EVOLUTION OF DISSIPATION FACTOR VALUES OF NEW AND PRE-AGED PILC CABLES REGARDING FREQUENCY AND TEMPERATURE

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ABSTRACT

The ageing behaviour of new and pre-aged PILC cables is investigated in an extensive ageing test field under laboratory conditions. Within this setup, the test specimens are aged at an artificially accelerated rate. The results of this test setup are described for two frequencies (0.1 Hz/ 50 Hz) and two temperatures (10 °C/ 70 °C). The behaviour at different lifetime levels and the development of the measured values for the dissipation factor are discussed. When comparing the different measurement curves with regard to temperature and frequency, large differences in the dissipation factor values can be detected over time. This can be attributed to different conductivity and polarization effects.

KEYWORDS

PILC Cables, Dissipation Factor, Accelerated Ageing, VLF, Degeneration

I. INTRODUCTION

The framework conditions in power technologies have changed steadily in recent years. For example, centralized energy generation is changing to more and more decentralized generation. Moreover, the type of utilization will continue to significantly evolve in the future, for example, due to the rising share of electro mobility and heat pumps. Today in particular, network operators must therefore consider new approaches in order to operate their networks as optimally as possible. Hence, a project was initiated to investigate the ageing behaviour of medium-voltage cables. The examined specimens are paper-insulated, lead-covered cables (PILC cables), which were standard technology until the 1980s. Today, they still represent a large share of the existing medium-voltage grid. Due to the resulting age structure of these cables, more accurate estimation of the remaining service live will be necessary in the future.

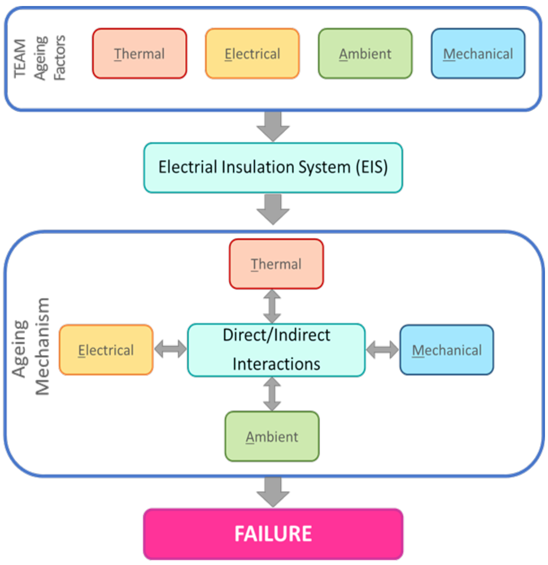

Figure 1: TEAM Ageing Factors[1]

Therefore, a project for artificially accelerated ageing of medium voltage PILC cables has started in 2017. Within the project, the ageing behaviour of new and pre-aged cables is precisely detected through an extensive experimental setup, enabling conclusions to be drawn about the particular ageing process in the future. In this paper first, the ageing processes within PILC cables are discussed as well as the experimental setup for artificially accelerated ageing is introduced in more detail. Subsequently, various results from the experiment will be presented and possible conclusions drawn from them with regard to the ageing behaviour. Based on the measurement results, different statements can be made about influencing factors with regard to the polarization and conductivity of aged cable test specimens. Since the measurement results are observed over a long period of time, it is also possible to detect improvements (e.g. due to the reflow of insulating compound).

II. AGEING PHENOMENA

In the following section, the individual factors influencing the ageing and degeneration of PILC cables are discussed.

A. Influencing Ageing Factors

According to IEC 60505 [1], ageing is an irreversible change in the properties of an electrical insulating system (EIS) as a result of exposure to one or more stresses. The stresses can be thermal, electrical, ambient and mechanical stresses (TEAM stresses), which have a negative effect on the electrical insulating medium (see Figure 1). The TEAM stresses can also lead to specific ageing mechanisms, which have a direct respective indirect effect on the EIS. Furthermore, a so-called multi-stress ageing may occur. This includes not only a singular ageing factor, rather one or more additional ageing factors. In addition to the influences themselves, the time aspect in which the influences affect the EIS must also always be taken into account. In this respect, long-term medium loads can be equally destructive to the insulation system as short-term high loads. Above all, the chemical decomposition processes (such as pyrolysis of the oil-paper layer of the cables) are also activated in short periods of time and can lead to a significant destabilization of the EIS [2], [3].