PD MONITORING OF 132 KV XLPE CABLE OUTDOOR TERMINATIONS: PRACTICAL EXPERIENCE

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ABSTRACT

This paper presents gained experience from continuous Partial Discharge (PD) monitoring during a period of 10 months, which was conducted on three outdoor terminations of 132 kV XLPE cable. Commercially available PD monitoring system was used for this purpose, which was installed and configured by STRI AB. The utilized monitoring system operates in Ultra High Frequency (UHF) range, i.e. measures signals in non-conventional PD bandwidth. Measured PD, disturbance issues and performance of the measurement system are discussed in the paper.

KEYWORDS

Partial discharge, monitoring, power cable, terminations.

INTRODUCTION

Partial Discharge (PD) measurement is a versatile technique allowing for detection of defects in insulation of power cable systems. These defects could be for example cavities in insulation, presence of contaminating particles in insulation or at interfaces, damaged semiconducting layers, misalignment of stress grading materials in joints and terminations, etc. The defects result in locally increased electric stress and can give rise to PD, which with time erode insulation and cause breakdown.

Laboratory PD measurement methods are well established [1] and are widely used as routine tests of cables and accessories of HV and EHV rating [2]. Furthermore, even though PD measurements during commissioning tests are only recommended in standard [2], these are becoming more common nowadays, e.g. see [3,4,5]. PD monitoring of cable systems on the other hand is still rather seldom used because of costs involved, however advantages of monitoring are starting to be recognized since monitoring can allow for detecting the defects before cable fault [6], this in turn would allow for planed repairs instead of costly outages. However, cable PD monitoring area is still rather unexplored and thus available information on the subject is limited.

This paper presents gained experience from pilot project where PD were monitored continuously during 10 month period in outdoor terminations of HV cable.

MONITORED CABLE

So far PD monitoring systems are still rather expensive, therefore from a cable owner's perspective it is reasonable to install such systems on vital cables, i.e. of HV or EHV rating. In this project two cables of HV rating were available for monitoring. The pair of them constituted a parallel power supply, where one of the cables was loaded, while the second (a reserve cable), only was energised. The design of the selected monitoring system, which is discussed in the following section, requires cable terminations to be mounted on support insulators. Only the reserve cable utilized such termination construction and thus this cable was selected for monitoring. The monitored cable was XLPE insulated, 132 kV rating and approximately 4 km long.

MONITORING SYSTEM

The installed monitoring system was PD-Guard/UHF produced by Doble Lemke. It consisted of: sensors installed in parallel with support insulators of cable termination (see Fig. 1); pre-amplifiers, installed close to sensors; an acquisition unit installed in a metallic cabinet at base of termination; and a server located in facilities of a substation. The server and the acquisition unit were interconnected by fiber optics. A 3G router was connected to the server, which allowed remote control of the monitoring system and data analysis from Internet.

Monitoring system PD-Guard/UHF is designed to measure signals in UHF bandwidth, i.e. 100 MHz - 1 GHz. The advantage of such design is that it allows for filtering the corona noise. The limitation is that high frequencies are strongly attenuated in a power cable and thus the UHF system can detect PD appearing only in proximity of the sensor, i.e. at the termination.

Since the system operates at UHF, conventional calibration procedures based on IEC 60270 cannot be applied. The system must be calibrated using a special fast rise-time pulse generator with short leads, which minimises the inductance in a calibration circuit. The pulses are applied across the sensor and such calibration generally is a sensitivity check, which allows for correction of slightly different sensitivities of the sensors and preamplifiers.

UHF measurements in mV could to some extent be related to conventional PD levels in pC. Laboratory experiments by Doble Lemke on similar cable system resulted in conversion factor of 200 mV/pC [7]. It must be noted that the factor is only indicative and must be used with care due to possible differences in termination configurations and PD nature.

Fig. 1: Installed sensor and pre-amplifier.