Expanding the Performance Potential of a Universal Medium Voltage Cable System Using a New Additive Water Tree Retardant Crosslinked Polyethylene Insulation

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ABSTRACT

In a recent development, additive water tree-retardant crosslinked polyethylene (TR-XLPE) has been evaluated as the insulation material in a Universal medium voltage distribution cable design. Due to the reduced polarity of this insulation, both bonded and strippable insulation shields can be employed, offering cable manufacturers a broad design choice. This paper highlights data from medium voltage cable core production trials using an advanced additive TR-XLPE and a strippable outer semi-conductive layer. Recent results from a Cenelec 500 Hz wet ageing test illustrating the excellent retention of wet aged breakdown strength of these cable cores.

KEYWORDS

Universal cable, XLPE, water tree retardant insulation.

INTRODUCTION

Cross-linked polyethylene (XLPE) was first introduced in the 1960s as insulation material for medium voltage cables. In the 1970s, underground cables which were used in wet environments and were insulated with XLPE began failing prematurely due to the phenomena known as water treeing. Water trees drastically reduce the estimated lifetime of a XLPE cable by the initiation of an electrical tree. Different solutions were introduced to increase the medium voltage cable resistance to water treeing. Besides better radial water barriers, improved extrusion processes (triple extrusion), improved compound quality (cleanliness, smoothness) and improved laying practices, three different material solutions were introduced to improve the quality of the insulation namely: high cleanliness XLPE homopolymer, high cleanliness XLPE containing a minor blend component of polar copolymer, and high cleanliness XLPE containing an additive tree retardant. Each XLPE technology has its advantages and its disadvantages.

Additive TR-XLPE Insulation Solutions

Water trees in insulation are generally considered to be degraded, chemically oxidised structures which are observed as a dendrite pattern of water filled micro cavities and sub-micro cavities. As water trees grow, the electrical stress on the insulation can increase to the point where an electrical tree initiates at the tip of the water tree. Once initiated, electrical trees grow rapidly and lead to catastrophic failure of the cable. Additive TR-XLPE technology, introduced more than 30 years ago, is based upon the incorporation of a novel polymeric additive package in a very clean low density polyethylene. TR-XLPE insulation has demonstrated a reduction in the number and length of water-trees which develop as a result of the insulation aging due to the combined effects of electrical stress and installation in wet conditions. TR-XLPE insulation has been designed to provide effective tree-retardancy for excellent long life cable performance. It is expected this new advanced TR-XLPE insulation will lead to extremely long life power distribution cables in diverse environments.

New Advanced Additive TR-XLPE

Recently, an advanced additive TR-XLPE insulation has been developed that represents a major step change improvement in wet electrical performance. This new insulation also delivers an improved balance of cure and scorch resistance for the cable maker. More importantly, this formulation is able to offer cable makers the ability to manufacture medium voltage cable cores with outer strippable insulation shields while still delivering excellent retention of breakdown strength even after being exposed to a wet environment.

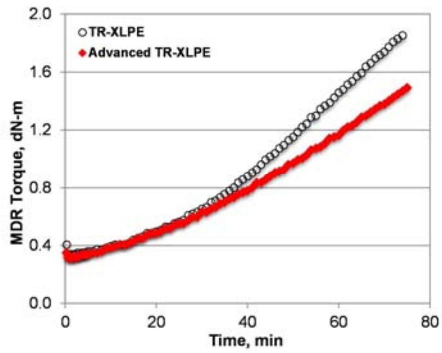

Fig. 1: 140°C MDR torque build up as a function of time for current and advanced TR-XLPE compound showing improved scorch performance.

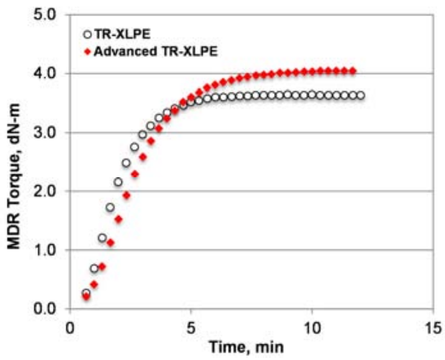

Fig. 2: 182°C MDR torque build up as a function of time for current and advanced TR-XLPE compounds showing improved cure performance.