C.8.1.12.

Sensitive PD detection on drained paper insulated cables

T. Kumm, R. Heinrich, K. Rethmeier, P. Jacobsen, W. Kalkner
Technical University Berlin
Institute for High Voltage Engineering
E. Zinburg
GEW Rheinenergie AG

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

Investigations on several 110 kV external gas pressure cables have revealed, that contrarily to expectations for so-called thermally stable cables a displacement of impregnating compound has occurred which has lead to void formation, local partial discharges (PD) and finally to a break-down of the cable. Hence, sensitive on-site PD measurement is needed to get reliable information about the condition of the cable.

The conventional PD measurement with decoupling of the pulses at the cable ends is often not suitable for long cable lengths. However, an integration of sensors along a laid cable seems not acceptable either because of the design of oil-paper-insulated 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 of the high voltage cable have been investigated.

The behavior of PD, which are caused by a migration of compound, has been examined in laboratory using broadband PD sensors on short oil-paper insulated cable lengths, which were artificially migrated. The broadband PD sensors allowed an exact determination of the PD pulse characteristics, like pulse width, repetition rate etc. as well as an exact localization of the PD. Several PD sources were found even on short cable samples which supports the theory that larger zones of the cable suffer from migrated compound which leads to PD. Thus a localization accuracy of several meters seems to be acceptable for on-site measurements.

The measured PD characteristics were also used to estimate the conditions for PD detection at the cable ends. High frequency measurements on several short oil-paper insulated cable core samples were done and conclusions for PD detection at the cable ends concerning bandwidth, achievable sensitivity etc. were postulated.

Based on these investigations, a promising solution for a sensitive PD measurement at a cable end was found: a new, digital high precision PD measurement system, that provides a synchronous PD measurement on multiple locations. The PD measurement system can either be connected to a conventional coupling capacitor or to a sensor at the cable end, e.g. an inductive sensor (Rogowski coil). Using the synchronous measurement technique it is possible to locate a PD source by propagation time analysis. In this case, the measurement at both cable ends provides a significantly higher sensitivity than the widely used reflectometry since the reflected pulse at the other cable end is not needed for the evaluation of the PD origin.

The paper will report in detail about PD measurements using the synchronous measurement technique for short and longer cable lengths in the laboratory and on-site.