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Investigation of electrochemical degradation in a service-aged, cable-cure-restored-PE-insulated M.V. cables

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Abstract: The restoration of medium voltage cables by the cable-cure-method results in certain cases in increased number of failures which were often observed at cable-thickenings. It was found in microscopical investigations that strong corrosion of the conductor by methanol generated by the crosslinking of the injection fluid causes the cable-thickening. The presence of mechanical stress and electrolyte in the wire-area lead to the formation of cracks in the semicon layer by the ageing phenomenon SIED. The SIED-structures could initiate vented trees as well as effect strong punctual mechanical stress on the insulation leading to damages in the polyethylene and electrical failure of the cable.

Keywords: Electrochemical degradation, cable-cure-restoration, m. v. PE-insulated cables, failures

1 Introduction

Polyethylene insulated medium voltage cables manufactured in the beginning of the 70's are known to be very susceptible to water treeing at contaminants and protrusions when being exposed to wet ageing conditions. After several decades of service-ageing the number of failures can be unacceptable high and an expensive renewal of the cable-lines seems to be inevitable.

A possibility to restorate and conserve water tree aged cables was, however, developed by CableCURE®. It bases on the filling of the water tree structures with a polysiloxane-fluid.

Thereby, a special cable-cure-fluid (Phenylmethyl-dimethyloxisilane) is injected into the conductor area, diffuses into the insulation system and polymerizes under the influence of water inside the water trees. The filling of the water trees with low permittivity material effects the rejuvenation of the service-aged insulation system and leads to an improved residual breakdown strength of the cables.

Résumé: Dans certains cas, la réparation de câbles de moyenne tension par la méthode "cable-cure" a eu pour effet d'accroître les défaillances déjà observées là où le câble s'épaissit.

Grâce aux investigations par microscope, on a découvert que c'était une forte corrosion du conducteur par méthanol créé par l'injection du fluide de réticulation qui était à l'origine de l'épaississement du câble.

La présence de contrainte mécanique et d'électrolyte dans la région des fils conduit à la formation de fissures à l'intérieur de la couche semi-conductrice, phénomène dû au vieillissement SIED. Les structures pourraient générer des arborescences ainsi qu'un effet de contrainte mécanique ponctuel et fort sur l'isolation, occasionnant des dégâts dans le polyéthylène et causant la défaillance électronique du câble.

Mots clés: Dégradation électrochimique cable-cure restauration, corrosion, échec du câble

The restoration of older service-aged medium voltage cables by the cable-cure method has been applied successfully for over 15 years in the US cable network.

As advantages of the cable-restoration compared to the complete renewal of the cables low costs and increased service-reliability are claimed.

The cable-cure method was used by some German utilities, too. However, the testing and using of cable-sanitation in the German cable network in the last years had not always the expected success and lead in certain cases even to an increased number of failures which were observed very often at cable-thickenings [1]. The possible causes for the formation of this cable-thickening, which seems to be responsible for the failures, are reported and discussed in this paper. Furthermore, it is discussed why such failures were not observed and reported from US cables.

2 Restoration method by cable-cure

The restoration method by CableCURE® can be described as follows [2]: