.com, jacco.smit@alliander.com

John VAN SLOGTEREN, Liander N.V., Arnhem, the Netherlands, john.van.slogteren@alliander.com

ABSTRACT

In the Netherlands newly installed MV extruded power cables are tested according to the Dutch MV cable standard NEN-HD 620 S2. The main function of these tests is to check the quality of the installed cable system including cable and accessories. Basically the electrical test consists of a voltage withstand test on the cable insulation and cable sheath. Partial discharge (PD) measurements are mentioned as an option. The requirements for PD are not described in the standard.

In 2004 Alliander decided to add PD measurements in their after installation test policy.

Over the last years, dozens of accessories and a few cable parts were taken out of the tested cables, based on PD activity, measured during after installation test. In many cases severe abnormalities were found, threatening the reliability of the cable system, but also cases were found where the reason for PD was not clear. It is also discovered that cable systems can contain PD's in accessories but still survive the after installation test.

This paper describes the experiences with PD measurements on new installed MV extruded power cables. Also practical recommendations and knowledge rules developed by Alliander will be addressed. Finally examples are given of PD behavior in relation to poor workmanship and the design of accessories.

KEYWORDS

After Installation test, Voltage Withstand test, Partial Discharge Measurement, Tangens Delta Measurement, Failure Investigation, MV Cable Accessories, Field Experiences, Knowledge Rules.

INTRODUCTION

On yearly bases, hundreds of new MV extruded power cables are installed in the Netherlands. These cable systems are tested according NEN-HD 620 S2 [1] and consists of a sheath test (5 kV DC 5 minutes) and a voltage withstand test of the cable insulation ($3xU_0$ VLF 15 minutes). The main function of these tests is to check the quality of the installation work of the cable and accessories.

In general only in a few cases a breakdown of the main insulation is observed during the test. In case of a breakdown it mostly occurs within the first 5 minutes of the test.

The voltage withstand test is easy to evaluate (pass / fail). However, the test does not give any additional diagnostic information about the condition of the cable system.

AFTER INSTALLATION TESTS COMBINED WITH PD MEASUREMENTS

In 2004 Alliander decided to add PD and tangens delta measurements in the after installation test policy. The benefits of these measurements are:

- To gain more understanding in the start condition parameters of the cable system (first fingerprint);
- To have knowledge of the condition of the cable system, after the voltage withstand test is performed;
- In situations where the required test voltages are not possible (due to restrictions of old switchgear directly attached to the cable system or the probability of a flashover in case of small size cable boxes), condition measurements at lower test voltages can be a good alternative;
- There might be abnormalities in the accessories where a voltage withstand test is not enough to force a breakdown.

The after installation test policy of Alliander is given below:

- Voltage Withstand test of the cable sheath: 5 kV DC, 5 minutes;
- Voltage Withstand test of the cable insulation: $3xU_0$, Very Low Frequency (VLF), 15 minutes or $3xU_0$, Damped Alternating Current (DAC), 50 cycles;
- PD Measurements of the cable insulation during VLF or DAC at: $0,5xU_0$; $1xU_0$; $1,5xU_0$; $2xU_0$; and determination of the PD inception voltage;
- Tangens Delta Measurements of the cable insulation during VLF or DAC at: $0,5xU_0$; $1xU_0$; $1,5xU_0$; $2xU_0$.

This test program is applied for:

- Completely new installed extruded MV cable systems and;
- Cable systems longer than 500 m in circuit length or;
- Cable systems longer than 200 m in circuit length, with at least one cable joint.

Used test equipment

The systems that Alliander uses for PD and tangens delta measurements during after installation tests on newly installed cable systems are:

- Offline VLF true sinus (0,1 Hz)
- Offline DAC (OWTS)