American Polywater's
TechnicalTalk
ROUTE TO:
A PUBLICATION FOR ENGINEERS INVOLVED IN ELECTRICAL CABLE INSTALLATION

Volume 8

ELECTRICAL CLEANING SOLVENTS Part 2

This "Technical Talk" continues the discussion on key properties of electrical cleaning solvents. Previously, the inclusion of 1,1,1-trichloroethane (methyl chloroform) as an ozone-depleting chemical under the "Montreal Protocol" was explained. There is a need for alternative electrical cleaning solvents as trichloroethane is phased out of production. Part I ("Technical Talk" Volume VII) detailed the interrelationships between evaporation rate, flash point, and non-volatile residue in a solvent/cleaner.

A special concern occurs when cleaning solvents are used on high and medium voltage cable during splicing and termination. Will the solvent have an adverse effect on the cable or splice components? How can potential effects be measured? How important are field-cleaning methods in controlling any interaction?

The Cleaning Part

Solvent cleaners are used on electrical cables to remove contaminants that could provide a path over the insulation for tracking. Insulation shield residue, semi-conducting coating, inhibitor contamination, and other grime from handling are commonly removed.

Frequently, a failed splice is opened to reveal tracking which follows a "fingerprint pattern" of contaminants left during handling. An effective cleaning solvent removes such contaminants to eliminate any electrical path. The solvent itself, of course, must completely evaporate and not leave any residue of its own.

Unfortunately, not all solvents are equally "effective" at removing typical contaminants. One way to measure "effectiveness" is to saturate a white cloth with the solvent, and then wipe black semi-conducting shield residue from an insulation. After a few wipes, the amount of "black" (semi-conducting material) picked up by the cloth varies significantly, depending on the solvent. In our testing, we rated it from a zero (no visible black residue on the cloth) to ten (a lot of residue picked up very quickly).

Cleaning rating results from a series of solvents are presented in Table 1.

Solvent	Cleaning Rating
Solvent A	9
Solvent B	10
Solvent C	9
Solvent D	9
Solvent E	2
Solvent F	0

Table 1. Cleaning Ratings

Remember that the higher ratings reflect the most effective cleaning. In Table 1, note four of the six solvents tested were effective cleaners and two were not. We'll identify the solvents later.

The Cable Interaction Part

How do these same solvents affect cable or splice materials? Based on the way they're used, the primary concern with cleaning solvents has been their effect on semi-conducting materials. These semi-conducting polymers are very sensitive to solvent migration, which disrupts their carbon black network and raises their resistivity. An evaluation method used by some utilities and cable manufacturers has been to ***immerse*** the semi-conducting material in the solvent to measure the volume resistivity effects. Table 2 shows the effect on volume resistivity of a one-hour, room temperature soak of semi-conducting EPDM in solvents A through F.

	Initial	After Soak
Solvent A	3×10^2 ohm-cm	7×10^5 ohm-cm
Solvent B	3×10^2 ohm-cm	9×10^3 ohm-cm
Solvent C	3×10^2 ohm-cm	2×10^4 ohm-cm
Solvent D	3×10^2 ohm-cm	1×10^5 ohm-cm
Solvent E	3×10^2 ohm-cm	6×10^2 ohm-cm
Solvent F	3×10^2 ohm-cm	3×10^2 ohm-cm

Table 2. Soak Effect on Volume Resistivity

Note that solvents A through D have caused changes of several orders of magnitude in volume resistivity. We see in the Table 2 data these solvents, after only an hour soak, have raised the volume resistivity close to or above the 5 x 10^4 ohm-cm maximum in power cable specs.

Comparing Table 2 with Table 1, the best "cleaning" solvents were the ones that had the most effect on volume resistivity in an immersion test. If we choose a solvent that has no effect on the volume resistivity of the semi-conducting polymeric materials, we'll choose a solvent that won't clean the residue of these same materials from the insulation. And if it doesn't clean the residue, it leaves a potential path for tracking and splice failure.

Catch 22

To better understand this "Catch 22," let's "unmask" the solvents.

Solvent A	Trichloroethane
Solvent B	Aliphatic/Citrus Terpene Combo
Solvent C	Petroleum Distillate
Solvent D	Terpene
Solvent E	Alcohol (Isopropyl)
Solvent F	Water

Solvent A is trichloroethane. It ***has been used successfully*** for cable cleaning for decades, but it shows the greatest effect in volume resistivity in the immersion test. There must be something wrong with "immersion" as a "qualifying" test.

Don't Soak

To understand this, consider how cable is cleaned. ***No*** cable, splice, or connector manufacturer recommends "immersing" cable in solvent. In fact, it's just the opposite, and we can see why.

A ***minimum*** amount of solvent should be used to wipe residue from the cable insulation. Puddling, direct spraying, dipping, etc., should be avoided. A better evaluation would duplicate this type of exposure.

Table 3 shows the volume resistivity effects on semi-conducting XLPE insulation shield of a thorough wiping with a cloth saturated with solvent/cleaner (from the SpliceMaster® PEL-PAC® Cable Prep Kit). Note that even this type of wipe (on insulation shield) is not recommended procedure. Insulation shield ***residue*** should be cleaned ***from the insulation***. Wiping on top of the shield itself is not recommended.

	Before Wipe	**15 Mins.**	**1 Hour**	**20 Hours**
Trichloroethane	9x10^1	10x10^1	10x10^1	10x10^1
SpliceMaster® NF	9x10^1	9x10^1	9x10^1	9x10^1
SpliceMaster® HP	9x10^1	9x10^1	9x10^1	9x10^1
SpliceMaster® NO	9x10^1	10x10^1	10x10^1	10x10^1
No Wipe Control	9x10^1	9x10^1	9x10^1	10x10^1

Table 3. Wiping Effect on Semi-Con Properties

Table 3 presents data on the SpliceMaster® Cleaners as well as trichloroethane and the "no wipe" control. The SpliceMaster® Cleaners are specially formulated electrical cleaning solvents manufactured by American Polywater®. They represent several different solvent bases, all of which are good alternatives to trichloroethane. Note that all the solvents show an insignificant effect on the semi-con in this test. There are no orders of magnitude changes when these cleaning solvents are used properly (a wipe cleaning).

Table 2 and Table 3 reinforce the importance of proper procedure in cable cleaning. If improperly used, any of the functional cleaning solvents can adversely affect cable or splice components. Field users must avoid solvent immersion, wiping deposits from shield residue onto insulation, etc.

<u>Training Video Available</u>

Proper cable cleaning techniques, including what to avoid, are presented in an 8-minute video from American Polywater® entitled "Electrical Cable Cleaning." The video is "field-oriented" and primarily intended for training. It can be ordered by calling American Polywater® at 1-800-328-9384.

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