INSULATION AND JACKET SHRINKBACK

Shrinkback is the tendency for the insulation of a wire to pull back from a splice or termination connector. If shrinkback occurs, an excessive amount of copper (or aluminum) conductor can be exposed and increase the risk of a short circuit. Shrinkback can also occur on the jacket of a multiconductor cable. If the jacket pulls back from a splice or termination, it exposes the cable to dirt and/or moisture. Common causes of shrinkback and industry methods used to measure and control it are discussed below.

WHAT CAUSES SHRINKBACK?

Shrinkback can occur when built-in mechanical stresses are present in the insulation or jacket material as the result of the manufacturing process. For example, if a copper conductor moves through an insulation extruder head at a speed slightly faster than the molten insulation compound coming out of the extruder head, the molten insulation becomes stretched. When the insulation compound is cooled, the insulation can become "frozen" in this stretched condition. If the wire is later cut into short lengths, the insulation may pull back if friction with the copper conductor is too low to hold it in position. High temperatures and wide temperature excursions tend to accelerate the process. Polymers vary in their susceptibility to shrinkback as a result of their basic chemical structure. For example, the thermal coefficient of expansion of a polymer can affect shrinkback. A higher thermal expansion coefficient means a larger volumetric change during temperature changes. This could lead to larger shrinkbacks. Table 1 contains coefficients of linear thermal expansion for common wire and cable polymer resins.[1]

Polymer	Thermal Expansion Coefficient (10^{-6}°C)
Polypropylene	68-95
Polyethylene (low density)	100-200
Polyethylene (high density)	110-130
Fluorinated ethylene propylene	83-105
Polyvinylidene fluoride	85
Ethylene tetrafluoroethylene	59
Polytetrafluoroethylene	100
Polyurethane	100-200
Polyvinyl chloride (rigid)	50-100
Polyvinyl chloride (flexible)	70-250

Table 1: Coefficients of linear thermal expansion

INDUSTRY TEST METHODS

To minimize shrinkback, the wire and cable industry has developed test methods and standards to measure and control it. One test method frequently used to evaluate the shrinkback of communication cable insulation is contained in ANSI/ICEA Standard S-56-434.[2] Section 5.4.1.3 *Shrinkback* of the document details the test method. The test is performed on a six-inch sample from the insulation. The sample is placed in a circulating air oven for four hours at a temperature of 115° C for PE (polyethylene) and 130° C for PP (polypropylene) insulation. Shrinkback is defined as the total shrinkage of the insulation from both ends of the sample. The pass/fail criterion for this test is 0.38 inches (10 mm).

In addition to the ANSI/ICEA Standard, UL 2556 *Standard for Safety Wire and Cable Test Methods* also has test procedures for determining insulation shrinkback. UL 2556 Section 7.4 *Shrinkback* contains a test method for determining shrinkback on insulation in water by immersing a sample in water at 90° C. UL 2556 Section 7.5 *Shrinkback in Air* determines shrinkback in air by heating the sample to be tested and then allowing it to cool. Once the sample is at room temperature, shrinkback, if any, is measured.[3]

Although it is important to determine insulation shrinkback, it is necessary to also test cable jackets in order to decrease the chance of water and dirt migration into the cable. Section 5.4.3.3 *Shrinkback* of the ANSI/ICEA document contains the test method for a shrinkback test on cable jackets. It requires the removal of a 0.5 inch (13 mm) wide by 2 inch (50 mm) long strip of material from the jacket. This specimen is then measured in length before and after oven conditioning at 100° C (115° C for some materials) for four hours. The percent shrinkage is then calculated from these measurements. The maximum jacket shrinkage permitted is 5 percent.[2]

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INSULATION CLEARANCE

The distance between a termination device and the end of a wire's insulation is called "insulation clearance." This distance is shown as measurement "A" in Figure 1. Shrinkback can contribute to excessive insulation clearance and the risk of a short circuit. Maximum recommended insulation clearance is defined in Section 4.4.1 *Insulation Clearance* of IPC/WHMA-A-620.[4]

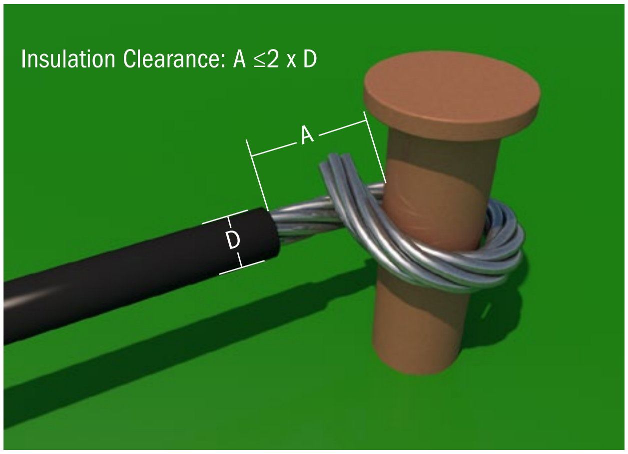

Figure 1: Insulation Clearance[4]

This document requires the insulation clearance to be less than two wire diameters (shown as "D" in Figure 1) or 0.06 inches (1.5 mm), whichever is greater. One way to minimize the effect of shrinkback on insulation clearance is to use terminations that employ insulation support crimps as discussed in Section 5.1.1 *Insulation Support Crimp* of IPC/WHMA-A-620[4].

SUMMARY

One or more of the following methods can be used to minimize the potentially negative effects of insulation and jacket shrinkback:

- Choose an insulation (or jacket) material that is inherently less prone to shrinkback.
- Increase the amount of friction between insulation and conductor, i.e., increase the wire's insulation strip force requirement.
- Employ splice and termination devices that are equipped with insulation support crimps.

REFERENCES

1. J.A. Dean (ed) "Lange's Handbook of Chemistry", McGraw-Hill, New York, USA, 14th edition, 1992.
2. "ANSI/ICEA S-56-434 Polyolefin Insulated Communication Cables for Outdoor Use", Insulated Cable Engineers Association, Fifth Edition, September 1983.
3. "UL 2556 Standard for Safety Wire and Cable Test Methods." Underwriters Laboratories, Third Edition, 2013.
4. IPC/WHMA-A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies, Wiring Harness Manufacturer's Association, January 2002.

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