Cable Lore

ANACONDA

BY POWER CABLE ENGINEERING AND RESEARCH

Issue No. 44

January 16, 1976

STABILITY OF STRESS RELIEF LAYERS

Approximately 50 years ago, cable engineers became aware that the simplest cable concept of conductor/insulation/shield was voltage limited as far as safety, efficiency and longevity were concerned. Two problem areas were recognized and R&D efforts to this day are still concerned with the best solution of these problems.

1. The interface between the dielectric and conductor contained voids or pockets where the insulation did not penetrate fully into the valleys of the outer layer of stranded wire. Corona discharge across the resulting air gaps would deteriorate the insulation. Further, the small radii of the individual wires in the outer periphery of the conductor and especially any irregularities in their surfaces produced points of high electrical stress, several times that of a smooth cylinder over the conductor.

2. A similar problem developed between the insulation surface and the outer metallic shield or sheath. The shield, of course, provided a fixed path to ground for charging currents. This was required for safety, electrical efficiency and to improve the odds of cable survival.

The use of conducting components in stress relieving layers at both conductor and shield was a giant step toward the solution of the two problems[1]. Two types of material, in particular, made significant contributions: Tapes and Extruded Materials. The tapes were the first solution. Extruded materials are the present day solution.

1. Taped Stress Relief Layers. These were porous fabric tapes impregnated with carbon black particles. These tapes were helically wrapped around the conductor, resulting in a strand screen with the same potential as the conductor. Since it was in intimate contact with the insulation interface, there was no corona discharge, unless gaps were left at tape edges. Helically wound tapes over the insulation relieved the stress at the edges of the shielding tapes, provided a bedding for the metallic tapes, and assisted in eliminating voids or gaps should the metallic tape buckle or deform during bending, insulation or expansion.

[1] UL has adopted the term "stress relief layer" in place of semi-conductive conductor or insulation shields. AEIC has adopted "conductive" in place of semi-conductive.

2. Extrudable Stress Relief Layers. These were developed to overcome some of the difficulties experienced with semi-con tapes, for example tape overlaps, loose threads, buckled or wrinkled tapes, tape splices and carbon black residues imbedded in the insulation that had to be removed when splicing and terminating. Extruded strand screens or shields presented a rounder, smoother, continuous layer completely filling the outer layer of strand interstices. An extruded semi-conducting layer over the insulator conductor provided more intimate contact with the insulation. The inclusion of extruded layers for stress relief at the conductor and metal shield in cable concepts improved corona levels, breakdown voltages and reliability, especially in wet environments.

Once stress relieving components are part of a cable design, it is a prerequisite that the conductivity (low radial and volume resistance) that qualified them remains adequate in a variety of environments for the life of the cable. Present industry standards require that conductivity remain at a level equivalent to a volume resistivity of about 10^5ohm-cm.

These materials depend primarily for their conductivity or close proximity between particles of special carbon blacks. Increasing the space between particles or oxidizing the carbon black particles can result in a loss of conductivity. Conductivity can be adversely affected by:

1. Severe bending of fabric tapes, which increases in the bends separation of the particles.
2. Contact with solvents, such as oil or creosote, which swell or expand the material and increase the particle to particle separation.
3. High temperatures that expand the material and accelerate oxidation.
4. The adhesive of some pressure sensitive tapes which swell or expand the material.

As a result, the performance of extrudable stress relief components depends upon the base polymer, carbon black, and antioxidants in the formula as well as proper dispersion of the ingredients. Our "UniShield" jacket/stress relief compound has a balanced set of properties that remain effectively stable, even at high temperatures and after exposure to chemicals. The main factor is its chlorinated polyethylene (CPE) base polymer, which is solvent resistive and expands little with temperature in contrast to the usual polyethylene base polymer whose volume increases considerably at 100°C. Our compound is also resistant to radiation and is compatible with accessory materials.

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