American Polywater's
TechnicalTalk
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ROUTE TO:

Volume 7-2

ELECTRICAL CLEANING SOLVENTS

This issue will update "Technical Talk" Volume 7 with added information on some new solvent technologies being used in electrical cleaning. We'll review some of the key performance properties of electrical cleaners, talk about the cleaners available today, and discuss the field use techniques that have been developed for these new cleaners.

Background

For several decades, electrical maintenance cleaning and degreasing was done with chlorinated solvents, first using carbon tetrachloride, and then switching to the less toxic 1,1,1-Trichloroethane (also called methyl chloroform, trichlor, or TCA). Aerosol cans, wiping pads, and small bulk packages of trichlor and trichlor blends were common for electrical cleaning.

This chlorinated solvent was used in electrical maintenance for motor refurbishment and cleaning bushings and breakers. Trichlor was also used in medium and high voltage splicing, where corrosion inhibitors, semi-con polymer residue, filling gels, and general hand grime has to be removed from the insulation to prevent tracking failure.

Trichloroethane has several physical characteristics that make it suitable as an electrical cleaner. It dissolves and removes a broad variety of electrical grime. Trichlor evaporates quickly and it is *non-flammable.*

Interestingly, trichlor was not used in electronic cleaning. This strong solvent could adversely affect plastic contact mountings and circuit boards. A less powerful solvent, CFC 113, was common for such "contact cleaning" use.

However, both trichlor and CFC 113 are *Class 1 Ozone Depleters*, and their production has not been allowed in the larger industrialized countries for several years. Less industrialized nations will also soon have to phase out the production and use of these solvents.

Several alternative solvent systems have been developed and used successfully in electrical cleaning. In the United States, slower drying petroleum distillates have worked well. In Europe, isopropyl alcohol (isopropanol) has been used. Occasionally, the more toxic chlorinated solvents perchloroethylene and trichloroethylene are seen. And recently, new technologies have been developed as represented by American Polywater's SpliceMaster® Types NF and TR.

To analyze alternative electrical cleaners, we must first understand their key functional properties. The properties we'll discuss in this issue are:

1. Evaporation Rate
2. Residue
3. Flash Point/Combustion Properties

Future issues of Technical Talk will deal with:

1. Interaction with Cables, Splice Components, etc.
2. Dielectric Properties
3. Cleaning Effectiveness/Solubility Character
4. Toxicity/Vapor Exposure/Safety

Evaporation Rate

One key feature of trichlor was its quick evaporation. You can wipe a surface with trichlor, and then watch the solvent quickly disappear. This powerful solvent would swell many polymer materials if they were soaked in it, but trichlor evaporates so rapidly that the contact time is minimal.

"Evaporation rate" can be determined in several ways. A crude but simple measurement involves placing a measured quantity of the solvent in a container (open), and determining weight loss over time. Evaporation is in milligrams/minute at a given temperature and solvent configuration (surface area to volume).

It is common to compare evaporation rate to a "control" solvent, as a "times-greater-than" number. For instance, if solvent A evaporated at 75 mg/min and solvent B evaporated at 225 mg/min, we would say that Solvent B evaporated 3 times as fast as solvent A. A common control or reference solvent is often used. Butyl acetate is one such reference, and is used in the data below.

Table 1 presents evaporation rate data for a number of our SpliceMaster® and other common electrical cleaners. The reference butyl acetate has an evaporation rate equal to 1 (or 1 times itself). Note also that water is included as an additional reference, although it is not a suitable electrical cleaning solvent.

Table 1. Relative Evaporation Rates

Solvent Cleaner	Evap Rate
SpliceMaster® NF	8.0
SpliceMaster® TR	6.0
Trichloroethane	6.0
SpliceMaster® FD	3.0
Isopropanol	2.0
Butyl Acetate	1.0
SpliceMaster® GP	0.5
Water	0.05
SpliceMaster® HP	0.02
Paraffin/Citrus Cleaner	0.01
High Flash Petroleum Distillate	0.001

Note the broad range in evaporation rates of the solvents in Table 1, a factor of 8,000 from the top to the bottom of this list. The data on the table confirm trichlor's fast evaporation (six times faster than butyl acetate, three times faster than alcohol, etc.)

Only American Polywater's SpliceMaster® NF and TR have evaporation rates comparable to trichlor. While TR and NF are expensive specialty solvents, packaging them in small quantities with just enough to do the job minimizes the cost of use. But why aren't there more cleaners that evaporate quickly? What about alcohol, acetone, MEK, hexane, etc.? This question is best answered by studying the combustion properties of fast-dry alternatives.

Flash Points

Table 2 presents closed cup flash points (PMCC) for the cleaners in Table1. Flash point is a measure of solvent combustibility often used in shipping and disposal regulations. While there are many test methods, the general procedure is to put the solvent in a covered (closed) cup, heat it up slowly, expose the *vapors above the liquid* to a regular spark or flame, and record the liquid temperature where the vapors first burn (or pop). This temperature is called the flash point (closed cup).

In the United States, all liquids with flash points under 93°C (200°F) are regulated for shipping purposes. Liquids with flash points under 38°C (100°F) are called flammable liquids and are the most restricted. The point is, low flash point solvents must be handled with knowledge and care for both legal and safety reasons.

Table 2. Flash Points

Solvent Cleaner	CC Flash Point
SpliceMaster® NF	None
SpliceMaster® TR	None
Trichloroethane	None
SpliceMaster® FD	~-7°C (20°F)
Isopropanol	~13° C (55°F)
Butyl Acetate	~21°C (70°F)
SpliceMaster® GP	~52°C (125°F)
Water	None
SpliceMaster® HP	~63°C (145°F)
Paraffin/Citrus Cleaner	~71°C (160°F)
High Flash Petroleum Distillate	~93°C (200°F)

Table 2 clarifies a limitation with many cleaners that evaporate as quickly as trichlor. While solvents like alcohol can be formulated to dry almost as quickly as trichlor, they have low flash points. Such highly flammable materials are not appropriate for at least some types of field use.

Besides the non-flammable TR and NF, American Polywater offers a range of evaporation rates in the electrical cleaners. From the fast but flammable Type FD to the much slower evaporating Type HP.

When is evaporation too slow? While this is a subjective judgment, we feel cleaners in the .001 evaporation rate range are simply not practical. They are more like oils than solvents. Solvents in the .01 range can be used successfully with proper field procedures.

To understand how slower drying solvents are best used in the field, remember that the evaporation rate of a solvent is dependent on "configuration" (volume versus surface area) and temperature. A 0.02 evaporation rate cleaner, such as Type HP, works fine if it is not puddled or used in excess. The cleaning procedure should "dry" the cleaner to a very thin film and then allow time for evaporation. This is why the HP Tandem Pack (Cat # HP-P158ID) is popular. The wipe is lightly moistened with the HP solvent (no excess), and a drying wipe is included with the package. All wipes are non-linting of course.

Residue

A good electrical cleaner should not leave a "residue," that is, some part of the cleaner that does not evaporate. A residue could provide a path for tracking or potentially interfere with the electrical function of the part.

Some "degreasing" solvents available to the electrical industry contain "surfactants." These surfactants are left as residues, and cleaners containing non-volatile surfactants should not be used for electrical cleaning. Occasionally a user will conclude that a slower drying cleaner leaves an "oil residue." High purity slow-dry solvents do dry completely; they just don't do it quickly.

What's Best

There is no single answer to the evaporation rate/flash point dilemma. Evaporation properties in the field not only depend on the cleaner, but also the ambient temperature and cleaning procedure. Type TR is the closest match to trichlor's characteristics, but is only available in wipe form. Type NF is also a good match, but is pricey in bulk. Type FD is very fast evaporating and economical, but its flammability dictates care in use. Type GP is a good intermediate alternative. Type HP is a very powerful and popular replacement with a lower price! The HP Tandem Pack provides everything needed for convenient use of the solvent cleaner.

Different users will resolve the replacing chlorinated solvent dilemma in different ways. American Polywater supplies different SpliceMaster® Cleaners to cover the broad range of "practical" evaporation rates. Evaporation rate is only one property of cleaners. Other important considerations will be discussed in future issues.

Samples of our SpliceMaster® Cleaners are available for field trial to help you decide what works best in your environment. If you would like trial samples, please call, fax, or e-mail American Polywater Customer Service at the numbers below.

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Web Site References for This Issue

All begin with: **http://www.polywater.com/**
SpliceMaster® NF: **typenf.html**
SpliceMaster® TR: **typetr.html**
SpliceMaster® HP: **typehp.html**
SpliceMaster® FD: **typefd.html**
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