A new approach for evaluating the condition of cable systems and estimation of remaining life time of MV underground power cables

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ABSTRACT

The comprehensive understanding of the remaining life time of medium voltage cables was the key motivation for extensive cable diagnostics performed by the Korean Electric Power Corporation (KEPCO). Since 2011 more than 15,000 cable routes were diagnosed to assess the cable condition. A unique algorithm and evaluation logic was developed for accurate estimation of the remaining life time of XLPE power cables. The approach was evaluated over the past two years leading to appropriate assessment results. A study on the applicability of this methodology on other utilities network is shown in this study.

KEYWORDS

cable life time; VLF Tan Delta; cable diagnostic; KEPCO; life time assessment; asset management; condition monitoring.

INTRODUCTION

The importance of a reliable medium voltage cable network is well understood by the cable operators today. When planning the maintenance of these networks DSOs have to manage the conflicting requirements of scarce resources, high standards in terms of service security and the issue of networks that become older and more complex. In addition, the energy transition towards renewable energy sources pushes underground cable networks to their limit.

Very Low Frequency (VLF) Monitored Withstand Diagnostic was found to be a very effective tool for the evaluation of the cable condition. Based on the results a decision on the urgency of partial or sectional replacement can be made [3]. The estimation of the remaining life time of a cable is the challenging key for DSOs in order to manage investments and resources. In Europe it can be assumed that the average costs for the installation of a new cable route is in the range of 100,000 €/km. Commonly the life expectancy of a XLPE cable can be assumed with 30 to 40 years. A reliable diagnostic tool allows categorizing an old cable to be still in a healthy condition. Therefore, the cable can remain in service for another 10 years. The resulting extension of the life expectancy a particular cable route can be quantified up to 25 % of the initial investment cost. In case this applies to several cable routes savings of several 100,000 € per year are possible. The application of the best cable diagnostic tool available today and result–based diagnostic knowledge are the fundamentals for finding weak cable sections which can be replaced individually, instead of replacing the entire routes [7].

XLPE cables were installed all around the world since the early 1980s and already reach service life times of close to 40 years, whereas nobody can seriously define the life cycle of a XLPE cable.

How can the remaining life time of medium voltage power cables be estimated?

KEPCO Korea (Korean Electric Power Corporation) has addressed this question during the past years to their research group and found a unique solution and answer to this question. Korea Electric Power Corporation (KEPCO) can be considered as the leading pioneer who implemented cable diagnostic on a large scale for their entire distribution cable network. Since the implementation of VLF Tan Delta and VLF Partial Discharge Diagnostic in 2011, more than 15,000 cable routes were diagnosed in Korea, with the intention to understand the health condition of each individual cable. KEPCO's primary goal was always to strive for a position where a remaining lifetime of a XLPE cable can be estimated. With the vast amount of diagnostic data KEPCO developed a statistical tool that allows identifying a critical state of a cable when a cable failure is very likely to happen. Combining VLF Tan Delta (TD) and Partial Discharge (PD) diagnostic it is possible to identify and localize weak individual spots along a cable. After weak spots are cleared, the general aging condition of the cable can be judged by the new approach of KEPCO and the remaining life time can be estimated. This new tool is available to asset managers to help developing a preventive maintenance strategy for their power networks all around the world.

This study shall also reveal the applicability of the KEPCO approach to other distribution system operators (DSO). Diagnostic results are compared with the KEPCO approach in order to understand how XLPE cables of other utilities can be judged in a comparable way.

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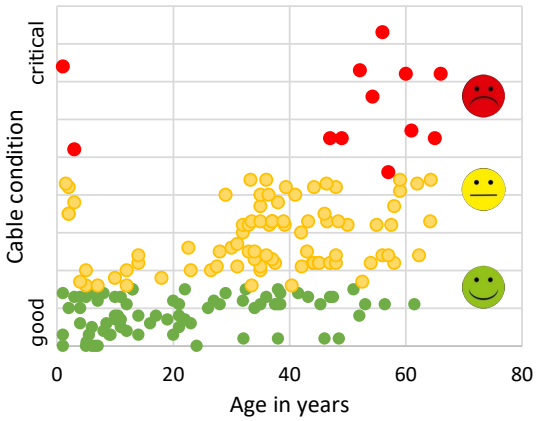

Fig. 1: Distribution of cable condition vs. duty period