IMPLEMENTATION OF MODERN METHODS OF ON-SITE TESTING AND DIAGNOSIS OF HV POWER CABLES

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ABSTRACT

To control the quality of the installed transmission power circuits on-site and with regard to test possibilities after installing a new cable system, different types of on-site voltage withstand tests can be used to determine the assembling quality of the complete cable section. Based on the scientific work, extended field applications this contribution is focused on fundamental and applied aspects of on-site testing and diagnosis of new and service aged HV power cables. In particular application of testing procedures of damped AC voltage testing combined with standardized PD detection for monitored on-site testing of transmission power cables will be discussed.

KEYWORDS

Transmission power cables, monitored testing, damped AC voltages, partial discharge detection, diagnosis, condition assessment

INTRODUCTION

Power cables are distributed insulation systems up to multiple kilometers. It is known, that small damages and/or bad installation operations on power cables may deteriorate and lead to failures which can occur in the cable insulation and/or accessories as a result of the normally applied operational stresses or during transient voltage stresses, such as lightning or switching over-voltages [1-12], figure 1.

As a result in addition to factory routine tests the reliability of power cables may further be improved by on-site testing and diagnosis. In general the on-site testing can be applied for three main reasons:

1) as part of commissioning on-site: to demonstrate that the transport from manufacture to site and the final assembling has not caused any new and dangerous defects in the insulation,
2) after on-site repair: to spot bad workmanship during complete installation of the cable (including joints and terminations). To demonstrate that the equipment has been successfully repaired and that all dangerous defects in the insulation have been eliminated,
3) as a diagnostic test where using non-destructive methods e.g. PD detection, dissipation factor measurement insulation defects and or the insulation degradation in power cables can be detected.

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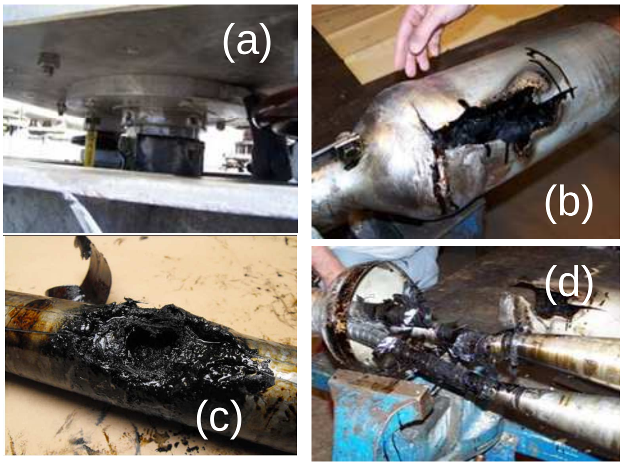

Fig. 1. Examples of insulation defects in power cables: (a) termination of 132 kV XLPE cable with un-sealed bottom resulting in contamination and moisture ingress in side insulator, (b,c) cable movement due to expansion of oil due to high temperatures. Directly resulting in cracks and voids in joint insulation with final breakdown, (d) electrical treeing in 150 kV gas pressure cables resulting in long term insulation degradation and finally cable breakdown [15]

In general as on-site acceptance test for newly installed or repaired circuits one of the two approaches is in use:

1) destructive withstand tests by over-voltage stresses applied, e.g. for 1 hour to the test object, or
2) alternatively a voltage test of 1xUo *as* applied for 24 hrs.

The first approach is based on the assumption that a healthy (defect-free and/or non-aged) insulation can withstand high level of voltage stresses and all insulation which is aged and/or consists of insulation defects should have lower level of withstand voltage and should produce a breakdown during the designated test time.

It is known that the above described, so called *non-monitored* voltage withstand testing methods only, can be not always sufficient to identify all manufacturing and installation problems. Moreover it has to be considered that:

1) due to test voltage stresses higher than the operational stresses, the test may be destructive even if no failure has occurred

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