Optical PD detection in high voltage cable accessories

Alexander **EIGNER**, Thomas **KRANZ**; Tyco Electronics Raychem GmbH, Germany, aeigner@te.com, tkranz@te.com
Klaus **VATERRODT**, Dr. Gerd **HEIDMANN**; IPH Berlin GmbH, Germany, vaterrodt@iph.de, heidmann@iph.de

ABSTRACT

A novel method in order to perform diagnosis of the insulation system is optical partial discharge detection. This method does not work with the electrical signals which are caused in case of partial discharges but rather detects the optical signals which are coming up at the same time. Based on this different physical process, external electrical noise can be neglected which leads to a much better usability in the field. Based on the fundamental physical studies which were done by BAM, HPS, IPH, Polymerics and TU Berlin in advance, this paper presents the application behind this detection technique as well as a possible solution of the integration into high voltage cable accessories. At this the setup of an integrated optical fiber including its embedding is explained. Furthermore several requirements and their solution are presented such as void free integration, mechanical stresses inside the system and electrical tests (AC, DC and Impulse). The paper closes with showing the results of an integrated and operating system and compares the gathered results with an electrical measurement which was done simultaneously.

KEYWORDS

Partial discharge measurement, optical partial discharge detection, silicone rubber, Fluorescence, stress cone

INTRODUCTION

High voltage cable accessories are expected to have a life time of more than 40 years without any failure [1]. In order to achieve this requirement, the insulation system and its performance have to be regularly checked. The today's most commonly used diagnostic method in order to perform this task is the electrical partial discharge (PD) measurement. This technique is based on the measurement of electrical signals with very small amplitude. Disadvantage of this technique is that due to the small amplitude it is very sensible against electrical noise caused by external electrical fields such as from transformers, overhead lines, etc. As a result of this, the electrical partial discharge measurement in a noisy environment e.g. on-site tests does not always allow a proper interpretation of the partial discharge measurement results and consequently an understanding of the condition of high voltage equipment is not possible.

ELECTRICAL PD MEASUREMENT

The today most commonly used diagnostic method in order to obtain the status of high voltage cable accessories is the electrical partial discharge measurement according to IEC 60270. This setup consists basically of a high voltage source (which could be based on different techniques such as standard 50Hz or resonant system), a coupling capacitance for signal extraction and a quadrupole for the adaption of the PD signals for direct measurement. Each partial discharge event causes during the treeing process a short current signal which can be detected with the connected measuring device (see figure 1).

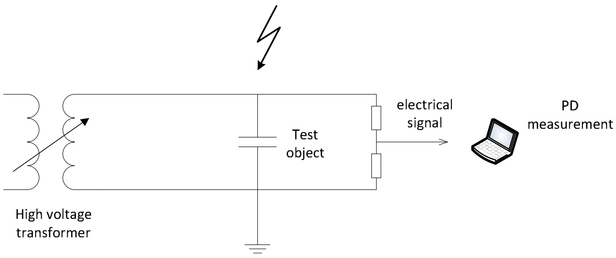

Fig. 1: conventional electrical PD mesurement

There is no big difference for this measurement technique when being used either at a high voltage test laboratory or during an onsite test. But normally high voltage laboratories are shielded and avoid the coupling of high frequency noise from other surrounding electrical equipment. Hence the complete test arrangement should have a noise level below 2,5 pC at test voltage which allows a precise judgment and interpretation of the partial discharge level.

For on-site tests such a shielding is missing and the typical noise level by measurements in a frequency range according to IEC 60270 is in the range of some 100 pC. This does not allow a sensitive PD measurement, especially when measuring a long cable length. Therefore electrical PD measurements in the field are still strongly dependent on the local situation.

OPTICAL PD MEASUREMENT

Optical partial discharge detection is based on the detection of the light caused as a result of the physical breakdown processes during the discharge [2-7]. The wavelength of the generated light depends on the material where the discharges occur. Basically it can be differentiated into three main groups which are used in high-voltage engineering: air, oil and SF6. Even within solid materials most of the discharges are related to air discharges as the void contains air or the failure is often caused by air entrapment. Based on this, the characteristic wave length of the discharge can be seen in figure 2 [8].

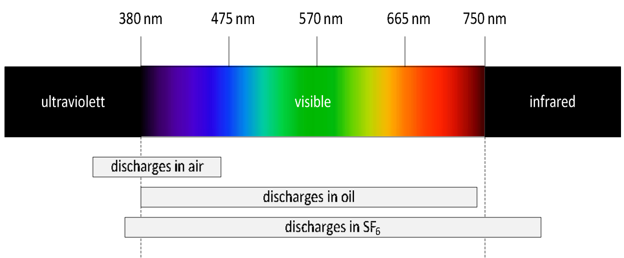

Fig. 2: Wavelength of emmitted ligth of electrical discharges in different media