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B.4.1. Développement de matériaux pour des techniques nouvelles de rétraction à froid

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Résumé Dans l'industrie des accessoires de câbles de puissance, la recherche de matériaux est à la base du développement de tout nouveau produit. Cette exigence est d'autant plus necessaire pour la nouvelle technologie du "rétractable à froid". En effet, les performances électriques et mécaniques requises sont dans ce cas tellement sévères, que la réalisation d'un produit fiable ne peut s'envisager sans un contrôle parfait des élastomères utilisés. C'est dans cet esprit que nous avons développé une jonction de câbles moyenne tension rétractable à froid, basée sur une étude exhaustive des matériaux. A titre d'exemple nous présentons dans cet article la démarche suivie pour aboutir à l'optimalisation d'une matière isolante pour le corps de jonction. Cette approche fut également respectée dans le développement des autres matières de la jonction, et est directement transférable à tout type de matériaux.

B.4.1. Material development for the new cold shrink technology

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Abstract Material research is the basic point of any new product development, but it is even more true in the cold shrink technology. The materials performances required are in this case so severe (combination of high mechanical and electrical properties), that a final reliable product cannot emerge without a perfect control of elastomers.
Within that context, a cold shrinkable joint for medium voltage has been successfully developed, based on an exhaustive study of materials. As an example, we will present in this paper the scientific process that has been followed for the development of an insulation for a medium voltage cold shrinkable joint. This approach was also taken for the development of other materials of the joint and this concept is general for the development of any type of materials.

I. Introduction

In the medium voltage cable accessories field, a new technology is emerging that presents numerous advantages compared to the existing ones. The so-called "cold shrink technology" combines the non size sensitive features of the heat-shrinkable products (stock reduction) and the installation security of the slip-on technology (no flame, no special tools). In this new technique, the accessory is pre-stretched on a removable support at the production site. During the installation on the cable, the support is removed and the accessory shrinks and can adapt on a wide range of cable sections. By making the most of this new concept (accessory completely pre-installed on the production site), the installation ergonomies of the product can be notably improved, in comparison to the existing technologies.
More than any others, this new technology relies on the mastering of materials. Added to the severe electrical properties required for any medium voltage accessories, the cold shrink materials must have very specific mechanical features to adapt to a wide range of cable sections, after pre-stretching.
This objective cannot be reached without a rigorous and exhaustive study. As an example, we present in the paper the resulting insulation developed for a medium voltage cold shrink joint.
First the required properties of the final product have been defined. We have then studied the influence of each formulation constituent on the developed material, leading to a hierarchization of the formula parameters.
In this paper, the influence of content and nature of fillers and extender on physical (e.g. hardness, elongation at break, tear resistance, modulus), electrical (e.g. dielectric losses and dielectric strength before and after immersion in boiling water), and visco-elastic properties (e.g. shrinkability at 0°C) of the material is presented.

The comparison of results to the requirements has allowed to define a functioning domain for each material property. The correlation of all the results has lead to an optimum formula specifically adapted to the insulation layer of our cold shrink joint. This approach has been directly transposed to the development of the other layers.

II. Required properties

Any cold shrinkable product must present a combination of high electrical and mechanical performances. The product must be storable under radial expansion during 2 years minimum and shrink on the cable with less than 25% instantaneous set. The product can be installed under severe conditions, as well as at very high and at low temperatures, in humid regions... The product will be installed mainly underground and will have to resist to various aggressions.
After the installation on the cable, the product has naturally to ensure a long term operability under high thermal, mechanical, and electrical stresses, under various climatic conditions.
On the material side, the impact of the pre-cited requirements has lead to high mechanical properties, like high elongation at break and tear resistance, low residual deformation after long expansion time and quick recovery in a wide range of temperatures
($-5°C < T < +40°C$); high electrical performances, e.g. for the insulation layer : high dielectric strength and low dielectric losses, even after immersion in boiling water. The specifications vary also depending on the considered material of the joint.