ON-LINE PD SPOT TESTING AND CONTINUOUS MONITORING FOR IN SERVICE POWER CABLES – TECHNIQUES AND FIELD EXPERIENCES

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ABSTRACT

Applications of on-line PD spot testing and monitoring for in service power cables are presented. The motivation and advantages of the on-line approach to the cable insulation assessment are covered. The different aspects of PD testing are discussed: detection, location and continuous monitoring. The test techniques for different types of transmission and distribution cable circuit are shown with field examples. Integration of continuous monitoring with existing test techniques such as off-line testing and PD localisation is also shown.

KEYWORDS

On-line partial discharge PD monitoring medium high voltage power cables

INTRODUCTION

On-line partial discharge (PD) assessment is now widely deployed for detection of insulation defects in power cables and accessories when in-service for both new and service-aged circuits. In this paper the different aspects of on-line PD measurements are discussed including detection, location and continuous monitoring for different cable types and voltage classes.

The on-line PD detection approach often struggles with high electromagnetic interferences from the neighbouring equipment since a test object (power cable) is galvanically connected to the rest of network on both ends. A signal extraction technique based on the pulse shape analysis and the assessment of similarity to the pre-defined PD pulse shapes.

Continuous PD monitoring is discussed for routine assessment of cables (e.g. for several hours only), to trend PD activities vs load cycle after defects found and to permanently monitor key circuits on the network. The described monitoring system presumes the sensor installation at just one end of the cable. Although localisation possibilities in this case are limited, the pulse shape recognition algorithm allows clear differentiation between cable and switchgear defects and their independent criticality assessment.

TEST APPROACHES

In order to PD test cables spot-testing and continuous monitoring methods can be used. Spot-testing has the advantages that it is reasonably quick to deploy with tests between 15 minutes and a few hours per circuit. Various advanced techniques can also be applied for noise discrimination, which is of particular use on transmission class cables where corona interferences can be more present [1]. Due to this spot testing is currently the most viable method for many transmission class circuits, especially those terminated into outdoor terminations.

Continuous PD monitoring is carried out to trend PD activities over time; for example in the case of distribution class paper cables where load varying PD trends are often observed; an example of this is shown in Figure 1. Continuous monitoring also allows detection of PD level rises or other changes in the PD activity trend that have been observed to occur immediately before failure [2].

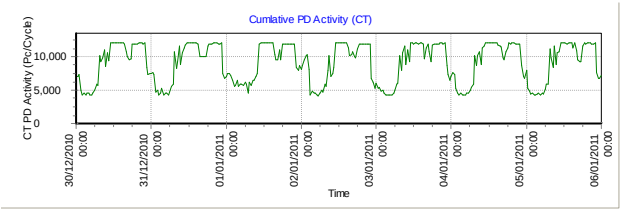

Fig. 1 Load varying PD activity in 10 kV paper insulated cable over one week

The continuous monitoring techniques have been mainly applied to distribution class networks with portable equipment, which is often more economical than permanent monitoring for assessment of many cables in an aged distribution network [3].

Subsequently the use of continuous PD monitoring has been combined with off-line PD diagnostics. This is as a means to focus existing routine off-line measurements and reduce the number of cables that are not PD effected being de-energised for measurement.

SENSING TECHNIQUES AND MEASUREMENT SYSTEMS

On-line Sensor Attachment

In order to detect PD activity on-line, non-intrusive sensors must be utilised. The sensors used for on-line PD detection are the high frequency current transformer (HFCT) for detection of the current impulses from PD in the cables and switchgear and transient earth voltage sensors (TEV) for detection of electromagnetic radiation from local PD activity from sources nearby to the sensor attachment point for example in the cable termination or switchgear. By using a combination of sensors, sensitivity to different types of PD can be obtained and the measurements from different sensors correlated to aid in the diagnosis.

HFCT Sensors Attachment

HFCT sensors may be attached onto the cable sheath or cable with the metallic sheath brought back through. A key requirement is the cable metallic sheath has a single connection to ground. Both positions are illustrated in the picture in Figure 2.