OPTICAL PD DETECTION IN STRESS CONES OF HV CABLE ACCESSORIES

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ABSTRACT

Sensitive partial discharge (PD) measurements on HV/EHV cable systems are usually based on electrical or electromagnetic PD detection. Unfortunately, interferences may significantly reduce sensitivity, especially in on-site after-installation testing and, even more, in on-line PD monitoring. This paper deals with optical PD detection, which is absolutely immune to any kind of electromagnetic interference. Optical PD detection necessarily requires transparent or translucent insulation systems to be applicable. Stress cone elements for HV/EHV cable accessories meet the requirements for optical PD detection, if made from transparent silicone elastomers.

KEYWORDS

Optical PD detection, silicone rubber, fluorescent optical fibre, stress cones

1. INTRODUCTION

PD measurements proved as a generally accepted part of routine and type testing, not only of cables and cable accessories. Sensitive PD measurements are best suited to detect and to locate weak spots within the insulation systems. To reach optimum sensitivity, conventional PD measurements according to IEC 60270 require screened test chambers, line filters and PD-free HV test equipment. Though actually not demanded by the relevant standards IEC 60840 and IEC 62067, on-site PD measurements during after-installation (offline) testing of HV/EHV cable systems became more and more popular. Since 2009, CIGRE working group B1-28 is investigating on-site Partial Discharge Assessments of HV and EHV cable systems. Without doubt, on-site PD measurements require sophisticated equipment, like special PD sensors, flexible PD instruments, advanced de-noising procedures etc. as well as experienced test engineers to enable sensitive measurements and to conclude meaningful results. Nevertheless, the often noisy and complex on-site environment holds a remaining risk of misjudging PD measurement results.

Online PD monitoring of cable systems faces usually a higher impact of external interferences compared to offline testing with low-noise AC resonant test systems. Consequently, the capability to unambiguously distinguish between external interference and (eventually) internal PD becomes imperative for online PD monitoring systems.

Non-conventional methods are increasingly employed to improve offline and online PD measurements on-site with respect to sensitivity and selectivity. The focus is actually on electromagnetic (HF, VHF, UHF) and acoustic PD detection. Application of optical PD detection, as part of the non-conventional methods, is restricted to transparent or translucent insulation materials. Optical PD detection is mainly used to locate external discharges (corona, surface discharges). Until now, there has been no extensive use of optical methods in PD detection, especially inside full-sized high voltage equipment. Nevertheless, similar systems are very successful for measurements in the field of electrical tree growth and breakdown characteristics of solid insulation materials, e.g. [1] – [4]. Research is also done in connection with special fibre-optic cables as a receiver unit for emitted optical radiation caused by partial discharges [5], [6] and application of the optical PD detection method for gas-insulated equipment seems to be promising [7].

2. EXPERIMENTAL SET-UP

The main points of our investigation in optical partial discharge detection were:

- to use a digital multi-channel PD measuring system with electrical and optical channels
- to measure electrical and optical PD signals *simultaneously* to allow correlation of optical and electrical PD signals on a pulse-by-pulse basis

and

- to use sensors, which are directly applied inside or on the surface of high voltage equipments without any impact on the insulation system performance

The used experimental set-up is shown in fig.1. It consists of a high-voltage source, a coupling capacitor and the multi-channel PD measuring system with only one electrical channel MP1.1 and optical channel MP1.2 or MP1.3. Fig. 2 shows an example of a practical test-set-up. As PD measuring system we choose the system MPD 600 (Omicron) with synchronous multi-channel PD acquisition, real-time pre-processing hardware, communication via optical fibre, a standard PC for system control and result visualization as well as PD evaluation according to IEC 60270 [8].