

The influence of operating conditions of cable lines in grids on selected properties of extruded cable insulation

Jozef Jacek **ZAWODNIAK**, Aleksandra **RAKOWSKA**, Poznan University of Technology, Poland,
jacek.zawodniak@wp.pl, aleksandra.rakowska@put.poznan.pl

ABSTRACT

Medium voltage cable lines maintained by distribution companies operate in various configurations – in underground power networks or in mixed configurations with overhead power lines. Tests of several dozen sections of MV cables with extruded insulation, maintained in real conditions, confirmed that the process of degradation of polyethylene cable insulation depends on where the cable is placed in the MV power network. Measurements of thermal properties and resistance to partial discharges, and assessment of molecular molar mass of particular insulation layers were conducted, with the samples of insulation obtained from real cables.

KEYWORDS

distribution power cables, thermal impact on extruded insulation.

INTRODUCTION

Currently we observe a dynamic increase in the rate of use of cable lines in service in the MV power network. Therefore it is necessary to pay greater attention to the state of the cable lines. It is also necessary to study the phenomena which may have a destructive influence on the insulation system of power cables maintained in various operating conditions. In recent years no new cables with impregnated paper insulation have been installed, and cables with extruded insulation dominate in MV power networks.

In predicting destructive phenomena in insulation systems of power cables it is necessary to include knowledge gained by research and development centers. Thorough analysis of destructive phenomena should encompass, on the one hand, knowledge gained in laboratory analysis, regarding the scale of degradation of polyethylene insulation), and on the other hand an assessment of operating conditions of the network where a given cable line works and where the researched samples come from. Such analysis will make it possible to determine the impact of particular parameters on degradation of polyethylene insulation of cables. It will also make it possible to determine how to maintain a cable line to limit the influence of degrading factors. Knowledge gained by R&D is also applicable in the process of making decisions about implementation of new technologies in installations, especially in existing distribution power cables, where the insulation is already weakened as a result of prolonged service. The fulfilment of a goal which has priority at a given moment may have unwanted consequences in the future, in terms of long term expenses.

Tests of several dozen parts of MV cables with extruded insulation, which were in service in real conditions, confirmed that the process of degradation of polyethylene cable insulation depends on where the cable line is located in the MV power network. Measurements of thermal properties and resistance to partial discharges, and assessments of molecular molar mass of particular insulation layers were conducted.

Analysis of the measurement results led to the conclusion that changes in selected properties of the extruded insulation of MV cables maintained in real conditions depend on the kind of cable network. In cable insulation coming from the lines working in underground power networks faster deterioration of the physical and chemical properties of insulation is observed next to the metallic screen (return conductor), while in the cable cooperating with the overhead line the destruction processes are more prominent in the insulation next to the conductor.

MV CABLE LINES – MAINTENANCE CONDITIONS

The most important electrical parameter of insulating systems is electric strength, defined as breakdown voltage, causing permanent destruction of a solid material. The operation of external factors may lower electric strength due to degrading processes in extruded insulation. As a result of these degrading processes, the polymer chains in polymer insulation may become deformed, insulation may oxidize, molar mass of the material may decrease, and some properties and parameters may change. In microscale, the mechanical process of degradation of polyethylene consists in extension and breakup of the polymer chain, the creeping of molecules, cracks and tensions in the polymer. The scale of mechanical degradation and the moment it appears are very difficult to establish as mechanical degradation results from a number of factors. Therefore it is extremely important to follow the recommendations regarding the installation work and the instructions issued by manufactures of cables and accessories.

One maintenance hazard which has a destructive impact on cable insulation systems is inner overvoltage (Table 1), which occurs e.g. during recovery after short circuit, especially those cases that lead to re-ignition of the arc. Phenomena which accompany short circuits in cable lines depend, among others, on work conditions of the neutral point of the MV network. In the national MV distribution network the following ways of grounding are used: network with isolated neutral point, network with neutral point grounded by inductance (impedance), network with neutral point grounded through resistance. In some cases overvoltage can exceed accepted values of overvoltage