NEW APPROACH FOR HIGH VOLTAGE CABLE ON-SITE TESTING

Volker BERGMANN, TU-Berlin, Dep. of HV-Engineering, (Germany), bergmann@ihs.ee.tu-berlin.de
Peter MOHAUPT, BAUR Pruef- und Messtechnik GmbH, (Austria), p.mohaupt@baur.at
Wilfried KALKNER, TU-Berlin, Dep. of HV-Engineering, (Germany), kalkner@ihs.ee.tu-berlin.de

ABSTRACT

The focus of this contribution is the application of sinusoidal VLF test-voltage as it is established for medium voltage cable systems, also on high voltage cable systems. Therefore a HV-test-voltage source and a 110-kV test cable system were realised at the TU Berlin. Typical high voltage components were applied for comparing the results of PD measurements gained at 50 Hz and 0.1 Hz respectively. It could be found out that typical PD characteristics as PD inception voltage, maximum PD levels, average PD levels and even visual diagrams as PRPD pattern are very similar at VLF compared to 50 Hz measurements. A diagnostic assessment of high voltage cable systems can be successfully performed by PD measurements with applied sinusoidal VLF test voltage.

KEYWORDS

Sinusoidal 0.1 Hz VLF test-voltage, On-Site-Testing, PD measuring, HV-Cable-Testing, Artificial defects

INTRODUCTION

Due to higher loads on cable networks caused by liberalisation and deregulation of energy markets it is more important than ever to know the condition of the asset [1]. Therefore diagnostic measuring techniques as tan delta and PD can be very helpful to find weak spots in the cable grid in order to exchange single cable lines with expired lifetime.
Furthermore it is necessary to diagnose even new installed systems because of the ongoing outsourcing process and the resultant loss of know how.
For medium voltage grids the VLF test techniques are well known and accepted [2]. The advantage of these low frequency test voltages is the low demand of reactive power. This leads to smaller and lighter test devices with optimal mobility under on-site conditions.
Nevertheless it has to be ensured that all high voltage components of a cable system, designed for operation frequency, can withstand the VLF voltage as well. Also it should be considered that the results of diagnostic PD measurements can be compared with PD measuring results achieved at operation frequency. In this case all established interpretation methods can be easily adapted.

HIGH VOLTAGE TEST SOURCE AND DUT

At the high voltage test labs of the Technische Universitaet Berlin a high voltage VLF source was developed, constructed and tested in order to perform diagnostic PD measurements on a 110-kV cable system. A voltage test level of 3.5 U_0 can be reached at a very low PD base noise level (typ. <5pC) with this test arrangement.
The components of the test cable system are standard HV components as a XLPE cable, a slip-over joint, a GIS cable adapter, a GIS circuit breaker and an outdoor cable termination. Multiple PD sensors were installed at different components of the cable system to get maximum information about possible PD defects [3-5].

Test voltage source

The VLF test voltage source itself consists of two "Greinacher cascades" which generate a positive and a negative high voltage respectively. These voltages are afterwards superposed and this leads to a sinusoidal voltage with a frequency of 0.1 Hz at the test object.
In figure 1 a photo of the experimental test voltage source is shown. The three poles at the left and the right side of the room are parts of the cascades. In front the output of the voltage source can be seen, connected with two resistors to the cascades.

Figure 1: Photo of the experimental VLF test voltage source at the TU-Berlin

Test cable system (DUT)

One phase of a typical 110-kV test cable system was set up. The components of this test cable system are commercially available HV components:

Cable
As test cable a XLPE-insulated 110-kV cable with laminated sheath (2XS(FL)2Y 1x240/35 64/110-kV) was used. Two short lengths are connecting an air-insulated termination with the joint, and the joint with a SF6-insulated termination (GIS-side).

Outdoor cable termination
A silicon-insulated termination of type ES-S 110-kV (CCC GmbH, Berlin) was connected to one end of the HV cable.