TECHNICAL NEWS

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EPR SEMICONS  A PERSPECTIVE

The subject of EPR (Ethylene Propylene Rubber) semicons is an interesting one because the manufacturers of EPR insulated cables utilize a variety of semi conductive shields depending on the CV extruder arrangement available. In fact, Okonite is the only manufacturer who utilizes thermosetting semi conducting insulation shields based on EPR.

Fundamentally, when one considers EPR insulation, the true consideration is an "insulation system". That is, the combination of specifically compounded semiconducting shields in direct contact with the EPR insulation.

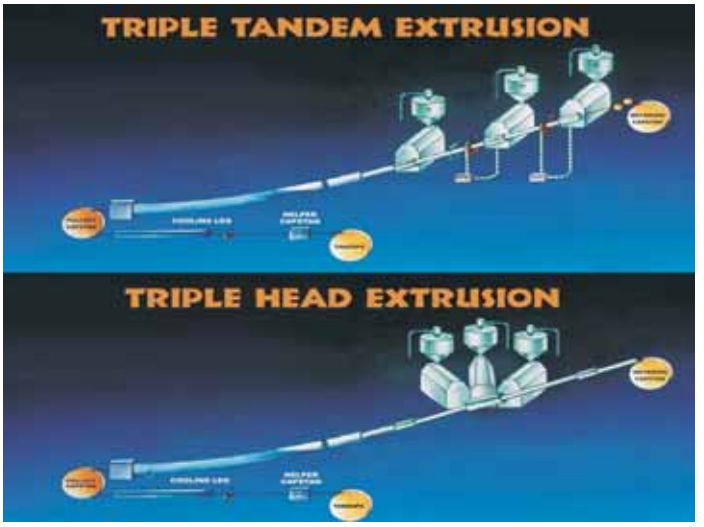
Critical considerations for the "system" are:

1) Chemical Compatibility – The shields and the insulation shall not have any components of composition which adversely affect the physical characteristics of the other.

2) Thermal Aging Characteristics – The shields should age similarly to the insulation when exposed to any applicable exposure such as heat, cold, oils, solvents, etc.

3) Thermal Expansion Characteristics – Power cables are subject to thermal cycling due to operating load conditions as well as environmental exposure. It is extremely important that through the normal course of service over an expected 40 year life, that the shields expand and contract in perfect concert with the insulation so that interfacial separations do not occur which could lead to internal electrical discharge and ultimate cable failure.

In the modern world of solid dielectric cable extrusion, the predominant CV extrusion line arrangement is configured in two or three ways, all achieving co-extrusion and vulcanization of the three layers simultaneously. Triple tandem lines have three extruders in a row. Triple head lines have three extruders connected to a common head. Dual head lines have one extruder/head in line with two extruders feeding a common head. The fundamental difference is that Triple Head or Dual Head extrusion lines, generally used to manufacture conventional XLPE or EPR insulated cables, require the use of a dissimilar polymer-based insulation shield in order to obtain free-strippability for terminating and splicing the cable. The use of the dissimilar polymer based semicon compound challenges the insulation system compatibility issue.



Obviously, conductivity is a primary characteristic of semiconductors. Resistivity, the inverse of conductivity, is typically the characteristic measured.

When compounding semiconductors, one chooses tests to discriminate characteristics with sensitivities to physical, chemical and environmental conditions.

Significant characteristic differences do develop on the shields in the compression mode. In an actual cable service situation, the thermal expansion of the insulation experiences compressive forces trapped between the metallic conductor and the metal shield or neutral. In this condition, a rise of resistance in the shields would not be a desirable characteristic.

Medium voltage cables are rated to operate at emergency temperature for 1500 hrs. Again, under these actual conditions, the resistance stability of the semi conductive shields should remain constant. In Figure A, one observes the XLP conductor screen on a commercial XLPE cable to exceed the 1000 ohm-m requirement in less than 500 hrs at all but ambient temperature. The EPR screens remain stable through all temperatures for the 1500 hrs.

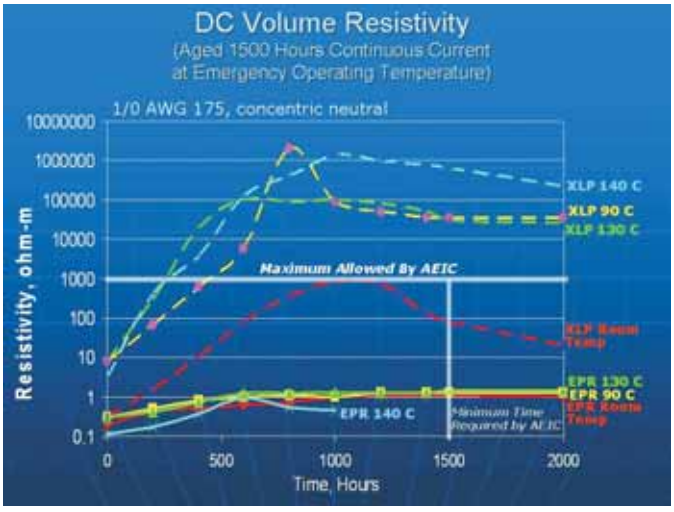


Figure A

CONCLUSIONS:

When compounding semiconductors to optimize insulation system performance, many factors must be considered:

1) The "Insulation System" compatibility is key.
2) The carbon black type and loading levels are significant.
3) Resistivity stability over a range of tension and compression stress is important.
4) Thermal expansion compatibility as well as physical property responses at the extremes of temperature are important.
5) All three extruded layers must be thermoset materials and fully cured.

The triple tandem, all EPR system has withstood the test of time, with a service record of 40 years and represents a very successfully engineered cable insulation system design.

This article was the subject of a presentation conducted at the Spring 2007 meeting of the Insulated Conductors Committee of the IEEE in Orlando, Florida.

If you have further interest in this subject and would like a copy of the presentation, call your local Okonite representative or contact us at www.okonite.com and one will be sent to you upon request.

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