Development of a XLPE insulating with low peroxide by-products

Jean-Christophe **GARD**, Isabelle **DENIZET**, Mohamed **MAMMERI**

General Cable, Montereau, France,

jcgard@generalcable-fr.com; idenizet@generalcable-fr.com; mmammeri@generalcablre-fr.com

ABSTRACT

The chemically crosslinked polyethylene (XLPE) is widely used in MV/HV insulating due to its good electrical properties and good thermomechanical behavior. However as a result of the chemical crosslinking, the gas and polar by-products from the peroxide are generated. The presence of such gas modifies the interface pressure between cable and pre-molded accessories which could lead to partial discharge generation allowing to the dielectric breakdown. The degassing of insulating is a key parameter for the reliability of the cable system. Furthermore, the polar by-products influence electrical properties under DC stresses. The purpose of this paper is to present a new XLPE with very low content of by-products fulfilling the standard requirement regarding crosslinking density.

Keywords

Crosslinking, Hot Set Test, Co-agent, By-product

INTRODUCTION

Although Low Density Polyethylene (LDPE) has very good electrical properties, it is not suitable for high power cables due to its temperature of operation which is limited to 70°C. This problem can be solved by crosslinking. Radical reaction with organic peroxides is one of the most widely used crosslinking methods to enhance the insulation ability to withstand high temperature.

However, crosslinking generates volatiles and no volatiles by-products. The gas released need to be removed from the cables for safety reasons, mechanical considerations (high pressure on the interface to the accessories) and electrical reasons (risk of partial discharges). Degassing or thermal treatment is an important step for cable manufacturing process. This step needs several days of heating depending on the insulating thickness and the length of the insulated cable core.

As example, the effect of degassing is illustrated in Fig. 1 in case of crosslinked polyethylene. FTIR analysis shows that an important proportion of acetophenone and cumyl alcohol can be removed by degassing the sample for 2 days at 50°C.

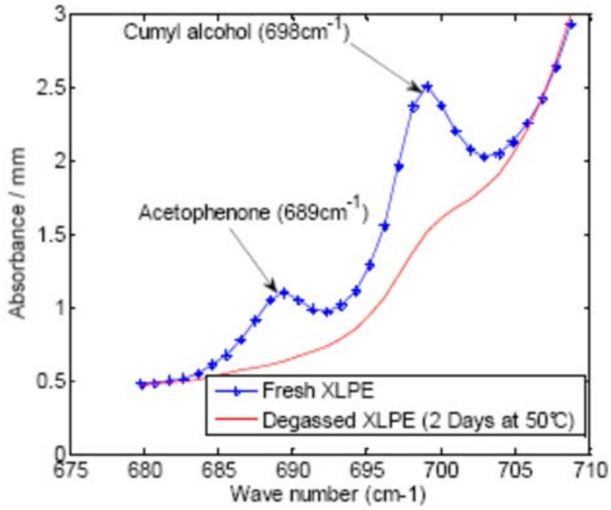

Fig. 1: FTIR spectrum of degassed and non-degassed XLPE samples crosslinked .

In case of dicumyl peroxide, high boiling point substances such as acetophenone, cumyl alcohol and alpha-methyl styrene remain in the insulation for a long time and are thought to assist the transport of charges by introducing a certain level and number of traps in the insulation bulk.
To minimise the impact of by-products, additives are often used. The performances of XLPE can also be improved through the reduction of the concentration of high boiling point by-products residues. This can be achieved by using a suitable crosslinking agent.

This paper reports a new crosslinking network where the overall by-products content before degassing step has been dramatically reduced compared to standard crosslinked polyethylene.

EXPERIMENTAL INVESTIGATIONS

Organic additives-polyethylene mixtures are prepared by absorption process. A rheometer is used to monitor the cure characteristics of the compounds through the value of the torque (Mh = lb.inch). The crosslinking density is measured thanks to the hot set test value at 200°C under 0,2 MPa. The crosslinking assessment has been explored on sample crosslinked at 200°C for 10 minutes. The gas content was measured by gas chromatography from crosslinked pellets under nitrogen atmosphere for 10 minutes at 190°C. The content of polar by-products is measured by chemical extraction with a solvent followed by gas chromatography.