EXPLORING THE WATER TREEING INHIBITION EFFECT OF ANTIOXIDANTS FOR XLPE INSULATION

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ABSTRACT

A review of commercial water tree retardant XLPE insulations reveals that water tree resistance is generally obtained by the use of either WTR additives, or polymer modification, or both.
Some of these formulations are now proven and their up and down sides are well known.
*This communication presents exploratory work conducted to identify antioxidants that have the dual effect of providing long term thermal stability **and** enhancing the water treeing resistance of XLPE.*
This line of research is thought to be of interest, for its simplicity of implementation (substitution of antioxidants), its cost effectiveness (no other additive or polymer modification required) and its compatibility with all cable manufacturing technologies (ready-to-use XLPE, self compounding, peroxide injection).

KEYWORDS

XLPE, water treeing, water tree resistance, liquid antioxidants.

INTRODUCTION

A review of publications reveals that water tree retardant XLPE insulation in now widely accepted and that the benefits provided by the new compounds is becoming increasingly quantified [1] [2].
We, however, noted that the approach to provide water treeing resistance is not uniform [3] [4] [5] and can consist of using polar polymer blends (Homopolymer-copolymer), non polar polymer blends (Homopolymer – non polar polymer), water treeing retardant additives, or even a combination of the above. This is summarized in figure 1.

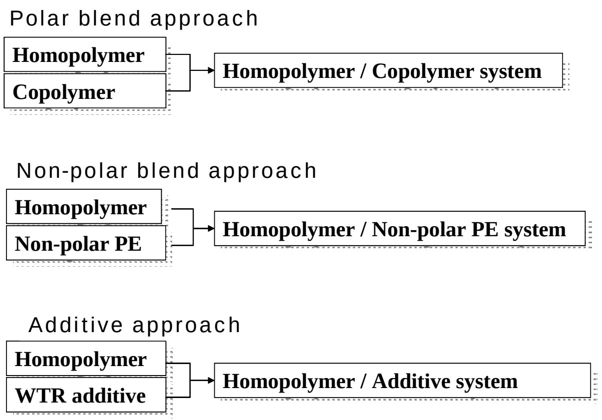

Figure 1: Approaches to water tree inhibition

However, the various approaches have advantages and limitations. The well known downsides for the various technologies can be summarized as follows:

Polar blend:
- Restricted to fully bonded insulation shields
- Higher dielectric losses

Non polar blend:
- Cleanliness of second phase polymer
- Gels in the second phase polymer

Additives:
- Permanence of effect
- Higher dielectric losses
- Exudation of additive

The composition of a water tree retardant XLPE insulation is relatively simple (in terms of components):

Composition of WTR XLPE:
- Polymer (single or blend)
- Peroxide for crosslinking
- Ao for thermal stability
- Water treeing inhibitor

The concept of an antioxidant with water treeing inhibition characteristics looks appealing, on paper, because it could replace totally or partially a component (the water treeing inhibitor itself) that may have the drawbacks of permanence, sweat out, dielectric losses and/or cost.

FOCUS OF THE STUDY

We focussed our study on antioxidants susceptible to be compatible with the XLPE technology and requirements, namely:
- Ageing
- Crosslinking
- Reduced sweat out
- Reduced water treeing growth
- High cleanliness, implying that it had to be liquid to allow fine filtration

Among the antioxidants initially screened, two appeared particularly promising (AO-L1 and AO-L2) and, therefore, were fully evaluated in an XLPE formulation and compared to the classical solid antioxidants (AO-S1) currently used in XLPE compounds.

Ageing

At this point in time, no optimization of the antioxidant content was attempted, it was established first that 0.2% of the liquid antioxidants were sufficient to pass the 10 days at