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INTRODUCTION

Cleaning metals is a common task for many small businesses. Machine shops, automotive maintenance facilities, plating shops, and small parts manufacturers are just a few organizations that require some process to clean metals. Organic solvents have been the backbone of the metal-cleaning industry for many years because they remove dirt and grease exceptionally well. However, the properties that make these chemicals effective cleaners also make them hazardous to human health and the environment. As our understanding of these hazards has grown, regulations governing the use and disposal of organic solvents have also grown.

This report examines how organic solvents are used and recommends alternatives that offer relief from the regulations associated with organic solvent use. Time, money, liability, and paperwork can be saved in applications in which alternative products replace many of the organic solvents used today.

METAL-CLEANING METHODS

Although cleaning processes vary among different industries, general categories of metal-cleaning chemicals can be identified. These include organic solvents (e.g. trichloroethylene, trichloroethane, perchloroethylene, and methylene chloride), alkaline cleaners, emulsions, acids, detergents, and electrocleaners and ultrasonic cleaning. Most common has been the use of organic solvents, especially in degreasing operations. For example, the percent of the market for four key chlorinated solvents used specifically for metal cleaning and degreasing is 9% for methylene chloride, 44% for trichloroethane, 85% for trichoroethylene, and 11% for perchloroethylene (Chemical Week, 1987). Alternative methods can be examined in relation to the safety and disposal considerations under discussion.

Acids are used for the removal of rust and scale and present their own complex disposal problems. They are not considered a good alternative to the organic solvents. Emulsions remove contamination and disperse it within the cleaning solution, making it necessary to use a centrifuge or other separation mechanism necessary for efficient disposal. For this reason, emulsion cleaners are not an ideal substitute for organic solvents. Alkaline cleaners are effective through the nature of their high pH, and are relatively easy to treat for disposal to local treatment works, however they require extensive safety precautions and employee training. Electrocleaners produce tiny

air bubbles that "scrub down" the material being cleaned, a method often used in conjunction with detergent cleaners. Detergent cleaners are often slightly alkaline and employ a variety of compounds to substitute for organic solvents. Ultrasonic cleaning using water-based or solvent chemicals can be used to achieve cleanliness levels not achieved by other means. More specific information on these processes can be found in the Metal Finishing Guidebook and Directory and other handbooks.

GOVERNMENT REGULATION OF ORGANICS

Regulations governing organic solvents fall into three categories: waste management under the Resource Conservation and Recovery Act (RCRA), transportation under the Hazardous Materials Transportation Act, and employee training under the Occupational Safety and Health Act (OSHA). The 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA are responsible for the current emphasis on disposal practices and safety. Separate publications are available describing how small businesses are affected by these amendments (Kraybill, 1987; USEPA, 1986). In general, the regulations state that if a business produces more than 220 pounds (about half a barrel) per month, it is responsible for cradle-to-grave documentation of the hazardous wastes it generates. In addition, the business may be liable for damages resulting from improper transportation and disposal of hazardous wastes, even if someone else was hired to transport and dispose of these materials.

Hazardous wastes covered by these regulations are explained in the law and in the USEPA Small Quantity Generators Manual (1986). Some wastes are listed in the text of the law; others are covered by having specified properties such as flammability, ignitability, corrosivity, or EP toxicity.

The four most important organic solvents used in the metal-cleaning industry are U-listed RCRA hazardous waste: 1,1,1 trichloroethane (U226), trichloroethylene (U228), methylene chloride (U080), and perchloroethylene (U210). Each of these solvents is regulated under RCRA as discussed previously. The task at hand is to find an effective cleaning method to replace these solvents. By reducing the amount of hazardous waste generated, the costs and liability associated with disposal are reduced. No alternative can be judged effective unless it can perform the cleaning task adequately, so individual testing is necessary. However, biodegradable cleaners that can replace many chlorinated solvents are available and have overall usage costs comparable to those of chlorinated solvents. A list of solvent recyclng companies is included in this report. For current users who have a recycling service, some suggestions to minimize the loss of solvent and make efficient use of degreasing equipment are also listed.

AKLALINE CLEANERS

A. Heavy Duty Alkaline Bath Cleaning

One alternative to organic solvents is using alkaline cleaners in parts washers or dip tanks. Many public treatment works will allow these solutions to be poured down the drain after their pH level has been lowered. Requirements of treatment works vary from area to area but in general, heavy metals concentrations must not exceed a given value and the pH of the solution must be adjusted to a range of 6.0 to 9.0. Check with the local treatment works to reach an agreement on disposal of this waste to the sewer system. The batch discharges may be too small and too infrequent and may not require any treatment if bled into other streams from the shop.

If the shop has a septic tank system, or cannot meet local discharge requirements, spent baths can be hauled away by waste disposal companies such as Chemical Waste Management, Chem-Clear, and Envirite. Their charges depend on volume, transportation distance, and chemical analysis of the waste. A list of these companies is attached. Chemicals are available to make heavy metals settle out of the spent cleaning solution, and other chemicals can lower the pH. The remaining liquid can then be flushed into the local treatment works. However, the sludge produced is a hazardous waste and must be disposed of according to RCRA regulations.

As long as treatment works can accept a business's waste and still remain in conformance with its own discharge permit, alkaline cleaning wastes can be discharged to the sewer and owners will not be held responsible for the documentation and handling requirements under RCRA. The administrator of the local publicly owned treatment works can provide a copy of specific regulations for each area.

B. Safety Considerations When Using Alkaline Cleaners

When alkaline cleaners are used for metal cleaning as a substitute for the organic solvents following precautions should be observed:

Do not store or mix with strong acids, flammable liquids, strong oxidants, or halogenated compounds.

Will cause severe burns to skin, eyes, digestive tract, or any exposed tissue. Avoid contact, inhalation, or ingestion.

Wear appropriate safety goggles, rubber gloves and apron, and an approved dust mask.

Certainly, wastes from this process are easier and more economical to dispose of than solvent wastes, but safety concerns about strong alkaline cleaners are no less important than concerns about organic solvents. To avoid injury, employee training is still an important requirement. Appropriate safety tips from the Metal Finishing Guidebook and Directory excerpted below should be posted and explained to personnel.

1. When making up cleaner tanks, never add the dry cleaner directly into the hot tank without first predissolving it in water. Violent eruptions can occur if cleaners are added directly to hot water. Eruptions can also occur if large quantities of cleaner are added directly to the tank in one charge instead of dissolving portions of it at a time.

2. Avoid breathing fumes and dust from alkaline cleaners, since respiratory problems can occur.

3. It is always safer to use warm water (about 120 F.) than hot water in making up alkaline cleaners.

4. When handling chemicals, one should always wear protective clothing and equipment, especially eye protection (goggles).

5. In case of injury, contact a physician as soon as possible. Give first aid immediately. See suppliers' literature for treatment.

6. If spillage of any chemical does occur, never let it remain on the floor. Always clean up a spill as quickly as possible to avoid any future reaction with any other chemical with which it may come in contact.

7. Avoid hydrogen explosions, which can occur in electrocleaning. Disconnect the current before removing work from an electrolytic cleaning tank.

8. Do not allow personnel to work over hot solution without adequate protection. Never work alone!

SLIGHTLY ALKALINE DETERGENTS: A BETTER ALTERNATIVE

Another alternative is a mildly alkaline detergent cleaner. Ideally, such a cleaner would be water-based, allow the separation of contaminants to extend bath life, be nonflammable, and be disposable into the public treatment works. Of course, the product must also be effective for a user's own cleaning applications, as well as safe for employees to use.

In the past, these detergents had a poor record of effectiveness, but new technology has given rise to several products hailed by industry as "replacements for the organics." Based on the sales literature of several manufacturers of these products, it appears that these detergents constitute a class of products whose time has come. Several major corporations have tested these products and found them to be well-suited for their applications. In using such products, these companies are lowering the costs, liability, and training needs associated with organic solvents and highly alkaline cleaners. Letters of testimony to the success of these products are usually available from the manufacturers.

There are several differences among these detergents. Some are formulated so the contaminants float to the top for easy removal. Others are emulsion-type cleaners that disperse the contamination throughout the solution. Clearly, the latter type has some disadvantages. The life of the solution cannot be extended by skimming the contamination layer from the top, and the spent solution will need treatment before disposal because the contaminants cannot be poured down the drain. This process is preferable to the use of organic solvents, but it would be better to use a compound that floats the contaminants to the top for easy removal. Again, consideration must be given to the compound that does an effective job for a specific application.

WHAT IF THE ALTERNATIVES FAIL?

If analysis of an operation reveals no acceptable substitutes for the organic solvents, there are still measures to take to reduce the amount of waste generated. Solvent distillation is an option to both reduce the amount of waste and reduce the amount of new solvent must be purchased. Solvent may be recycled with a private distillation unit or be taken to a commercial recycler for processing. Commercial recyclers usually employ a sophisticated process that can deal with many types of contaminants. A private distillation unit, on the other hand, can be put to use in an individual shop but may not be as successful with removing a particular contaminant. Some companies have preferred a private distillation unit because they know exactly what goes into the process and what comes out. Residue left in the still after distillation is considered a hazardous waste and has to be disposed of according to RCRA regulations. Negligent use of these stills may cause serious

explosions. Get in touch with several manufacturers and discuss with them the details of a specific operation. Following are suggestions for minimizing the loss of solvent and making efficient use of degreasing equipment for current users who have a recycling service.

- Increase the height of freeboard above the vapor level to 75% of the tank width,
- Cover the degreasing unit when not in use
- Install refrigerator coils (or additional coils) above the vapor zone,
- Rotate parts before removal from the vapor degreaser to allow all condensed solvent to return to the degreasing unit,
- Control the speed at which parts are removed (10 ft/min or less is desirable) in order not to disturb the vapor line.

Pre-cleaning will extend the life of the vapor degreasing solvent. Wipe, squeeze, or blow parts with air. Cold clean with mineral spirits to remove the bulk of the oil before final vapor degreasing. Recycle the cold cleaning solvent. Only degrease parts that must be cleaned; do not routinely degrease all parts.

CONCLUSION

Two alternatives to the use of organic solvents in industry have been examined. These alternatives show great promise in applications in which they can effectively clean the material being processed. Some manufacturers will set up a demonstration to show how their products can work in specific applications. AT&T has successfully used biodegradable solvent Bioact EC7, produced by Petroferm Inc. of Fernandina Beach, Florida for cleaning operations. According to David Chittic, vice president of environmental engineering at AT&T, this new solvent, derived from orange rinds and other citrus products will replace from a quarter to a third of their current three million pounds use of CFC113. Hurri Kleen Corporation has biodegradable products available for automotive shop use, such as carburetor cleaner, engine degreaser, brake cleaner, and paint prep. The following list of manufacturers of chemicals and solvent distillation units is not comprehensive, but should provide a good start for making contacts. Guidance or referrals are available from the Illinois Hazardous Waste Research and Information Center.

MANUFACTURERS OF ALTERNATIVE CLEANING COMPOUNDS

Penetone Corporation
74 Hudson Avenue
Tenafly, NJ 07670
201-567-3000

Petroferm, Inc.
5400 1st Coast Highway
Fernandina Beach, FL 32034
904-261-8286

Hurri-Kleen Corporation
6000 Southern Industrial Drive
Birmingham, AL 35235
205-655-8808

JHM, Inc.
314 Straight Street
Grand Rapids, MI 49504
616-458-1981

Delta Foremost Chemical Corporation
P.O. Box 30310
Memphis, TN 38130
800-238-5150

Oakite Products, Inc.
50 Valley Road
Berkely Heights, NJ 07922
201-464-6900

Allied-Kelite Division
Witco Corporation
2701 Lake Street
Melrose Park, IL 60160-3041
800-942-9767

Starlite Chemicals, Inc.
1319 West North Avenue
Chicago, IL 60622
312-772-4830

MANUFACTURERS OF SOLVENT DISTILLATION UNITS

Finish Engineering Company
921 Greengarden Road
Erie, PA 16501
814-455-4478

Thomas Equipment Company
901 Tonne Road
Elk Grove Village, IL 60007

SOLVENT RECYCLING COMPANIES

Safety-Kleen
777 Big Timber Road
Elgin, IL 60120
312-697-8460

Solvent Systems Interna'l, Inc.
339 W. River Rd.
Elgin, IL 60123
312-931-5315

Sea Corporation
75 Sanger Street
P.O. Box 5098
Peoria, IL 61601
800-322-6145

LIQUID WASTE HAULERS AND DISPOSERS

Chemical Waste Management
3003 Butterfield Road
Oakbrook, IL 60521
312-572-8800

Envirite Corporation
600 West Germantown Pike
Plymouth Meeting, PA 19462
215-828-8655

Chem-Clear, Inc.
11800 South Stony Island Avenue
Chicago, IL 60406
312-646-6202

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