Long lengths transmission power cables on-site testing up to 500 kV by damped AC voltages

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ABSTRACT

Since 2004 damped AC (DAC) voltages are in use for on-site testing and diagnosis of (E) HV cables. DAC testing is an alternative method to conventional ACRTS testing and has got worldwide at several utilities and service providers its acceptance for:

- *quality control of cable and accessories installation during after-laying testing,*
- *maintenance testing during operation or in conjunction with repair work after a failure,*
- *condition assessment of service aged cable circuits,*

In this contribution the newest mobile solutions for DAC field testing up to 500 kV of cable lengths up to 25 - 40 km will be presented. As an innovation to the existing single side (E)HV DAC systems for energizing long lengths and for PD detection on longer cable lengths compact high power sources with an additional range extension solution will be presented.

INTRODUCTION

After-laying tests of new installed and diagnostic testing of service aged transmission power cables are an important issue to obtain knowledge about the actual condition of the complete cable system and to prevent breakdowns during service. The application of damped AC (DAC) voltages including standardized conventional PD detection and analysis is world-wide accepted for on-site testing and diagnosis of (E) HV power cables [2-12]. This technology is based on the off-line energizing of a cable section with the possibility of testing with elevated voltages.

	ACRT	DAC
Max output voltage [kVrms]	160	191
Max test capacitance @ Umax [uF]	1.6	27
Min test capacitance [nF]	17	15
Frequency range at Umax [Hz]	30-300	10-800
Max. input power demand [kVA]	100	4.5
Transport	heavy truck with trailer (excluding generator)	small van
Total weight [kg]	26000	1050
Transport volume [m3]	67	9
Integrated dissipation factor (tan δ) measurement	No	Yes
Sensitive IEC 60270 PD measurement possible	No	Yes
PD detection integrated	No	Yes
PD localization	terminations and cross-bonding joints only	terminations, all joint types and cable insulation

Table 1: Example of a comparison of ACRT system characteristics to those of a DAC system.

In contrast to existing multi units ACRT solutions the damped AC technology makes it possible using one single unit to energize long lengths of power cable with a high capacitance with a low input power demand [1]. In table 1 an example of a comparison is shown.

In addition to the PD inception equivalence of sinusoidal damped AC voltages (in the frequency range of 20-300Hz) compared to the 50/60 Hz network stresses the characteristics of the applied technology meets the specification of an on-site testing system:

- Lightweight modular system,
- Compactness in relation to the output voltage,
- Low effort for system assembling,
- Low power demand, even for long cable lengths,
- Low level noises and possibility of sensitive PD detection and dissipation factor measurements.

Onsite testing with damped AC voltages makes is possible to include IEC60270 standardized PD detection method, see Fig. 1. There are different parameters which can influence the quality of the partial discharge measurement [12-23]. Especially in the case of long length power cable systems, the PD detection sensitivity is a known issue that can be challenging. Also the PD origin localization in long cable lengths can become more complicated compared to shorter cable lengths. Due to limited sensitivity, which is affected by the noise level at on-site situations, the detectable PD magnitude is an important factor for each PD test.
To localize the origin of PD, a common used method is the time domain reflectometry (TDR). Using this technique, a detectable reflection of the PD pulse from the far end of the cable has to be detected by the measurement device.

Fig. 1: Example of a 300 kV DAC test system with double side PD testing and diagnosis extender for long transmission cable circuits

The PD measurement sensitivity and localization chance