New integrated solution for DAC and VLF testing and diagnosis of distribution power cable circuits

Ben **QUAK**, Paul P. **SEITZ**; Seitz Instruments AG, Niederrohrdorf, Switzerland, bq@seitz-instruments.ch
Edward **GULSKI**; onsite hv solutions ag, Luzern, Switzerland, e.gulski@onsitehv.com
Frank **DE VRIES**, Liandon BV, Alkmaar, frank.de.vries@alliander.com

ABSTRACT

Following the recent IEEE 400 guideline where both damped AC (DAC) and very low frequency (VLF) test voltages have been accepted and widely in use for after-laying, maintenance and diagnostic testing of medium voltage cable circuits. As the conventional DAC and VLF technologies used till now are respectively DAC or VLF single system solutions it is obvious that a multi voltage source solution would be an optimal solution for an effective on-site testing and diagnosis. In this contribution an innovative new generation of combined DAC and VLF sinus voltage test and diagnosis (PD and tan δ) solution up to 40 kV will be presented.

KEYWORDS

MV power cables, damped AC voltage (DAC), very low frequency (VLF), after-laying testing, on-site diagnosis, condition assessment, partial discharges, dissipation factor.

INTRODUCTION

The main reason for testing and diagnosis in distribution power networks is to obtain actual knowledge on component condition directly by an after-laying, or during maintenance for the remaining component lifetime estimation. This knowledge can be applied to identify quality or availability issues on forehand on both new as well as aging infrastructure to optimize investment planning, eliminate unplanned outage and to enable proactive maintenance actions.

To identify, locate and evaluate weak spots in cable insulation and accessories in all types of medium voltage power cables in an early stage of possible insulation failure (see figure 1), partial discharge (PD) testing is the technique of choice, whereas for the determination of the more global insulation status good experience with dielectric loss / tan delta measurements have been made.

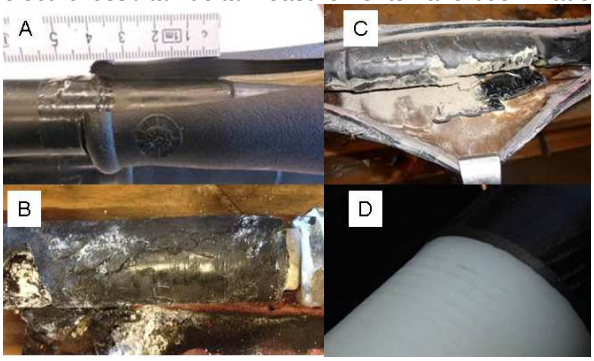

Figure 1: Examples of insulation degradation in MV power cables: (a) bad positioning of field grading, (b) electrical treeing and breakdown, (c) thermal problems in connector, (d) residual semicon layer.

Referring to the worldwide practice in testing and diagnosis of distribution power networks both damped AC (DAC) and very low frequency (VLF) test voltages have been accepted and widely in use for after-laying, maintenance and diagnostic testing of medium voltage cable circuits [1]. In the last 10 years it has been demonstrated that

- PD monitored voltage withstand testing using damped AC voltage is a very effective method to detect most insulation weak-spots by breakdown. In combination with dissipation factor estimation (tan δ) it can be used to investigate the degradation of oil-impregnated insulation.

- The voltage-withstand testing using sinusoidal VLF is sensitive to demonstrate the insulation weak-spots. In combination with dissipation factor measurement (tan δ) it is an excellent diagnostic tool for moisture related defects and cables with water-treeing.

As a result the recent IEEE 400 Guide (2012) and the IEEE 400.2 as well as the upcoming IEEE 400.4 describe that both technologies represent effective test voltages for testing and diagnosis of MV cable networks.

As the conventional DAC and VLF technologies used till now are respectively DAC or VLF single system solutions it is obvious that a multi voltage source solution would be an optimal solution for an effective on-site testing and diagnosis. Moreover in addition to DAC or VLF voltage withstand testing the application of PD detection at DAC and dissipation factor estimation at both DAC and VLF are possible to localize discharging defects and/or to asses the insulation degradation of all types e.g. XLPE, paper-oil, EPR of cable insulation.

In this contribution supported by practical application an innovative (patent pending) new generation of combined DAC and VLF sinus voltage test and diagnosis (PD and tan δ) solution up to 40kV will be presented.

DAMPED AC TESTING

To generate damped AC (DAC) voltages with a duration of a few tens of cycles of AC voltage at near power frequency, systems have been developed [2,3] which have been in practical use for over 15 years. These systems are used to test on-site, to measure and to locate partial discharges in power cables in accordance with IEC 60270 recommendations and to estimate dielectric losses [4]. DAC systems have the benefit of a small and lightweight form factor that due to their operation principle do not have a large power requirement to compensate the capacitive load demand normally observed by testing power cables. This makes DAC testing an optimal technology for use in the field. Furthermore, due to the