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Sensitive PD detection on high voltage XLPE cable lines using field coupling sensors

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Résumé:
Avec des essais en laboratoire et les essais après-pose, les avantages et désavantages de différents capteurs de décharges partielles aux accessoires des câbles PR de haute et très haute tension ainsi que des méthodes et instruments de mesure sont discutés et comparés.

Abstract
Based on experiences of laboratory and on-site after laying tests the advantages and limits of different sensors for PD detection at high voltage and extremely high voltage XLPE cable accessories as well as suitable methods and measurement devices for evaluation of the measured signals are discussed and compared.

1 Introduction

Partial discharge (PD) measurements on electrical components and complete systems gain more and more in importance. Thereby, it is of increasing interest to carry out sensitive PD measurements not only in (expensive), well shielded laboratories, but also under noisy conditions, e.g. unshielded laboratories for routine, type and development testing. Particularly with regard to on-site testing of high voltage extruded cable systems, sensitive PD measurements deliver high reliability [1].

The suitability of PD measurements depends essentially on the actual noise level on site and on the achievable sensitivity. Due to the strong damping of PD impulses at their propagation along the cable the conventional PD detection at the cable end leads strictly to a strong decrease in PD sensitivity with increasing cable length. However, the cables already have been PD-tested during their routine test at the manufacturer, so cables should be free of PD faults when leaving the factory. Cable damages due to transport or laying are usually discovered by sheath testing. So, on-site PD measurements on cable systems can focus on cable accessories [2, 3]. Of course, components of prefabricated accessories were already PD pre-tested at the manufacturer's lab, but mounting the accessories on site leaves a certain risk for remaining faults, which might lead to breakdown later-on in service. To achieve maximum PD sensitivity on site, PD sensors directly at resp. inside the accessories are used. Different kinds of unconventional PD coupling methods basing on e.g. capacitive or inductive sensors led to increased PD sensitivity at the accessories (joints) compared to conventional PD detection at the cable end. Nevertheless, most of these methods hardly reach target PD sensitivity of a few pC under noisy on-site conditions [4].

However, a considerable improvement could be reached by the use of directional coupler sensors. In principle, directional coupler sensors give a clear and reliable distinction between PD caused inside a joint and external (noise) signals from the left or from the right of the joint. The very high measuring sensitivity of ≤1pC becomes also possible under extreme electromagnetic disturbances on site (or also e.g. in a completely unshielded laboratory) [5, 6, 7]. This is an essential advantage of the directional coupler PD measuring technique compared to any other type of sensor without inherent directivity (e.g. capacitive sensors, Rogowski coils). In addition, the high frequency range of the directional coupler