United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604
EPA 905-F-00-026
October 2000

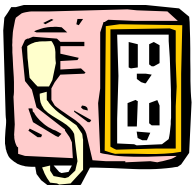
TECHNICAL FACT SHEET FOR 1,1,1-TRICHLOROETHANE (TCA) HAZARDS AND ALTERNATIVES

1,1,1-trichloroethane (TCA), also known as methyl chloroform, is considered persistent since it does not easily breakdown in the atmosphere. It is also recognized as an ozone depleting substance in the environment and contributes to ground smog formation. TCA may also affect human health by causing respiratory and circulatory paralysis, including loss of conciousness, numbness and slowing down reaction time.

EPA PARTNERSHIP AND YOU...

The United States Environmental Protection Agency (EPA) has identified numerous persistent, bioaccumulative and/or toxic chemicals that may be present in some industrial hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA). In addition to its ongoing regulatory activities, EPA will encourage efforts to achieve reduction of the generation of chemicals that are either persistent, bioaccumulative and/or toxic. EPA will also work with states, industry, and environmental groups through workshops, technical assistance programs, partnership agreements, regulatory reinvention projects, and other strategies to promote progress toward the goal of reducing the generation of RCRA PBT's in hazardous waste by 50 percent by the year 2005.

THE TCA CONNECTION



TCA is a man-made halogenated solvent which is primarily used as a cleaning and degreasing agent. TCA became widely used due to its stability, ease of drying, and effectiveness in removing contaminants without affecting the quality of the intended final product. The demand for TCA has decreased in recent years due to the anticipation of stringent regulations generated from the Clean Air Act Ammendments of 1990 regarding the use of TCA, which has been identified as an ozone-depleting chemical. Nevertheless, large amounts of waste TCA are still generated by a wide variety of industries. Many industrial processes and operations use TCA for a variety of cleaning, degreasing and other operational needs.

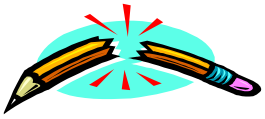
Here are a few of the uses for TCA:

- Cleaning
- Vapor degreasing
- Lubricating
- As a carrier to inject graphite,
- As a carrier to inject graphite, grease and other lubricants
- Line and drain cleaning
- As a cutting fluid
- Gas regulators
- Printing press cleaning
- As a solvent in drain cleaners, shoe polishes, spot cleaners, insecticides and printing inks

Here are some of the industries that may use TCA:

- Manufacturers of electronic components
- Manufacturers of fasteners
- Manufacturers of medical equipment
- Manufacturers of fabricated metal parts
- Metal finishers

BREAKING THE TIE WITH TCA



There are many different alternatives available to substitute in place of TCA. When a company decides to replace or eliminate TCA, the facility should evaluate their processes and test several applications to determine what replacement method would best fulfill its needs, keeping in mind there is no single replacement for TCA. Here are several replacement alternatives:

Fluoroiodocarbon Solvents (FICs) - Fluoroiodocarbon solvents, or FICs, are considered to be a "drop-in" for TCA, requiring very little other changes to the cleaning process. FICs have been shown to have excellent cleaning abilities, and an extremely low environmental impact. FICs are also nonflammable and have a low level of toxicity. The downside is that FICs are currently expensive, costing between $100 and $300 per pound of chemical, however, methods for inexpensive synthesis are under study. FICs are best used when cleaning surface-mounted electronics, semiconductor wafers, optics, gyroscopes and gaseous or liquid oxygen systems.

Aqueous (General) - Water-based chemical solutions may be used in cleaning processes in place of TCA. The solutions most often include alkaline and acidic products that may also contain surfactants, emulsifiers and detergent additives to facilitate the cleaning action. Aqueous solution alternatives to TCA include the following processes; abrasive deburring systems, water wash tanks, soap-water solutions, and a combination of heat and agitation. Special additives such as builders, pH buffers, inhibitors, saponifiers, emulsifiers and deflocculants can be added to solutions to meet desired cleaning requirements. Aqueous cleaners significantly reduce hazardous air emissions, and can be used in a wide range of industrial processes. However, aqueous solutions create a liquid waste stream which may not have existed previously. Contaminants may be present in aqueous wash and rinse baths, rendering the rinse a hazardous waste which then must be dealt with according to applicable regulations. Measures must also be taken to prevent corrosion or scaling on parts.

There are three types of aqueous cleaners; acidic, alkaline and neutral. *Acidic Aqueous* solutions are routinely used to remove scale, rust and oxides from metals. *Alkaline Aqueous* solutions can remove greases, coolants, cutting oils, shop dirt, fingerprints, cosmolene, petroleum and some water-based paints. These solutions may be used to clean items such as hydraulic valve bodies, fuel-injector components and machined aluminum castings. *Neutral Aqueous* solutions are good at removing light oils, particles, chlorides and other salts for use in ultrasonic and spray applications.

Semi-Aqueous - Semi-aqueous solutions utilize water at some point during the cleaning process. The most common semi-aqueous cleaning solutions are terpenes and other citrus and pine derivatives. Semi-aqueous cleaners are effective at room temperature, and they are generally biodegradable and noncorrosive. They also possess a very low evaporation rate, which in most cases, will result in low use cost and low volatile organic compound (VOC) emissions. However, several semi-aqueous cleaners have low flash points and become volatile when sprayed. In addition, the health effects associated with terpenes are still unclear. Semi-aqueous solutions are best used for removing waxes, heavy greases, tar and baked on organic materials.

Petroleum Hydrocarbons - Petroleum hydrocarbons may be substituted for TCA in many parts cleaning operations. Examples of petroleum hydrocarbons include products such as mineral spirits, kerosene and naptha. These products are typically used in immersion or hand-washing processes. The toxicity levels of petroleum hydrocarbons are generally considered to be low, but this varies with each specific material. After use, these materials can be recycled by distillation or disposed of by incineration. Petroleum hydrocarbons are flammable, as are VOCs, which means they are regulated in most areas. Petroleum hydrocarbons are best used for the removal of heavy oil and grease, tar and waxes.

Miscellaneous Organic Solvents - This group includes acetone, alcohols, ketones, esters and other related chemicals that generally have lower boiling points and have been used for many years as industrial cleaners. Some of the more common organic solvents that may be used to replace TCA are described in more detail below.

- Acetone is a good drying agent for wet parts, and is used mostly as a hand-wipe solvent. Acetone effectively removes some greases, oils, waxes and inks, uncured fiberglass resins, varnish and lacquer, and may be useful for applications that require a highly volatile cleaner. By using acetone, hazardous wastes will still be generated, but the toxicity level and the volume would be significantly reduced.

Please note: Acetone is a flammable VOC and it should not be sprayed or heated without extensive safety precautions.

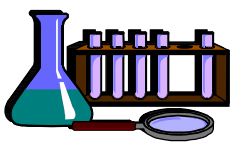
- Ethyl Lactate removes silicone oils and greases, machining coolants, tapping oils, lithium grease, layout inks and fingerprints. Ethyl lactate may be disposed of by incineration at an approved facility, or may be recycled with filtration or vacuum distillation. Ethyl lactate is commercially available and is considered to be biodegradable, however, it is combustible and may be considered a VOC, depending on location.

- Dibasic Esters (DBE) is commonly used as a paint stripper. It is considered to be biodegradable, and may be recycled using a vacuum still. It is also possible to mix DBE with other chemicals to reduce air emissions. DBE may be considered a VOC, depending on location.

- Other Organic Solvents such as *n*-propyl bromide-based solvents that have similar physical and cleaning properties to TCA, but present minimal environmental/health concerns, are also being developed.

Vacuum Furnace Deoiling - Vacuum furnace deoiling is a new process that removes surface oils from parts through vaporization, without using TCA or other ozone-depleting or hazardous chemicals, water, or detergents. Parts are loaded, and a heater and pump are actuated to warm and evacuate the unit's chamber. The oil's boiling point falls with pressure so heating in a slight vacuum dries the part quickly. In most cases, parts can be cleaned by vacuum deoiling in 20 minutes or less. Vapors can be condensed and collected for reprocessing or recycling, so hazardous waste disposal costs are reduced or eliminated. Adjustments may be needed for each new material or oil being removed. The product must also be able to stand the necessary temperature and vacuum pressure. Vacuum deoiling is used for the removal of oil from both metal and nonmetal parts. This process has also been used for the removal of paint solvents, drying ink and paint designs, and precleaning for brazing, plating or heat treating.

Inert Gas Soldering - TCA has been used in the manufacture of electronic components. The role of TCA in the soldering process may be replaced through the use of nitrogen or another inert gas as a process gas to provide an inert, oxygen free soldering atmosphere that promotes wetting and an improved soldering quality. No-clean inert atmosphere soldering is environmentally friendly, uses no solvents, and eliminates cleaning equipment. Inert gas soldering provides for a reduction in overall soldering defects, an increase in solder joint strength, and an elimination of metal surface oxidation. Inert gas soldering processes can result in reduced equipment maintenance and a reduction in labor costs. Inert gas soldering has been proven effective in circuit board production.



Dry Ice Blasting - Rather than using TCA, solid pellets of carbon dioxide can be used as a blasting medium for cleaning metal parts. When the dry ice pellets impact the surface, the drop in surface temperature helps to pierce the contaminant or residue. Once contact is made with the base the kinetic energy acts laterally along the base surface, lifting the residue away. The carbon dioxide pellets disintegrate upon impact and dissipate to the atmosphere.

Because the carbon dioxide disintegrates during the cleaning process, there is no liquid residue or spent solvent to dispose of. Using dry ice blasting reduces harmful air emissions and generally creates no addition to the volume of the cleaning process waste stream. The speed or flow can be controlled to tailor the system to a specific cleaning medium, and in-process machinery can be cleaned on-line, resulting in decreased labor costs and less down-time. In most instances, dry ice blasting is done by cleaning companies, which means increased costs for outside labor and maintenance. Dry ice blasting is best used for removing paints or other coatings in printing, electric motor repair, tire and rubber molds, nuclear decontamination and biological applications.

MEASURE YOUR SUCCESS

There are many companies that have implemented successful replacements for TCA in their operations or manufacturing processes. Companies have also benefited from savings in replacing TCA with a more environmentally friendly alternative. Here are some success stories for several types of alternatives or processes associated with replacing TCA:

- A company that performed metal stamping previously used TCA in a vapor degreaser to remove oil-based lubricants. This company realized a savings of nearly $36,000 in one year by replacing the vapor degreaser with an upgraded abrasive deburring system using a vibratory tumbler and a wet sander, along with water-based cleaning solutions.

- Another company, in an effort to reduce TCA use, decided to install aqueous-based ultrasonic cleaning equipment to replace TCA-based degreasers and parts washers. The initial capital costs were $487,000, yet the yearly savings were estimated to be $198,000. This made the payback period close to 2 ½ years.

- A gas regulator that had used TCA to degrease metal parts in its surface preparation units eliminated TCA by

converting to a multiple stage water wash tank. The new processes cost between $300 and $500 a year with a savings of nearly $20,000 per year.

- A manufacturer of flexible polyurethane foam replaced TCA with acetone as an auxiliary blowing agent (ABA). The manufacturer found acetone to be over three times more efficient than TCA as an ABA, and they found that acetone cost-effectively gave them needed control over critical parameters.

- Vacuum furnace deoiling replaced the use of TCA in vapor degreasing by installing a vacuum furnace at a cost of $192,000. The operating costs were found to be significantly lower than the capital costs which resulted in a payback time of 2 years for a 4,000 hr/yr operation period.

- An aluminum foundry that casts parts had used TCA as a carrier in the wash used to coat sand cores. The facility has successfully substituted IPA- and water-based coatings for TCA resulting in a net cost savings of $44,500.

FOR MORE INFORMATION...

There are various resources to locate more information on the substitution and potential elimination of TCA from your workplace. Here a just a few of the websites available via the Internet and government agencies listings that would be able to provide more information.

Websites

- www.epa.gov/reg5rcra/wptdiv/p2pages/index.html
- www.es.epa.gov/studies (EnviroSense)
- www.manufacturing.net/magazine
- www.epa.state.il.us/p2/index.html
- p2.utep.edu/casestudies
- www.state.in.us/oppta/index.htm
- www.emcentre.com
- www.mntap.umn.edu
- www.etec-nm.com/library
- www.epa.ohio.gov/opp
- www.deq.state.mi.us/ead/p2sect/
- www.epa.gov/opptintr/p2home
- www.pwrc.usgs.gov/new/chrback.htm

Government Listings

U.S. EPA Region 5
P2 Hotline
⇨ 888/745-7272 (888-PIK-P2P2)

Illinois Environmental Protection Agency
Office of Pollution Prevention
⇨ 217/782-8700

Indiana Dept. of Environmental Mgmt.
Office of Pollution Prevention
⇨ 317/232-8172

Michigan Dept. of Environmental Quality
Environmental Assistance Division
⇨ 800/662-9278

Minnesota Technical Assistance Program
⇨ 612/624-1300

Ohio Environmental Protection Agency
Office of Pollution Prevention
⇨ 614/644-3469

Wisconsin Dept. of Natural Resources
Cooperative Environ. Assistance
⇨ 608/267-9700