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Sensitive PD detection on drained paper insulated cables

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Abstract: External gas pressure cable systems which are widely used for high voltage power transmission are very reliable. However, if PD caused by a displacement of compound start, a failure has to be expected. This paper reports on investigations in order to find out promising solutions to detect these failures reliably and well in advance. Therefore the high frequency properties of oil-paper insulated cables as well as the characteristics of PD due to a displacement of compound are presented and discussed. Based on these investigation results, conclusions for sensitive PD detection at the cable end are done and possibilities of conventional PD measurement are discussed.

Keywords: external gas pressure cable, PD due to a displacement of compound, PD characteristics, PD diagnosis

1. Introduction

The impregnated paper insulation has become an important part in the field of power cables during the last century. In spite of the fact that nowadays polymeric cable systems dominate more and more in the field of power transmission, oil-paper insulated cables are still in service, especially at high voltage levels. Since the reliability of high voltage power transmission systems is a significant factor for power utilities it is necessary to know the ageing condition of the insulation.

Among other influences (e.g. increase of moisture content, thermal degradation of oil and / or cellulose etc.) the current impregnating condition of the insulation mainly determines the ageing behaviour of high voltage paper insulated lead sheath covered (PILC) cables. Investigations on several aged 110 kV external gas pressure cables have revealed, that contrarily to expectations for so-called thermally stable cables [1] a displacement of impregnating compound has occurred in service which has lead to void formation, local partial discharges (PD) and finally to a break-down of the cable [2].

Résumé: Les systèmes de câble à compression externe de gaz travaillent en général fiablement. En cas des décharges partielles à cause de migration de matière dans l'isolation une défaillance du câble est possible. Cette publication parle des recherches dans le but de trouver des solutions prometteuses pour signaler des fautes rapidement et certainement. Pour cela, les qualités de haute fréquence des câbles avec un diélectrique papier/huile et les caractéristiques des décharges partielles liées à la migration de matières seront présentées et discutées. On présente également des conclusions en ce qui concerne la mesure sensible des décharges partielles à l'extrémité décharges partielles conventionnelles.

Mots clés: câble à compression externe de gaz, décharges partielles à cause de migration de matière, caractéristique et mesure des décharges partielles

The conventional PD measurement [3] with decoupling of the pulses at the cable end is often not suitable for long cable lengths due to the high frequency attenuation. However, an integration of field sensors along a laid cable seems not acceptable because of the design of external gas pressure cables. Therefore the on-site PD detection has to be done at the cable ends.

In order to estimate the achievable sensitivity of a PD measurement at the cable ends the PD pulse characteristics as well as the high frequency pulse propagation properties on oil-paper insulated high voltage cables have been investigated.

Furthermore, this paper reports on a comparison of the sensitivity of conventional and broadband sensor based PD measurement with respect to recognition of oil-starved cable sections.

Finally, results of laboratory investigations using a new, digital high precision PD measurement system are presented and discussed.