Testing and PD Diagnosis of Transmission Power Cables Using continuous and damped AC Voltages

Edward **GULSKI**, Lodz University of Technology, Lodz, Poland, edward.gulski@p.lodz.pl
Jarosław **PARCIAK**, onsite hv solutions Central Europe Sp. z o.o., Warsaw, Poland, j.parciak@onsitehv.com
Rogier **JONGEN**, onsite hv solutions ag, Lucerne, Switzerland, r.jongen@onsitehv.com
Robert **PARCIAK**, power arbor Sp. z o.o, Warsaw, Poland, r.parciak@power-arbor.pl

ABSTRACT

Considering the IEEE 400 Guide, as well as the Cigre technical brochure 841, in this paper different practical applications of continuous and damped AC voltages and testing procedures for on-site testing and diagnosis of underground power cables up to 275 kV will be discussed based on general considerations and practical examples.

KEYWORDS

Transmission power cables, continues AC voltage, damped AC voltage after-laying testing, PD monitored after-laying voltage withstand testing, non-destructive testing, maintenance testing.

INTRODUCTION

It is known, that an insulation failure of a power cable can occur as a result of the normal operational voltage stresses or during elevated stresses, like e.g., a transient voltage due to lightning or switching surges.

Most failures occur as a result of localized electrical stresses that are higher than the dielectric strength of the dielectric materials in the area of the localized stress or if the bulk dielectric material degrades to the point where it cannot withstand the applied voltage. To find these defects (which are mostly the result of poor installation of accessories or demanding service conditions) prior to a failure, on-site dedicated tests are applied to assess the quality and cable system integrity, as well as the availability and reliability of the cable circuit. Therefore, to reduce the risk of a failure during the service operation, a modern on-site testing and diagnosis of transmission power cables should consist of voltage withstand testing, partial discharge detection and dissipation factor measurements applied for:

Fig. 1: Examples of AC Resonance System (ACRT) (top) and Damped AC Voltage (DAC) system applications for on-site testing of long, high-voltage cable systems (bottom)

1. After-laying testing of newly installed cable systems, as well as
2. Maintenance and diagnostic testing of cable systems in operation

The above-mentioned approaches are fundamental for the reliable operation of underground distribution and transmission power networks.
To support the quality assurance of newly installed cable systems, as well as to create a sound basis for condition-based maintenance; this paper discusses the technical challenges of field-testing of transmission power cables. Furthermore, it compares damped AC and the continuous AC testing methods with each other and discusses practical applications for testing and diagnosis of transmission power cable systems.

TESTING METHODS OF POWER CABLE SYSTEMS

In the last 20 years there has been a continuous development of new and more advanced technologies for testing new cable installations and diagnosing service-aged cable, e.g. AC resonance testing (ACRT), fig. 1a, or with damped AC voltage, [1-16], see fig. 1b.

Sensitive partial discharge (PD) detection of insulation weak-spots is crucial to determine the condition of a cable circuit. The PD levels that are related to such defects are in the range of few tens of pC's. The experiences have shown that in case of continuous AC voltage sources, due to the high level of EM disturbances in the order of several thousands of pC's occurring by on-site generation of resonant AC voltages, the PD detection in accordance to [13, 14] and or [17] is not sensitive enough to be used for PD detection in cable insulation and in all types of cable accessories.
The testing methods accepted in the international recommendations [1,2,15, 21-23] as well as discussed in e.g. in [18] include:

1. AC 20 to 300 Hz - test with sustained resonant alternating voltage (ACRT)
2. Damped AC 20 to 300 Hz - test with damped resonant alternating voltage (DAC)

Figure 2 shows the principal differences between the