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NEW HIGH PERFORMANCE, ENVIRONMENTALLY FRIENDLY MV POWER CABLE INSULATIONS

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ABSTRACT

New polymers based on metallocene catalyst technology are now being offered in the marketplace. These polymers include new elastomers that could compete with traditional EP and EPDM materials used in cable making. These new polymers offer great promise because along with being produced in a more environmentally friendly process they have much lower catalyst residues-hence promising potential advantages in electrical and thermal performance. These new polymers have not fully lived up to their promise to date however.

A new elastomer insulation based on metallocene resins with a number of improvements in environmental impact and use possibilities is presented in this work. This new insulation shows much improved performance over current insulations. The paper will provide small sample and cable test data in comparison to traditional EP formulations available today.

KEYWORDS

Power Cable, Catalyst, EAM, Filled Insulation, HALS

INTRODUCTION

Traditionally, medium volt power cable producers had two choices for insulation. These broad categories are XLPE and EP, and include all variations such as TR-XLPE, EPR, and EPDM. Rubber insulation for cables date back to the Gutta Purcha used on Samuel Morse's telegraph lines. Synthetic EPR became available in the early 1960s with the invention of Ziegler Natta polymerization catalysts. Insulation compounds based on these synthetic EPRs soon became available (Ohm). These insulation types are approaching 40 years of reliable service. Rubber insulation is chosen for its proven service life, flexibility and performance in high temperature operation (Brown). Most rubber insulations produced today are based on EPR or EPDM polymers. Current EPR and EPDM insulations have been used successfully for many decades at all service voltages up to 138 kV.

Ziegler Natta catalyzed resins have been the dominant polymeric class of materials in wire and cable since their discovery in 1954 (Billmeyer). While many improvements in catalyst technology have been made since the first Ziegler Natta catalysts, few have found service in wire and cable due to the demanding specification and long service life requirements. Metallocene catalyst technology, for instance, is now widely used to manufacture elastomeric polymers. The manufacture of metallocene polymers by single site catalysts is described by Gomez.

These materials include the traditional ethylene and propylene building blocks as well as other C2 to C8 Alfa Olefins. The most common new building blocks are butene, hexene and octene (four, six, or eight carbons respectively). Since these molecules all contain carbon to carbon double bonds, they fall under the general chemistry family called alkenes. ASTM D-1418, *Standard Practice for Rubber and Rubber Lattices - Nomenclature* gives eight classes of rubbers. The ethylene alkene polymers fall into class M, which are described as rubbers having a saturated chain of the polyethylene type. The standard indicates that the classification letter should be listed last preceded by the subsistent groups on the polymer chain-in this case EA for ethylene alkene which gives us the term EAM.

These new polymers offer potential promise in wire and cable because they have potential advantages in flexibility, thermal performance and have lower catalyst residues than traditional types (Kuttila). Catalyst ions can contribute to the degradation of cables by providing a path for metal ion catalyzed oxidation processes and as initiation sites for water-trees in dielectrics (Dissado). This modern route to polymer manufacture also produces polymers in a more environmentally friendly process requiring no solvents or large quantities of water to wash out excessive catalyst residue. Early work suggested good electrical properties and also suggested they might be able to be used in formulations without lead oxide stabilizer (Camillo). These new materials have not lived up to their promise to date, however. Some suffered higher dissipation factors, poorer thermal stability, and poor performance on accelerated cable life tests. They have found only limited use in power cable insulations.

Lead oxides have a long track record of use as stabilizers in EP insulations with great success. Lead oxide is necessary for thermal as well as electrical stability (Brown). It is well known that there are significant legislative pressures to discontinue use of lead as a stabilizer in manufactured products-one example is the European RoHS directive (European Parliament). Much work has been done to find a suitable alternative to lead oxide stabilizers for both traditional EP polymers and the newer metallocene materials. At the same time, North American cable users