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USE OF NANOFILLERS IN HIGH PERFORMANCE OF MV CABLES UNDER FIRE CONDITIONS

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ABSTRACT

Currently, most new specifications of MV flame retardant cables request for a high performance under fire conditions, low smoke production and good mechanical properties. Indeed, this is due to fire safety issues which are increasing its level of demand. This performance is difficult to obtain via traditional technology. The authors present two different achievements of the General Cable group where nanotechnology is used.

The paper describes the most important properties of the oversheath nanotechnology compounds, which make them the most suitable material to use in MV flame retardant cables.

KEYWORDS

Nanofillers, Fire performance, MV cable, HFFR material.

INTRODUCTION

As it is well known, the main feature of the oversheath of a MV cable is to protect the core (including inner screens) from potential outer damages: mechanical shock, humidity diffusion as well as soluble ions which can flow from the earth. Lately, in many cases, MV cables technical requirements ask for higher mechanical properties of the oversheath (1) in order to avoid problems during rough installation conditions (abrasion). Furthermore, the cable shall comply with fire propagation and low smoke emission issues. In this article two real cases are considered where the use of nanotechnology has allowed achieving an optimum design.

The first cable considered (case 1) is a MV cable (rated voltage up to 18/30 kV) used in tunnel applications. Actually there was no previous design because of two issues related to the oversheath that couldn't be properly balanced: flame retardancy and high mechanical properties (tensile strength and elongation at break). The use of these new materials has shown a rather good behaviour. It complies with the requirements of flame propagation test on bunched cables (IEC 60332-3-23 Category B) demonstrating an improved performance (slow combustion and low smoke emission) due to the effect of char formation (fire barrier) produced by the nanofillers combined with good mechanical properties that ensure abrasion resistance.

The second cable (case 2) is, as well, a medium voltage cable (rated voltage up to 18/30 kV) designed for fixed installations such as distribution networks or industrial installations. The new sheathing compound substitutes the previous double-layer design (oversheath and fire barrier) for a single flame retardant oversheath. In the same manner as the former case the high fire performance is achieved by the improvement in fire retardancy but especially by means of the char formation effect. In this case it passed the fire propagation test (IEC 60332-3-24 Cat. C).

CABLE DESIGNS

Some cable prototypes were manufactured in order to carry out the research presented in this paper. The following table shows the basic information and the comparison between the previous designs (case 1 and 2) and the final ones improved using materials with nanofillers (case 1+ and 2+):

	Cross section (mm^2)	Rated voltage (kV)	Construction Standard	Over-sheath	Fire Barrier
1	1x240	12/20	UNE 211620-5E (DMZ2 Type)	TPO-01	Yes
2	1x150	12/20	IEC 60502-2 (ST8 Type)	TPR-05	Yes
1+	1x240	12/20	UNE 211620-5E (DMZ2 Type)	TPO-03	Yes
2+	1x150	12/20	IEC 60502-2 (ST8 Type)	TPR-19	Not necessary

Table 1: Basic features of each cable design

It is important to highlight the difference between the oversheath materials in both cases. ST8 type (see IEC 60502-1 Table 18) is considered a "soft" material (low mechanical properties) whereas DMZ2 is more suitable for rough installation conditions. In this case, the cable is subjected to potential damage, cracks, due to abrasion or tear.

ST8 TYPE

ST8 type flame retardant materials are not new, in fact, very well known. The balance between moderate mechanical properties and quantity of fillers (mostly mineral flame retardants) needed to pass the fire tests it's relatively easy to achieve. The main objective of the work presented in this paper (case of study 2) was to develop a high performance material in terms of flammability, HRR, heat of combustion, char formation…good enough to pass the fire tests bearing in mind to:

- Minimise the thickness of oversheath
- Remove the extruded fire barrier
- Reduce the overall diameter

Furthermore, this material can be compounded in-house and extruded at a high velocity.