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New XLPE insulation for HV and EHV cables

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Abstract: With its excellent electrical insulating properties, superb mechanical properties, environmental compatibility, and low cost, crosslinked polyethylene (XLPE) is the material of choice for insulating high voltage power cables. New crosslinkable polyethylene insulation materials have been developed, which provide significant advantages for cable manufacturing operations and cable quality while maintaining the excellent dielectric properties expected from XLPE. These new formulation technologies are currently being utilized in commercial standard melt index and low melt index (low sag) XLPE compounds. The performance of these new insulation materials in terms of properties important to the cable manufacturer and the cable user will be presented.

Keywords: polyethylene, cross-linking, scorch, dissipation factor.

Résumé: Les excellentes propriétés électriques et mécaniques du polyéthylène réticulé, ainsi que son coût réduit, en font un matériau de choix pour la réalisation des isolations de cables Haute Tension.
Les caractéristiques de nouvelles formulations d'isolation en PE réticulé sont présentées ici: Elles offrent de meilleures propriétés de mise en oeuvre et une amélioration de la qualité du cable fini, tout en maintenant les excellentes propriétés diélectriques attendues d'un PE réticulé. Ces nouvelles formulations sont commercialement utilisées dans des compounds à indice de fluidité standard ou réduit ("low sag").

Mots clés: polyéthylène, réticulation, roussissement, facteur de dissipation.

1. Introduction

Over 40 years ago, polyethylene was introduced as an insulation material for electric power cables. Polyethylene's inherent characteristics of toughness, resistance to chemicals and moisture, low temperature flexibility, and excellent electrical properties, along with low cost and easy processability, make it a very desirable material for insulating low, medium and high voltage electric cables. Since its introduction, there have been a number of significant advances in materials technology that have contributed to polyethylene's continued worldwide position as the material of choice for insulating cable.

One area of dramatic improvement over the years has been in the cleanliness of the insulation. Today's high voltage and extra high voltage cables use "super clean" insulation materials to achieve their high levels of performance These "super clean" materials have a very high level of cleanliness. Reduced contamination levels over the levels experienced 40 years ago have been found in the USA and Europe to increase lifetime expectance for long term operation reliability of both medium and high voltage cables.

Cross-linking polyethylene via organic peroxide has emerged as the dominant process technology employed throughout the world for medium and high voltage cables. The choice of the cross-link additives and the stabilizers has a significant influence on the short and long term performance of medium and high voltage cables as well as the extrusion characteristics of the insulation compounds.

Though the production of peroxide cross-linked polyethylene cables via extrusion processing has been practiced for over thirty years, the extrusion of these materials is still a complicated art in which process and compound formulation technology are very much interrelated. One such interrelationship is between the peroxide and the extrusion processing of the polymeric insulation. On the one hand it is desirable to extrude the insulation at high rates with long runs in order to maximize process economics. On the other hand, peroxide, which is required to cross-link the polymer in order to meet the property requirements of the finished cable, undergoes a low level of homolytic cleavage even at relatively low extrusion temperatures such that premature low levels of cross-linking occur during normal extrusion of cable insulation. Such premature cross-linking,