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Engineers Cite CFC-Free Contact Cleaning As Troublesome Area

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Over the past decade, chemists and engineers around the world have put enormous resources into the development of ozone-safe electronics cleaners. While it has not been an easy battle, their success has become clear as CFC consumption has plummeted. One industry estimate puts current CFC usage down 60%-70% from the 1986 high-water mark.

Despite all this innovation, all we've done is "shoot all the slow rabbits" as they say in Texas. Many precision cleaning applications remain tied to CFCs because none of the new alternatives meet the performance requirements. Of these, one of the largest remaining CFC applications is contact cleaning. In an effort to determine the scope of the issue, the authors surveyed a number of companies about their contact cleaning requirements and evaluated most of the new solvents coming to market.

Contact cleaning is essentially a manual procedure. It does not readily lend itself to automated or batch cleaning practices. Dispensed as an aerosol spray, these cleaners are found in virtually all aspects of the maintenance, repair and system integration of precision electronic

devices and mechanical equipment. While contact cleaners only remove light contamination such as oils, dust, fingerprints and grime, many of today's precision electronics are sensitive to such contamination.

This is a global problem. At the United Nations, UNEP is the subcommittee working on environmental problems, including the ozone issue. At a recent meeting in Nairobi, Kenya the committee discussed the problems of contact cleaning. Speakers stated that contact cleaning remains a problem and unless good alternatives are found industry may need an exemption from the 1995 CFC phase-out. In France alone over 400,000 pounds of CFCs were used as contact cleaners; if that number is extrapolated to the global market perhaps as much as 8,000,000 pounds of CFCs may be required.

Table 1 is an overview of the physical characteristics of every new alternative solvent which could be considered as a contact cleaner. It is clear that no material is completely safe for the environment and meets all of the required physical attributes, but chemists around the globe are working to improve the performance of their products to meet these criteria.

Test Systems Require Nonflammable Circuit Cleaners

One example of contact cleaning is the maintenance of electronic test equipment because, by definition, these units are extremely sensitive to spurious circuit noise. Bob Pelton, at Tektronics in Gaithersburg, Maryland, supervises warranty repairs on their highly advanced test equipment. Eliminating noise on the test circuits is critical to their calibration processes. No longer able to use CFCs, they have tried HCFCs, ethanol and several slow-drying solvents. None have been satisfactory, and Mr. Pelton reported that their main problems included long drying times, residues, solvent entrapment inside potentiometers and safety issues.

Low flashpoints are often cited as the main safety concern. Contact cleaners commonly are used on equipment that is electrically energized, often with high voltages. While it would be simpler to clean with the power off, often the costs associated with shutting down a machine are high, or the machine must be running to confirm the effectiveness of the cleaning, or a system's function is so essential that it does not allow for even a brief shut-down for cleaning.

Numerous examples were cited: process controllers for high speed textile looms; telephone switching equipment, power generating stations, and the radar and radio systems at

every major airport. Electrically energized circuits produce heat and open electrical arcs; both are potential sources of ignition and represent an unacceptable risk of fire, worker injury and property damage. Photo 1, left, highlights one typical example: a telephone closet, where thousands of connections need to work flawlessly.

Sometimes, even when the machine can be shut down, flammable contact cleaners remain a hazard. Donny Perkins is the Industrial Safety Engineer at Alloy Piping Products in Shreveport, Louisiana. Alloy Piping makes butt-welded pipe fittings, and uses contact cleaners on the machinery and systems in the plant. Mr. Perkins has three electricians on his staff and reported that they experimented with the alcohol-based cleaners. "We found out quickly we couldn't use them," Mr. Perkins reports. "One of my guys powered the machine up too quickly after cleaning it and got a flash [momentary fire] from it."

This is not the only time flammables have presented a hazard. One company from the Pacific Northwest, which requested they not be named, was cleaning elevator motors with an isohexane/isopropyl blend described as a contact cleaner. However, the heavy motor was hot; the heat volatilized the cleaner and the fumes ignited.

Even the U.S. Government is concerned. The Veterans Administration has issued a safety warning about the fire hazards from cleaning personal computers and CRT screens with flammable liquids, including isopropyl alcohol. In one case, where the cleaner was being absorbed into a paper wipe "the static electricity inherent in all CRT's discharged into the employee's hand and set the tissue on fire." At least one GSA stocked product had to be recalled, and the warning cautions about the use of cleaners containing flammable propellants.

Ventilation also was reported to be an issue. Contact cleaners are frequently used in poorly ventilated areas such as closets, electric cabinets, control panels and racks. Even when a machine is located in a larger manufacturing space, its electrical controls are normally located inside a confined protective housing that is relatively compact in size. As a result, users are subjected to repetitious direct skin contact with the liquid and direct exposure to solvent fumes. This makes it essential that the cleaning agent be nonflammable and low in toxicity.

Many Solvents Attack Soft Plastics

Since contact cleaning is widely accepted as a general maintenance task, cleaners must not harm components. Old-style CFC-based contact cleaners were widely used because they were mild and enjoyed broad-based materials compatibility but many of the new cleaners react with metal or plastic components. This presents a substantial risk since maintenance workers cannot identify the plastics used in most devices. For example, connectors and motor mountings commonly are made from polycarbonates and ABS based plastics; the wrong solvent could destroy those components.

Howard Montone has been in the electronics business for 25 years and currently is at DBS Logics in Kanata, Ontario. He is unequivocal about the new solvents: "90% of the contact cleaners attack plastics, and that's a serious problem." He adds "There are now

many good alternatives for cleaning fluxes and other manufacturing situations, but the new contact cleaners need work." He cites the problems of cleaning variable resistance potentiometers, which have sensitive gold contacts. "The slow drying solvents seem to make their own contamination" and make the cleaning problems worse, he says.

Another engineer at a large midwestern electronic plant agreed that plastic compatibility was a major issue. "One cleaning product had been widely used throughout the plant, on our [finished] products and as a maintenance or crib type item," the engineer reported. When the solvent manufacturer changed the chemical formulation, trying to remove the CFCs from the blend, "their new ingredient attacked plastics," he said. This created an unexpected qualification problem, so the reformulated cleaner has been restricted to a few maintenance applications.

Because cleaning is often performed while a machine is in operation, a contact cleaner must evaporate quickly and be non-conductive. A conductive solvent can cause short circuits, destroying the machine instead of repairing it, and the longer the solvent remains on the board the greater the chance for a problem to occur. The engineer at the midwestern electronics plant noted that non-conductive solvents allow the technicians to bring manufacturing systems back on-line quickly, which is critical to keeping the assembly lines productive. "We've got almost 7,000 employees making 3,000 products a day, and the system must keep moving," he worried.

Residues a Persistent Problem

Residues from slow drying solvents also can negate the effectiveness of the cleaning process by attracting airborne dust to the wet surfaces. Donny Perkins, at Alloy Piping Products, said they discovered the residue problem for themselves. His team found "anything that has petroleum distillates in it leaves an oily film that we can't tolerate." Howard Montone agrees that the new contact cleaners need work. "The slow drying solvents seem to make their own contamination" and make the cleaning problems worse, he says.

Ken Lester, a manufacturing engineer at the PCB subcontractor PrimeTech in Montreal, Canada, notes that his people clean more than 5,000 circuit board connectors every day. Even if the slow-drying solvents added just a few seconds to the labor required on each connector, the costs could make their company uncompetitive.

Slow drying solvents also can migrate from the surface being cleaned onto adjacent areas. They can be absorbed into softer materials or even become trapped under wiring insulation. Once in contact with the insulation, capillary action can wick the solvent up stranded metal wire surprisingly long distances under the wire's insulation. The solvent then slowly leaches back down the wire and contributes to new problems such as shorting, corrosion, or the slow destruction of the insulation.

Blair Weeks is a Process Engineer at Hughes Aerospace in Tucson. He reports their group experimented with several alternative cleaners, including isopropyl alcohol, and found them unacceptable because they became entrapped in female connectors, attracting contamination and potentially causing corrosion.

At TRW in Redondo Beach California, Fred Cottrell works on integrating space craft systems into their final assemblies. Among other things, his team is cleaning ultra-precise radio frequency (RF) cable harnesses. These complex assemblies are unique because they have virtually no signal loss over their entire length. However, TRW's testing indicates the insulation may absorb the slow-drying solvents, which results in a phase shift in the RF signals. In this case, the long-term complications presented by a slow drying contact cleaner make fast evaporation an important physical necessity.

Technical Developments

The PFC solvents are close to the ideal answer with one overwhelming exception: they are very poor solvents. In fact, very few contaminates are disolved by the PFCs. Blending PFCs with other ingredients can compensate for this disadvantage.

With these requirements in mind, Micro Care has engineered a blend of HFC-134a, perfluorocarbons and HCFC-141b to serve as an interim contact cleaner until the ozone-safe HFC solvents come to market. This non-corrosive blend has been found suitable for all types of electronics including surface mount boards, hybrids, delicate mechanical assemblies, optics, precision bearings and connectors. It appears to be complete plastic-safe, which makes it an excellent choice for repair depots where the widest variety of components and materials are found. Very mild, it would even be suitable for light defluxing and degreasing.

Micro Care believes that this formula is an essential replacement for many contact cleaning applications that currently rely on CFC-11 and CFC-113. Current market-size estimates for this unique blend indicate demand could be as high as 725,000 pounds per year or about 10% of the total contact cleaning market.

HFC and HFE Contact Cleaners On the Horizon

Micro Care believes that contact cleaning is an important industrial process that cannot be ignored without risk to workers, the public and the economy at large. This product will smooth the transition from CFC-based contact cleaners to the HFC solvents (from DuPont) and HFE solvents (from 3M Corp.) which will become available in 1996-97. With the impending phase-out of CFCs there is no alternative that can fill this market need. Despite extensive research and detailed collaboration with virtually every other manufacturer of alternative cleaners, Micro Care and 3M believe Precision Contact Cleaner II is the only commercially available non-CFC contact cleaner available and

represents the best available technology for a critical cleaning application.

EDITORS NOTE: While this article was up-to-date when it was written, the technology has improved over the years (as predicted, above). Today, Micro Care markets HFC and HFE contact cleaners which are completely ozone-safe, non-conductive, nonflammable, and fast-drying. For more details, refer to the page in this web site about the new contact cleaners.

About the Authors:

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Table 1

Currently Available Alternatives for CFC-Based Contact Cleaners

as of August 1994

Fast-Drying	HCFC-141b	Strong cleaner, moderately low toxicity, almost odorless, nonflammable, attacks plastics, still an ozone-depleting solvent.
	HCFC-225	Strong cleaner, high toxicity, very limited production, available mainly in Japan, still an ozone-depleting solvent.
	HFC-134a	Poor cleaner, completely ozone-safe, mainly used as nonflammable propellant in aerosols.
	PFCs	Weak cleaner, nonflammable, plastic-safe. Can be blended for improved cleaning performance
		Ozone-safe, nonflammable solvents. Excellent

	HFCs and HFEs	toxicity, cleaning performance, miscible with many other ingredients to customize cleaning process. Available commercially in 1996/97.
Moderately Fast Drying	Isopropyl Alcohol	Ozone-safe, plastic-safe, weak cleaner, pronounced aroma, very flammable
	Ethyl Alcohol	Ozone-safe, plastic-safe, medium strength cleaner, pronounced aroma, very flammable
	Aliphatic Hydrocarbons	Ozone-safe, medium strength, some plastic problems, modest aroma, flammable
	Volatile Methyl Siloxanes	Ozone-safe, ultra-mild, very flammable, safe for all plastics, great toxicity ratings
Slow Drying	De-Ionized Water	Ozone-safe, plastic-safe, nonflammable, very mild cleaner, hard to retain purity
	Terpene	Ozone-safe, very powerful, slow drying, pronounced aroma, some plastic compatibility problems, good toxicity data.
	Non-linear Alcohols	Ozone-safe, the most powerful choice, barely flammable, definately attacks plastics, slow drying

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Related Information:

- For additional information about flammability and how it is measured, see this Technical Note.
- This web site features a list of nonflammable solvents from Micro Care.
- For additional information about the ozone-safe DuPont HFC solvents, check out the Vertrel® solvents web site.
- For other information about the Bromothane™ brand of nPB solvents, check out the Bromothane™ web site.
- For additional help, use the *Solvent Selection Guide* in this Site to help determine the optimal recommendation.

- A simplified PDF version of the same Selection Guide also is available.

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