Cable Lore

ANACONDA

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THERMAL STABILITY VS. HEAT-RESISTANCE

The term, "Heat-Resistance", when related to cable, is a catch-all expression for describing the ability of cable coverings to withstand deterioration when exposed to elevated temperatures and other contributing environments such as light and oxygen.

Full appreciation of heat-resistance is possible only when all factors directly influenced by elevated temperatures are related to cable reliability and longevity. The fact that a given insulation can retain a workable elongation and tensile strength after exposure to elevated temperatures is a good beginning but no sufficient data for broad evaluation.

Thermal stability is suggested as an expression that encompasses a range of cable characteristics influenced by heat. Stable properties in all of these areas would be reliable criteria for predicting service life.

A review of cable insulation properties that can be influenced by heat and tests normally used to evaluate these properties will clear up some of the "mystique" surrounding thermal stability:

(1) Heat Aging:

The effects of heat aging are usually measured by observing the degree of deterioration in an insulation or jacket after exposure to traditional heat aging tests. These include air oven, oxygen bomb, and air pressure heat test (APHT). They do not simulate actual service conditions. A good example is the APHT test - it was originally designed for inner tubes. Since these tests are used for accelerated aging they are useful for screening purposes and, used with discretion, yield valuable information to the compounder. Retention of original tensile strength and elongation are the chief criteria. Noting whether a material gets brittle or softens during these tests provides useful insight for polymer choice and compounding ingredient control.

(2) Deformation:

The ability of an insulation to retain its original shape under stress or load varies from polymer to polymer but in general most of the commonly used insulations show adequate resistance at normal or room temperature. As temperature is increased thermoplastic insulations have a tendency to deform more readily than thermosetting insulations. At temperatures over 100 C even the thermosetting compounds will show different degrees of resistance to deformation. The one retaining its original shape would be considered to be the most stable.

(3) Creep:

Creep could be defined as dimensional change with time of a material under load. Temperature will accelerate dimensional change. This could be most serious in vertical riser cable and in terminations. A movement of the insulation even in fractions of an inch could ruin an otherwise well made termination. An insulation with zero creep would be considered extremely stable in this regard.

(4) Thermal Expansion:

Thermal expansion is the fractional change in length or volume of a material for a unit change in temperature. The higher the temperature, the more the expansion. This characteristic is especially critical when the load is heavy for part of the day and lighter for the remainder of the day. The insulation will breath, so to speak, expanding when hot and contracting when cool. If the expansion is excessive there is a danger of disrupting the integrity of the over-all design and accelerating cable failure. Cyclic aging tests are used to measure stability in this characteristic.

(5) Physical Properties:

Test data and field experience indicate that elevated temperature will reduce the physical properties of some insulations dramatically. PVC and Polyethylene are two good examples. Properties such as tensile strength and cut-resistance drop to practically zero. Thermosetting materials also show a drop but retain a good degree of their original integrity. The compound retaining the greatest degree of its original physical strength would be considered the most stable.

(6) Electrical Properties:

Elevated temperatures can affect electrical properties. Most insulations are designed to remain stable through the normal operating temperature range. It is significant that electrical properties remain stable, especially with the industry trend leaning toward higher and higher temperature rated cable.

Ture, heat-resistance or, better yet, thermal stability, can only be realized when stability in each one of the properties effected by heat are incorporated into the product design.

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