ON-LINE SCREENING OF MV CABLE NETWORK GRID THROUGH PARTIAL DISCHARGE MEASUREMENTS

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ABSTRACT

Achieving a better grid reliability while dealing with an aging infrastructure is one of the main targets towards the grid of the future. In particular, power electrical distribution systems, considerably old in several countries, are susceptible to frequent failures. Partial Discharges represent an effective tool to assess the insulation condition of such MV systems. Running permanent monitoring represents, of course, the optimal technical solution, but can not be economically affordable for the distribution grid. Thus, periodical on-line PD tests can be a convincing alternative in order to carry out a screening of the network and conceive a maintenance plan. Methodologies and advantages of on-line PD tests are shown in the paper, focusing on MV cables.

KEYWORDS

Partial Discharge, Distribution System, Medium Voltage, Asset Management, Life Assessment, CBM

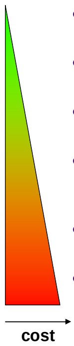
INTRODUCTION

Unexpected failures in MV cables can lead to huge indirect costs for power utilities and industrial plants. These are associated with extra man-working hours, loss of productions, penalties and also loss of image. Diagnostic quantities as, e.g., tandelta, sheath continuity, Partial Discharge (PD), and insulation resistance can be measured to carry out effective failure risk assessment, preventing outages. Such techniques may, however, envisage significant investments (in terms of both diagnostic apparatuses and personnel training). Moreover, most of them have to be carried out off-line, which means taking the cable out of service and using external voltage sources, thus, leading to a further increase of the costs. As an example, a common procedure to localize defects consists of performing PD measurement off-line using a VLF or OWTS generators, and locating the PD sources using reflectometric techniques [1, 2]. This procedure may be accurate, but quite long and costly, which suggests that offline PD location procedure must not be done extensively, but only at locations where PD activities have been previously observed and diagnosed as harmful.

In order to provide diagnostic practices that are both technically and economically viable, screening of MV cable networks on-line by PD detection and analysis seems the most promising solution [3]. This paper will describe a methodology and working cases relevant to MV cable screening by four basic steps: (a) PD detection, performed online using suitable sensors that ensure sufficient sensitivity and operator safety, (b) PD source separation, (c) identification, and (d) failure risk assessment. Steps (b) and (c) need to be performed since failure risk evaluation becomes possible only after having identified any single PD defect inside the cable. Then, diagnosis is carried out weighting several parameters as PD amplitude, repetition rate, and source nature (i.e., surface, corona, internal), as well as the cable insulation system (PILC, EPR, XLPE), age and rated voltage. The result of the screening consists of a series of alarms highlighting the cables which are critical. PD source location is carried out only in these cables, possibly on-line through either TDR or using GPS advanced systems.

ON-LINE TESTING PROCEDURE

The main task of the on-line screening of MV cables is to achieve the largest number of information about the electrical insulation, reducing both the cable shutdowns and the operators employment. In other words, operational costs shall be reduced as much as possible without affecting the quality of the diagnosis. For this reason we have sorted the operations which have to be carried out to achieve an accurate diagnosis prioritizing those which allow to get more information at lower cost:



- ONLINE PD detection – screening of the network
- PROCESSING: separation noise/disturbance/PD
- IDENTIFICATION: Corona / internal / surface
- DIAGNOSIS based on PD amplitude/trending and EXPERIENCE
- REPORT and SUPPORT to the CUSTOMER
- LOCALIZATION of CRITICAL EVENTS and OFFLINE TESTS if necessary

Each step is described in detail in the following.

PD Detection

A wide bandwidth detector (from tens of kHz to tens of MHz) is suggested to carry out the PD measurement on-line [4]. Indeed, conventional detectors ranging only in the IEC 60270 [5] bandwidth may not be effective enough because they are not able to separate external disturbances and environmental noise from the PD occurring inside the EUT. Furthermore, SNR can be poor if disturbances occur in the same bandwidth of the detector. The detection is generally carried out using HFCT inductive sensors (clamp-type, single-core or flexible) installed around either the cable ground lead or the cable itself [3,4,6]. The sensors are connected to the acquisition unit through coaxial cables, while the acquisition unit is connected to the operator's laptop through fiber optic. It must be underlined that a good acquisition is the base for a good diagnosis, which means that field operators have to be trained to correctly install the sensors (both for PD and synchronization) and to properly set all acquisition parameters (trigger, full scale, acquisition time, timelength etc) in order to collect a meaningful set of data. Furthermore, the sensor positioning shall be always the same if multiple