

# WORKING

# SAFELY



# with SOLVENTS

**When manually cleaning parts with halogenated solvents, a little safety goes a long way.**

by Richard Miller

Halogenated solvents are commonly used in many cleaning applications to remove flux, dirt, oil, fingerprints, and grease from a wide variety of parts and substrates and are applied automatically (in parts washers) or manually. When applied manually, special care must be taken to minimize exposure to these chemicals and their by-products.

Manual cleaning occurs during original equipment assembly, repair, and maintenance operations. During assembly, parts may become dirty through handling, soldering, or testing. Removal of residue from parts is essential for their efficient short- and long-term operation.

The same is true for equipment repair. Often, the first step in repair is cleaning the broken parts. After the repair is made, it is then necessary to remove any fingerprints, dirt, or other soil from the equipment.

Chemicals change when exposed to open flames or excessive heat sources.

This is particularly true of the family of chemicals called halogens. The three most common types of halogenated solvents are chlorinated, fluorinated, and brominated (see Table I, page 16), though some may contain both chlorinated and fluorinated components, or both chlorinated and brominated components.

### **Chemicals That Blend In**

Halogenated solvents are often blended with other chemicals to improve stability or cleaning performance. Some examples of stabilizers are 1,3-dioxolane and 1,2-butylene oxide. Chemicals such as methanol, isopropanol, and trans-1,2-dichloroethylene may be added to boost the cleaning performance of fluorinated solvents.

For any chemical-handling operation, the user should be aware of the acute (short-term) and chronic (long-term) hazards. Long-term health effects may vary from individual to

CHEMICAL NAME	ALSO KNOWN AS	COMMENT
<b>Chlorinated Solvents</b> 1,1,1-trichloroethane	methyl chloroform, TCA	Class I ozone depleting compound, phased out by Clean Air Act and Montreal Protocol
trichloroethylene methylene chloride perchloroethylene	TCE dichloromethane perc, tetrachloroethylene	
<b>Chlorinated/Fluorinated Solvents</b> CFC-113	trichlorotrifluoroethane	
HCFC-141b HCFC-225		Class II ozone depleting compound Class II ozone depleting compound
<b>Fluorinated Solvents</b> perfluorocarbons hydrofluorocarbons HFC-134a	PFCs HFCs	Used as a "duster" or an aerosol propellant
HFC-152a		Used as an aerosol propellant
Vertrel® hydrofluoroethers HFE-7100	HFC-43-10	Trademark of DuPont Produced by 3M
<b>Brominated Solvents</b> n-propyl bromide		
<b>Brominated/Chlorinated Solvents</b> Borothers™		Trademark of Amity Ltd.

**Table I**  
Halogenated Solvents at a Glance

individual and the best way to determine an individual's specific chemical response is to have a medical examination. Short-term hazards can be managed by controlling the environment in which the solvent is used.

When halogenated solvents are exposed to flames (torch, welding operations, furnace) or high heat (soldering, space heater, red hot metal), a chemical change occurs that may result in a by-product that is highly corrosive and potentially toxic.

Solvents containing chlorine may decompose to form hydrochloric acid (HCl) and, by secondary reaction, phosgene. The threshold limit value (TLV) of phosgene is 0.1 ppm, so exposure to even small amounts must be avoided. HCl is highly corrosive and exposure to the skin or inhalation can be very irritating.

Fluorinated solvents can decompose to form hydrogen fluoride (HF), which is also highly corrosive and can penetrate the skin. In addition, inhalation can cause pulmonary burns. Some fluorinated solvents can break down to form perfluoro isobutylene (PFIB), which has a TLV of 0.01 ppm.

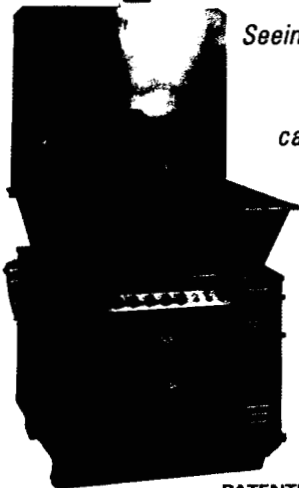
Hydrogen bromide may form as an oxygenation product of brominated solvents. Chemical compounds that have more than one halogenated component may form several decomposition compounds. In addition to forming halogenated by-products, other compounds (like carbon monoxide or benzene) have been known to form when halogenated solvents are exposed to open flames or high heat sources.

The health effects of exposure to halogenated solvent decomposition by-products vary, depending on the intensity and duration of exposure. Responses range from rashes and burns to severe heart and lung problems, and potentially death. While these conditions are serious, simple care can be taken to avoid a hazardous situation.

#### Variable Response

Companies should evaluate products for general workplace safety, as well as cleaning and economic efficiency. When transitioning from 1,1,1-trichloroethane or CFC-113 to another halogenated solvent, the physical characteristics of the new solvent must be evaluated carefully. Differences in evaporation rates and upper and lower explosion levels must be considered and subtle differences may lead to very different results. It may be necessary to change ventilation or alter work practices in order

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## KNOW THE DIFFERENCE

### Nonhalogenated Solvents Are:

Usually very flammable. The faster the drying time, the more flammable the solvent. Higher flashpoint solvents may be very slow to dry. This may be undesirable for some assembly or repair operations. These may also be considered VOCs.

### Water-Based Cleaners Are:

Very slow to dry. Hazardous to use around electricity. Ingredients added to water to enable them to clean may leave a residue, requiring an additional rinsing step.

to accommodate the new solvent, and there may be differences in cleaning efficiency.

With such a variety of alternatives available at varying costs, companies should choose a cleaner that is appropriate for the soil being removed, the substrate being cleaned, and the work area. CFC taxes and phase-out shortages caused the prices of traditional halogenated solvents to escalate dramatically, so the cost of halogenated alternatives should be no more than that of traditional solvents.

### Hazard Awareness

Individuals who use halogenated solvents must exercise reasonable caution to avoid a hazardous situation; for example, do not use them in a poorly ventilated area. The two most basic and easiest precautions an individual can take are:

- Reading and following the directions and warnings on the product label;
- Reviewing the information on the product's Material Safety Data Sheet (MSDS).

Users should be sensitive as to what took place in the area before he or she got there and what will occur after he or she leaves. Equipment could have a built-up charge even if power has been disconnected, so the technician must take the time to dissipate all electrical charge before proceeding with cleaning.

After cleaning with a halogenated solvent, the user must make sure the component is completely dry and the work areas ventilated. Subsequent operations, like welding, may be hazardous if trace amounts of the halogenated solvent remain. Halogenated solvents dry quickly and visibly to the naked eye. However, just because the user has seen the solvent flash off does not mean that all traces are gone.

The user should also be aware that, while some halogenated solvents do not have a flash point (by conventional test methods such as Tag

Closed Cup [TCC] or Cleveland Open Cup [COC]), they can be made to burn because they have an upper and lower explosion limit (UEL and LEL). Certain mixtures of the solvent and air will burn when exposed to an ignition source.

Equipment is often re-energized once repaired, which could generate a spark. Although this is not enough energy to cause significant decomposition of halogenated solvents, users should be careful if flammable or nonazeotropic blends have been used. A brief spark could be enough to ignite a flammable solvent under the right conditions.

### Handled With Care

Drying can be aided by increasing ventilation such as by opening a door or window, using mechanical ventilation, or increasing the drying time. If increasing ventilation or drying time is not possible, workers should

## SELECTION SUGGESTIONS

When selecting a cleaner, the company and user should:

- ✓ Consider the corporate environmental objectives;
- ✓ Evaluate cleaning and economic efficiencies; and
- ✓ Evaluate work practices and the environment by:
  - considering other operations taking place in the same area and what happens in the work area before and after cleaning;
  - being aware of adjacent operations (if soldering is taking place nearby, vapors may travel and be subject to decomposition);
  - ensuring appropriate ventilation in the work area;
  - exhausting vapors away from workers (since these chemicals are heavier than air, they will collect at floor level or low areas such as the bottom of a control panel); or by
  - directing vapors away from heat sources (such as soldering) and spark sources (such as an electrical connection).

be provided with personal protective equipment that includes positive-pressure breathing apparatus.

Similar precautions must be taken when working with nonhalogenated alternatives to ODCs. Fast-drying solvents are extremely flammable, and water-based products and flammable solvents may be ineffective, inefficient, or dangerous for some applications.

If simple precautions are taken into consideration, halogenated solvents can be used safely. Halogenated solvents are effective cleaners, dry quickly, and leave no residue. They continue to be an

excellent choice for vapor degreasing, parts cleaning, and cold cleaning. Users should consult with their local safety personnel or chemical manufacturers to determine the best product for their application.

When using any chemical, be informed, be prepared, and be alert. ■

### Author's Bio

Richard Miller is vice president of technology for CRC Industries (Warminster, Pa.). With more than 20 years of experience in the chemical industry, he holds a BS in chemistry from the University of Missouri and an MBA from the University of Dallas.

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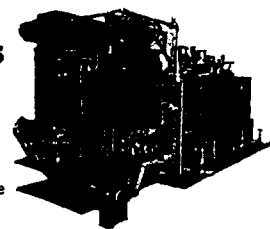


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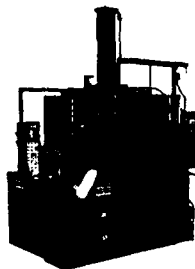
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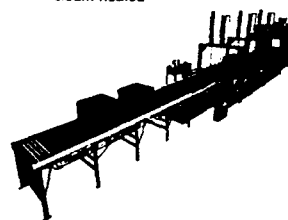
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