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Influence of corroded conductor on the performance of medium voltage extruded cables

PELISSOU S., Hydro Québec (IREQ), Canada

COTÉ J., SAVAGE R., ST ANTOINE S., Hydro-Québec (Distribution), Canada

Abstract : This paper presents the results of the characterization of medium-voltage extruded cables, with a corroded aluminum conductor and aged under various simulated field conditions. The goal is to determine whether “milky” water found in the conductor strands or the corrosion left on the conductor surface affect the performance of the cable. The field-aged cables, 28 kV class and XLPE insulated, were further aged under four conditions for the inner conductor: with and without water, with an aqueous solution, and with silicone. The results indicate that the presence of water and corroded aluminum in the conductor strands decreases cable performance. Furthermore, it is found that silicone-injected cable samples have in their insulation the least amount of water and the least number of and smallest water trees, along with the greatest AC breakdown strength.

Keywords: Corrosion, cables, performance

1. Introduction

In the underground distribution network, “milky” water is occasionally found in the inner aluminum stranded conductor of extruded cables [1]. The water may have entered into the cable either during installation or aging, or is the result of ingress through an unsealed termination. When the inner conductor is made of aluminum, the water may corrode it and alumina is formed, which explains the whitish color. This raises the question to what extent the milky water or the corrosion left on the conductor surface affects the performance or aging of the cable? It is already well known that the presence of water in the insulation of cross-linked polyethylene (XLPE) cables leads to water treeing degradation and ultimately to cable failure [2-5].

To fully address this question, results are presented on the characterization of a field-aged medium-voltage XLPE cable with a corroded aluminum conductor and after further aging under various

Résumé : Cet article présente des résultats sur la caractérisation de câbles extrudés moyenne tension, avec âme conductrice en aluminium corrodée, soumis à différentes conditions simulées de service. Le but est d'évaluer si l'eau « laiteuse » trouvée dans l'âme ou la corrosion laissée en surface a une influence sur la performance du câble. Les câbles, provenant du service, de classe 28 kV et isolés au XLPE, furent vieillis sous quatre conditions pour l'âme : avec et sans eau, avec une solution aqueuse et avec du silicone. Les résultats révèlent que la présence d'eau et d'aluminium corrodé dans l'âme réduisent la performance des câbles. De plus, il fut trouvé que les câbles injectés au silicone avaient la plus faible teneur en eau, le moins et les plus petits arbres d'eau, sous des gradients diélectriques en alternatif les plus élevés.

Mots clés : Corrosion, performance, câbles

simulated conditions. Four conditions were selected for the conductor strands: without water, with water, with an aqueous solution, and with silicone XL. These conditions enabled us to evaluate the cable samples once internally dry, with more or less further corrosion of the aluminum strands, and under a possible solution of rejuvenation, but all of them immersed in water. The characterization consisted of an inspection of the conductor strands, residual dielectric strength, insulation water content and treeing analysis.

2. Experimental

The cable under study was retrieved from service due to a failure after 15 years in a duct system. Its characteristics consist of: triplex cable, 28 kV class, 750 kcm aluminum compact conductors, XLPE insulated, steam-cured, concentric neutral and no jacket. At delivery, the cable was 150 m long and had milky water in the conductor and the strands were corroded, especially phase C, which was selected for the tests. Figure 1 shows the relative position of the