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Novel polymeric insulating compounds for HVDC applications

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Abstract: The advantages and concerns of HVDC extruded polymeric cable are discussed. Three different very low density polyethylene (VLDPE) resins made by various catalysts were evaluated by space charge measurement using PEA and a dc life test with polarity reversal. Effects of additives used with these resins were also studied by space charge measurement. Our results suggest that screening HVDC materials can not be based on a sole space charge measurement. One of the compounds showed excellent space charge characteristics as well as long life performance and appears to be a very good candidate for HVDC applications.

Résumé: Les avantages et inconvénients des cables HVDC (Haute tension, Courant Continu) à isolation polymérique extrudée sont discutés dans cet article. Trois résines PE très basse densité, produites au moyen de différents catalyseurs, sont évaluées par mesure de dispersion de charge (méthode PEA - Pulsed Electro Acoustic) et au moyen d'un test d'endurance sous courant continu à inversion de polarité. Les effets d'additifs introduits dans ces résines sont aussi étudiés par mesure de dispersion de charge. Les résultats montrent que la seule mesure de dispersion de charge ne peut à elle seule différencier les matériaux. Un des compounds montre une excellente caractéristique de dispersion de charge, de même que de bonnes performances d'endurance, et apparait comme un bon candidat pour des applications HVDC.

Keywords: HVDC cable, PEA, Life Test, VLDPE, Space Charge Measurement

Mots clés: Cable HDVC (Courant continu Haute Tension), PEA, test d'endurance, PE Très Basse Densité, Mesure de dispersion de charge.

1. Introduction

Over the last few years, there has been a high level of interest in polymeric insulations for high voltage dc applications. DC power transmission has several advantages over AC power transmission. These advantages include no length limit, particularly for long-distance submarine cables (>50 km), good connectivity among different networks/sources (e.g. windmills), lower operating cost due to low conductor loss and no power loss, superior power quality and flow control for system reliability/stability, and higher voltage ratings.

DC cables are usually more economical than ac cables due to low conductor loss and thinner insulation thickness for the same power rating. However, this saving is offset by the ac-dc converter equipment cost. For a given transmission power, the economical HVDC cable length is estimated at not less than 30 km for submarine cable system and not less than 80 km for an underground system [1].

Oil/paper cables have been used successfully for HVDC power transmission. The world's first HVDC oil/paper submarine cable was installed in 1954 and has shown properties equal to those of a new cable after 32 years of service [2]. Crosslinked polyethylene (XLPE) cables have several advantages over oil/paper cables for HVDC applications, such as lower cost to make, lower operation cost, ease of maintenance, higher temperature rating (90 vs. 60 - 70°C), and are environmentally friendly (due to no oil leakage). However, XLPE without modification can not be used in HVDC cable applications due to a significant reduction in dc breakdown strength when a dc