Condition monitoring of high voltage cable lines based on damped ac technique

Zoltán Ádám **TAMUS**, Budapest University of Technology and Economics, (Hungary), tamus.adam@vik.bme.hu
Róbert **EGYED**, Omexom Hungary Ltd., (Hungary), robert.egyed@omexom.hu
☐ **Young Researcher** (Proved full-time engineering and science university researchers and Ph.D.students under 35 YO)

ABSTRACT

Cable lines are of particular importance for the reliability of the electricity supply. A significant proportion of cable line failures are due to the improper condition of accessories. The condition of accessories can be effectively assessed by PD measurements. This paper presents three case studies of measurements on old cable lines using the DAC method. Based on the results, it is concluded that the DAC technique is suitable for monitoring the condition of accessories and is suitable for predicting incipient failures.

KEYWORDS

Damped AC; Partial Discharg Measurment; Condition Monitoring; Cable Accessories;

INTRODUCTION

Cable lines have an important role in electric power transmission and distribution. Roughly two-thirds of cable line failures are caused by fittings failures [1]. Hence the continuous condition monitoring of these components has paramount importance. The accessories' condition testing is usually based on measuring the characteristics of partial discharges of a cable line [2]. The partial discharges can be measured online or offline, and both solutions have advantages and drawbacks. The former continuously provides information about the actual condition of a cable during its operation. The latter enables testing above the operating voltage of the line, although the line has to be disconnected from the network. The most common techniques of offline methods are testing at power frequency, very low frequency (0.1 Hz) measurement, resonant measurement technique (20-300 Hz) and damped ac (DAC) technique [3]. The advantage of the latest is the relatively compact equipment, which is suitable for the conventional measurement of partial discharges on the cable line. It also allows the location of partial discharges to be determined by reflectometry. In addition, it is suitable for measuring the loss factor of the cable line. Although the IEEE Std 400.4-2015 standard provides a guideline for using DAC techniques on high-voltage cables, evaluating the results without adequate experience is quite difficult. Through some case studies, this paper introduces the effective application of PD measurement-based condition monitoring of cable lines by the DAC technique.

CASE STUDIES

In this section, three cases are overviewed. The first case introduces repeated measurements on a high-voltage cable line containing accessories with continuous PD activity. The second case briefly presents a faulty oil-filled termination, including the consequences of the disassembly. The third case shows an extreme fault with intensive PD activity in an extremely noisy environment.

Case study 1 — rrepeated measurements over seven years

A 3542 m-long, 64/110 kV cable line was investigated several times between 2012 and 2019. The cable was installed in 1992, and the structure of the cable line is depicted in Figure 1.

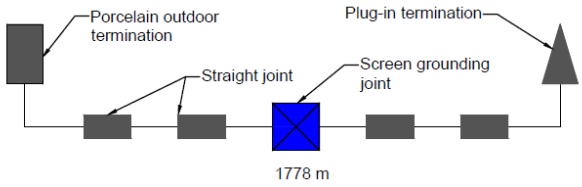

Fig. 1: The built-up of the case-study 1 cable line

Due to the cable's age, the operator asked for a diagnostic test, which was executed on 09/2012. The measurement results are summarised in Table 1.

	L1	L2	L3
PDIV [kV RMS]	76.4	75.7	76.4
PDEV [kV RMS]	64.3	66.9	64.1
PD level [pC] (PDIV)	106	102	83
PD level [pC] (Uo)	74	58	88
PD level [pC] (1.7Uo)	627	227	137
Capacitance [µF]	0.72	0.73	0.73

Tab. 1: Measurement results of measurement in 09/2012 (data from [4])

The PD inception voltages (PDIVs) are around $1.2U_0$ in each phase, and the PD magnitude at inception voltages is not high. Nevertheless, at $1.7U_0$, the PD level of L1 is extremely high compared to the others. Looking at the PD map, it is seen that the PDs in L1 originated in the screen grounding joint at 1778 m (Figure 2).

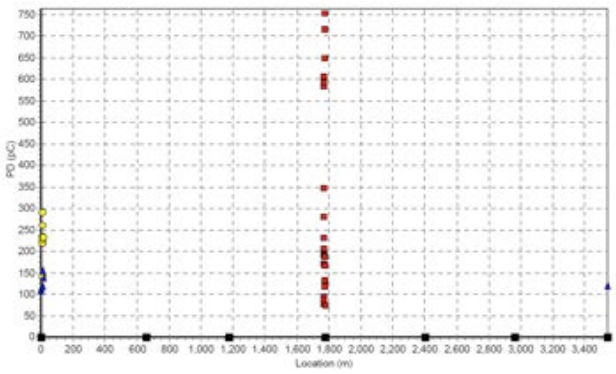

Fig. 2: PD map of the cble line in 09/2012 [4]

Since the loss factor of the line was below the measurable