

No Lead EPR Insulation



Background:

Southwire is a company with a keen environmental awareness. We seek to leave the lightest footprint possible on the environment in the course of manufacturing and delivering our products to market. To that end Southwire Company has innovated a product that accomplishes one of our environmental objectives – A medium and 600 volt Ethylene Propylene Rubber (EPR) insulation that contains no lead.

Discussion:

EPR is an insulation that combines superior mechanical and electrical properties. For these reasons it is used in a wide variety of applications such as: low, medium and transmission voltage cables, control and instrumentation cables, cords, mining cables and cable accessories. EPR is a compound that is formulated by mixing a rubber resin with other additives (normally 8 or more additives) to improve the mechanical and electrical properties. Typical ingredients of an EPR compound may be: ethylene propylene rubber (EP), inorganic mineral fillers, antioxidants/stabilizers, flame-retardants (for low voltage insulation materials), curing catalysts/coagents, and metal oxides including lead oxide. These ingredients are mixed (compounded) in an internal mixer and processed under stringent conditions to ensure quality and consistency. Extensive measures are taken to prevent the introduction of any contamination during manufacturing, storage or transportation process. The resultant blend, which is called a “compound,” is a proprietary formulation that each cable manufacturer certifies to meet all applicable standards. The compound is then packaged and shipped to cable manufacturers to be extruded as insulation for various cable voltages and constructions.

As mentioned above Lead Oxide is one of the ingredients found in today’s commercially available EPR compound. The Lead Oxide acts as stabilizer in mineral-filled EPR insulation when used in wet applications where it is believed to decrease the dissipation factor along with the dielectric constant giving the compound better moisture stability and less dielectric losses. The Lead Oxide most commonly used is Pb3O4 (Red Lead), which gives the compound its familiar red-salmon color. Other Lead compounds are also available such as Litharge (PbO yellow) and dibasic Lead phthalate (white), which are used for color change when Red Lead is not desirable. The level of Lead Oxide in the compound is relatively minimal in the range of 5 phr (part per hundred resin) and it is for that reason the EPR compound itself is not considered a toxic waste as defined by CFR 40 part 261.

Southwire Company, in cooperation with Electrical Cable Compounds Inc. (ECC) developed an EPR compound that no longer has Lead Oxide as one of its ingredients.. The compound is Envi-



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Environmentally Friendly and has the Ethylene Propylene (EP) resin's natural (off white) color instead of the familiar red-salmon EPR color. The (off white) insulation color contrasts the black color of the insulation semi-con making the semi-con easy to identify when terminating or splicing. The development of the "EFC" compound was made possible by the use of an alternative stabilizer system in combination with extra-clean components and a unique compound manufacturing process that allow for a high performance insulation material. It should be noted, however, that an EPR compound that is not red in color does not necessarily indicate that it is free of Lead. As mentioned above other Lead additives such as dibasic Lead phthalate (White Lead) can make the EPR compound color off white yet still contain Lead. The "EFC" EPR compound exhibits comparable and in some cases better mechanical and electrical results as those of the Leaded compound (see Tables below). The stability factor of the "EFC" insulation, which is the numerical difference between the percentage power factors of the first day and the fourteenth exhibits 2.5 times better stability in water compared to the leaded insulation. The compound also has passed the AEIC CS-8 qualification test that includes cyclic aging, impulse test and accelerated water tree testing – AWTT.

Summary

Southwire Company's new EFC insulation compound contains no Lead stabilizer yet exhibits both electrical and physical properties that are comparable to that of the Leaded compound. Elimination of the Lead Oxide (Red Lead) changed the insulation color from the familiar red-salmon color to an off white, which is the natural color of the EP resin. Today, through Southwire's R&D department and advances in polymeric technology Southwire can provide its customers with a cable that is environmentally friendly, UL listed, code compliant and reliable.

References and Acknowledgments:

1. M. Brown, IEEE Electrical Insulation Magazine, January/February 1994, Vol 10.
2. "Underground Transmission Systems Reference Book," published by EPRI 1992 Edition
3. "Building Wire & Cable Handbook," published by Southwire Company 1995 Edition.
4. UL 1072 Medium Voltage Cables, June 30, 2006.
5. The author wishes to acknowledge Gene Fridland of ECC for his technical assistance and data.

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Physical Properties†		
	Leaded EPR	Non Leaded EPR
Original		
Tensile (psi)	1530	1767
Elongation (%)	275	416
100% Modulus (psi)	920	800
168 hrs @ 136C		
RT %	106	97
RE%	98	98

Electrical Properties† (Accelerated water absorption) 14 AWG solid Cu, 45 mils				
	Leaded EPR		Non Leaded EPR	
	Recorded Value	Max Allowable	Recorded Value	Max Allowable
24 hrs Dielectric Constant	2.6	4.0	3.021	4.0
Increase in Capacitance %				
1-14 days	1.10	3.5	-2.21	3.5
7-14 days	0.08	1.5	0.0	1.5
14 day stability factor	0.10	1.0	0.04	1.0

†Physical and Electrical properties pass the following standards:

1. UL 1072 - Medium Voltage Cable
2. ICEA S-95-658 NEMA WC 70 - Power Cables rated 2000 volts or less for distribution of electrical energy
3. UL 44 - Thermoset-Insulated wires and cables up to 2000 volts
4. AEIC - CS8 Extruded Dielectric Shielded Power Cables Rated 5 - 46kv.

This application note was written by Sy Shaheen. Sy worked for First Energy electrical utility from 1985 – 1997 as a systems engineer at the Davis-Besse nuclear plant and an underground T&D engineer. From 1997 – 2003 he worked for Rome Cable as a Regional Sales Manager specializing in industrial cable sales. Currently, he is a Vice President of Engineering for Southwire’s industrial division. Mr. Shaheen holds a BSEE degree from Toledo University in 1984 and an MBA from Baldwin Wallace in 1990. He is a member of ICC and active on the IEEE Class 1E Cables for Nuclear Plants (IEEE 383) committee. He resides in Brecksville, OH with his wife and three sons.

