Integrated Testing and Diagnosis of Distribution Cables using Damped AC and Very Low Frequency Voltages

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ABSTRACT

Referring to the worldwide practice in testing and diagnosis of distribution power networks both damped AC (DAC) and sinusoidal very low frequency (VLF sinus) test voltages have been accepted and widely in use for after-laying, maintenance and diagnostic testing of medium voltage cable circuits.

Following recent IEEE 400 Guides and in particular the IEEE 400.4, IEEE 400.2 and several national standards and guidelines describe that both technologies represent effective test voltages for testing and diagnosis of MV cable networks.

In this paper based on practical examples an innovative new generation of combined DAC and VLF sinus voltage test and diagnosis (PD and tan δ) solution for distribution power cables 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

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 VLF sinus 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 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 sinus 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, see fig. 1.

Fig. 1: Example of an onsite cable test on a 22 kV cable circuit with a 40 kV multimode system that generates both DAC and VLF sinus.

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 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.

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