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The continuing evolution of semiconductive materials for power cable applications

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Abstract: The high quality of modern semiconductive screening materials has played an important role in providing the good reliability of XLPE power cables. Materials engineering have enabled advances in productivity by both increasing process temperatures and decreasing the risk of large defects.
The evolution of smoother and cleaner screens over the last 10 years has been significant and continues. At the very highest voltages major infrastructure projects utilise semicons with enhanced performance. Standard performance semicons have proven an extremely effective solution for distribution cable systems.

Keywords: Power cable, XLPE, semiconductive, processing, electrical properties, surface smoothness

Résumé: La qualité élevée des matériaux modernes pour écrans semi-conducteurs a été un facteur déterminant dans la fiabilité des câbles d'énergie PRC. Le développement continu de ces matériaux a permis des avancées sur le plan de la productivité aussi bien en augmentant les températures de mise en oeuvre qu'en diminuant le risque de défauts importants.
L'évolution au cours des dix dernières années aussi bien en ce qui concerne l'état de surface des écrans semi-conducteurs que leur niveau de propreté, a été significative et se poursuit. Les projets d'infrastructures THT de grande envergure utilisent des matériaux semi-conducteurs aux propriétés de surface et de propreté maximales. Les produits semi-conducteurs « standard » ont d'autre part largement fait la preuve de leur efficacité au sein des réseaux électriques de distribution.

Mots clés: Câble électrique, PRC, semi-conducteur, traitement, propriétés électriques, état de surface

1. Introduction

The reliability of XLPE cables has continuously improved since this technology was introduced to complement and then replace paper-insulated cables. The most important development steps have been the introduction of extruded conductive screens, triple extrusion, N_2-gas curing (instead of steam curing), higher requirements on cleanliness of the XLPE compounds and the introduction of high quality semiconductive materials. All of the improvements have together, enabled safe design and production of high stress AC and DC cables.

Experience (both from service and test) with cables of all voltages (MV – EHV) have clearly shown that the semiconductive screening layer plays a very important role in the successful operation of a power cable. The semiconductive compounds have been subject of tremendous development over the last two decades and have kept pace with all of the other advances in cable technology. The guiding principles in the semicon developments have been:

1. Improved electrical performance enabling higher stresses to be used
2. Extension of cable endurance, thereby increasing the longevity of cables
3. Easier and more robust processing

In order to realise these improvements and transfer them to practical cable performance it has been necessary to focus attention on some key attributes.

- Reduction in concentration and size of surface defects
- Increased chemical cleanliness
- Better resistance to precure – scorch
- Superior thermal stability
- Improved measurement techniques (smoothness, scorch etc) for both development and production

This paper will review the progress that has been made in the development of semiconductive materials for peroxide crosslinkable applications. Furthermore it will indicate further trends in development in terms of both measurement methods and materials technology.