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The environmental aspects of parts cleaning are regulated by numerous federal and state regulations that address air emissions, hazardous waste management, and wastewater discharges. The Colorado Department of Public Health and Environment (CDPHE) prepared this bulletin to convey information about switching to aqueous parts cleaning a source reduction opportunity. Source reduction, or pollution prevention (P2), practices complement emission control measures and waste management procedures required by regulations. CDPHE defines P2 as the reduction or elimination of pollutants or wastes at the source, by using less hazardous raw materials or using more efficient practices or processes. It includes reducing the use of energy, water, and other resources through increased efficiency or through conservation. For more information about regulations that apply to parts cleaning, contact Ed Smith at (303) 692-3386 or visit www.cdphe.state.co.us/hm/hmhom.asp.

The objective of this bulletin is to stimulate small quantity generators of hazardous waste to consider switching to aqueous parts cleaning. This document describes issues associated with solvent use, how aqueous cleaning works, types of aqueous cleaning units, and managing aqueous cleaning wastes.

Remember, P2 pays – on the “front end” through improved raw material utilization and on the “back end” by decreasing waste management and

What's Wrong With Solvents?

Mineral spirits is a solvent commonly used for part cleaning because of its ability to quickly dissolve oil, grease, dirt, grime, burnt-on carbon, and heavy lubricants. Although it is effective for cleaning, mineral spirits raises significant environmental and human health concerns:

- Mineral spirits contains volatile organic compounds (VOC) that contribute to smog formation and may be toxic when inhaled.

AQUEOUS PARTS CLEANING

This bulletin includes five case studies from Colorado facilities that have switched to aqueous parts cleaning, and vendor information.

For more detailed information about aqueous cleaning than is provided in this bulletin, please consult the information sources included at the end of the document.

After June 2002, contact the CDPHE P2 Program: Kirk Mills at (303) 692-2977 or Margo Griffin at (303) 692-2979. The CDPHE P2 Program (www.coloradoP2.org) provides confidential, non-enforcement, P2 assessments for Colorado businesses and follows up with a report that summarizes P2 opportunities.

HOTLINE!
Through June 2002, CDPHE is offering focused P2 research and implementation support through a P2 Hotline (303-312-8880). Take advantage of this free and confidential opportunity to obtain assistance investigating process improvements that are on your “wish list” or address waste streams that are expensive to manage or cause compliance problems. Call now!

- Mineral spirits evaporates quickly, making worker exposure difficult to control.
- Solvent cleaning units are often a major source of a facility’s hazardous waste.
- Solvent use for cleaning is increasingly regulated and restricted by local environmental agencies.

Using solvents creates unnecessary environmental, worker health, and fire liabilities for your

organization. Minimize your costs and regulatory liabilities by switching to aqueous solutions.

What Is An Aqueous Cleaner and How Does It Work?

Aqueous cleaners are water-based solutions that, unlike petroleum-based solvents, are nonflammable and contain little or no VOCs. Instead of dissolving grease and solids, aqueous cleaners rely on heat, agitation, soap action, and time to break dirt into smaller particles. Although they clean differently, aqueous cleaners perform as well as solvents.

For this fact sheet, aqueous cleaners are defined as water-based solutions that contain less than 5 percent (50 grams per liter) of VOCs. Hundreds of aqueous cleaner formulations are commercially available (see www.aqmd.gov/business/water/html for a list of aqueous cleaners with less than 5 percent VOCs. Information presented in this fact sheet is derived from studies performed by Colorado Department of Public Health and Environment, Colorado State University Waste Minimization and Assessment Center, the U.S. Environmental Protection Agency, and Tetra Tech EM Inc.

Dissolving The Myths About Aqueous Parts Cleaning

MYTH	FACT
1. Aqueous cleaning units do not clean parts as well as solvent units.	Aqueous spray cabinets and ultrasonic units can clean even difficult-to-clean parts. Aqueous parts cleaners can effectively clean a wide variety of parts from small computer components to transmissions.
2. Part rusting is a problem.	Rust inhibitors in aqueous cleaners decrease the chances of rusting. Rusting can be further minimized by drying parts immediately after cleaning.
3. Aqueous cleaning is expensive.	Most facilities can save money by 1) implementing aqueous spray cabinets to reduce cleaning labor and 2) maximizing aqueous solution life.
4. Aqueous cleaning wastes are a hassle to	Waste aqueous solution with sludge typically requires

Maximizing Aqueous Solution Life

With proper management, aqueous cleaning solution can last longer than solvents. Extending the life of an aqueous solution will save money by reducing your chemical purchase and waste disposal costs. To maximize aqueous solution life, you should:

- **Use microbe technology for sink-top units.** Solutions for these units have longer lives than solvent and with proper use rarely require disposal.
- **Filter the solution.** Filters, typically cartridge filters, are used to remove solids as small as 50 microns in size.
- **Perform oil skimming.** Oil skimmers remove free-floating oil from the solution, reducing the amount of oil residuals left on parts and significantly extending solution life. Microbial units do not need oil skimming because microbes degrade the oil.
- **Accept solution discoloration.** Many aqueous solutions turn gray or brown during use, but this discoloration does not affect its cleaning ability. Do not change cleaning solution only because it looks dirty.
- **Change the solution only when necessary.** Change the solution when its cleaning performance declines. Do not change the solution on a scheduled, need-it-or-not basis. Always dispose of cleaning solution appropriately.
- **Maintain solution concentration.** Perform chemical additions as needed to maintain the cleaning strength of the solution. Some vendors offer easy-to-use test kits to measure the concentration of the solution and determine when chemical additions are necessary.
- **Recycle solution using microfiltration.** Some vendors offer an on-site microfiltration recycling service that removes contaminants from the solution, eliminating waste solution generation and disposal.



Types of Aqueous Cleaning Units

The cleaning equipment used is critical to successful aqueous cleaning because it applies four important mechanisms to the cleaning process: mechanical force, heat, chemical action, and time. Four types of aqueous cleaning units—microbial sink-top units, spray cabinets, immersion, and ultrasonics—are described below. Each type of unit is designed for specific cleaning applications; therefore, many facilities may need more than one type of unit to meet all their cleaning needs.

<p>Microbial sink-top units: Best for quick, light-duty cleaning Aqueous sink-top units are used for manual cleaning of parts in the same way as conventional solvent sink-top units. Microbes present in the aqueous solution degrade oils and organic contaminants, significantly extending solution life. In addition, microbes are safe and pose no risk to technicians. Non-microbial aqueous sink-top units are also available; these units generally require more frequent solution changes, which may increase operating costs relative to microbial units.</p>	<p>Spray cabinets: For heavily soiled or large numbers of parts Aqueous spray cabinets clean parts by spraying high-temperature solution at high pressures within an enclosed cabinet. Spray cabinets are available in a full range of capacities from small to extremely large.</p>
<p>Applications</p> <ul style="list-style-type: none"> • Preventative maintenance and light-duty cleaning • Parts with light to moderate soil buildup • Small quantities of parts • Parts for immediate replacement 	<p>Applications</p> <ul style="list-style-type: none"> • Parts with heavy or difficult-to-remove soils • Moderate to very large quantities of parts • Medium to large sized parts • Heavy-duty repairs and rebuilding
<p>Key Features</p> <ul style="list-style-type: none"> • Solution heated to 110 to 120°F • Filtering available to remove solids • Microbes degrade oily contaminants 	<p>Key Features</p> <ul style="list-style-type: none"> • Solution heated to 130 to 190°F • Spray pressures of 40 to 60 pounds per square inch • Oil skimming options • Solution concentration typically maintained between 10 and 15 percent
<p>Advantages</p> <ul style="list-style-type: none"> • Low capital cost relative to other aqueous cleaning units • Little or no waste solution • Does not dry or chap technician's hands 	<p>Advantages</p> <ul style="list-style-type: none"> • Significant reduction in cleaning labor • High level of cleaning performance • Large cleaning capacities available • Lower waste management costs compared to solvent units
<p>Disadvantages</p> <ul style="list-style-type: none"> • May require more scrubbing effort than solvent • Difficult to clean heavy or stubborn soils • Keeping microbes alive requires proper worker training 	<p>Disadvantages</p> <ul style="list-style-type: none"> • Moderate to high cost
<p>Unit Selection Considerations</p> <ul style="list-style-type: none"> • Make sure the unit is at a comfortable height for workers • Greater sink-top size allows larger parts to be cleaned • Higher pump pressure improves cleaning action • Workers may react negatively to some microbial solution odors 	<p>Unit Selections Considerations</p> <ul style="list-style-type: none"> • Pump power, spray pressure, flow rate, and number of nozzles (higher spray pressures and greater coverage result in better cleaning performance) • A 220-volt outlet is often required • Temperature control helps to optimize cleaning performance • Insulated units are more energy efficient
<p>Cost \$800 to \$3,000</p>	<p>Cost \$1,700 to \$11,500</p>

Types of Aqueous Cleaning Units

<p>Immersion units: When soak option is needed Immersion units consist of a rectangular tank filled with aqueous solution and a removable false bottom. Immersion units give technicians the option of soaking parts in the aqueous solution below the false bottom to loosen soils on the parts or manually scrubbing parts on top of the false bottom, as performed in a sink-top unit.</p>	<p>Ultrasonic units: Clean blind areas Ultrasonic units consist of a steel tank filled with an aqueous solution and are equipped with transducers along the bottom or sides of the tank. The transducers generate high frequency sound waves that produce an intense microscopic scrubbing action on parts surfaces, including blind holds and interior surface areas.</p>
<p>Applications</p> <ul style="list-style-type: none"> • Parts with light to moderate soil buildup • Small to moderate quantities of parts • Light- to medium-duty cleaning 	<p>Applications</p> <ul style="list-style-type: none"> • Transmissions, carburetors and other hard to clean parts • Parts with blind holes and hidden surface areas • Heavy-duty or high-precision cleaning
<p>Key Features</p> <ul style="list-style-type: none"> • Allows soaking of parts • Solution heated to 110 to 120°F • Filter and oil skimming options • Solution concentration typically maintained between 25 to 30 percent 	<p>Key Features</p> <ul style="list-style-type: none"> • Transducers generate ultrasonic waves • Solution heated to 140 to 185°F • Filter and oil skimming options
<p>Advantages</p> <ul style="list-style-type: none"> • Soaking can improve cleaning and reduce scrubbing time 	<p>Advantages</p> <ul style="list-style-type: none"> • Very high performance cleaning • Ability to clean hidden areas on parts • Significant reductions in cleaning labor
<p>Disadvantages</p> <ul style="list-style-type: none"> • More expensive than sink-top units • May be difficult to clean heavy or stubborn soils 	<p>Disadvantages</p> <ul style="list-style-type: none"> • High cost • Some units make a "hissing" noise
<p>Unit Selection Considerations</p> <ul style="list-style-type: none"> • Make sure the unit is at a comfortable height for your workers • Greater size allows larger parts to be cleaned • Unit available in stainless steel or plastic construction 	<p>Unit Selections Considerations</p> <ul style="list-style-type: none"> • Greater ultrasonics power provides better cleaning ability • A 220-volt outlet is often required • Greater unit size provides more cleaning capacity
<p>Cost \$1,700 to \$3,500</p>	<p>Cost \$5,000 to \$12,000</p>



CONVENIENCE

" I can put wheel bearings covered in heavy grease in the spray cabinet turn on the machine, and go back to work. When I come back and pull out the bearings, they're all clean."

-Mark Foti

MUNI technician, San Francisco, California

Did You Know?

Often the greatest cost for parts cleaning is labor. The time your workers spend cleaning parts is time they could otherwise use performing additional duties. Spray cabinets reduce cleaning labor by as much as 80%.

Keeping Your Microbes Alive and Well

Killing your microbes will result in an unpleasant odor, oil accumulation in your solution, or loss of cleaning performance. Be sure to keep your microbes alive and happy!

- Maintain solution temperature
- Don't use aerosols above unit
- Allow time for microbes to adjust to new soils

- Don't overload the unit
- Monitor sludge and oil accumulation

Managing Aqueous Cleaning Wastes

The wastes generated from aqueous cleaning should be managed as described below.

Waste Solution. Aqueous cleaning solutions may qualify as hazardous waste after extended use because concentrations of metals such as cadmium, copper, lead, and zinc may exceed state or federal limits. Therefore, always use a licensed waste disposal company to manage waste solution. Many waste disposal companies will analyze the waste solution to determine whether it is hazardous. The cost of disposal will vary according to the characteristics of the waste and the volume generated, but will generally be \$2 to \$4 per gallon if it is a hazardous waste and \$1 to \$3 per gallon for nonhazardous waste. Unless you obtain permission from the local sewage treatment agency, do not dump waste aqueous cleaning solution in the sewer or septic system.

Skimmed Oil. Oil skimmed from an aqueous cleaning solution can be managed as used oil and recycled. Most recyclers will accept skimmed oil with used motor oil as long as it is not contaminated with solvent.

Used Filters. Used filters may be recycled along with spent engine oil filters with the permission of the recycler. Contact your oil recycler to determine if they will take your filters. Some recyclers will only accept used filters if they are encased in metal shells like engine oil filters. If they are not recycled with engine oil filters, used filters should be managed as hazardous waste and disposed of by a licensed waste disposal company unless they have been tested and determined to be nonhazardous.



Simple Sludge Management

Little or no sludge will accumulate in aqueous cleaning units with filtration, but units without filtration may accumulate sludge at the bottom. This sludge may be disposed of along with waste solution. Most waste disposal companies will accept a certain percentage of solids in the waste solution. If the sludge is separated from the solution, the sludge may not be disposed of as solid waste unless tested and determined to be nonhazardous.

Full Service Lease Agreements

Convenience at a cost. Most solvent users enjoy the hassle-free arrangement of full servicing and waste management provided by a solvent management company. Although some aqueous cleaning vendors offer similar servicing and waste management arrangements, most do not, usually because it's not necessary. Here's why:



- Aqueous solutions can last significantly longer than solvents and therefore do not need to be changed as frequently. Even with heavy use, a spray cabinet can clean effectively for as long as 3 months between solution changes. With proper use, microbial sink-top units may clean effectively over one year before requiring solution change.
- Servicing aqueous units requires minimal time and

effort.

SERVICING REQUIREMENTS

TIME TO PERFORM AND FREQUENCY

Add water and chemical	10 minutes, daily to every 2 weeks
Skim Oil (not on microbial units)	5 minutes, every 2 weeks to every 2 months
Replace filter	5 minutes, every 2 weeks to every 2 months
Drain and replace	1 hour, every 2 months to

solution

every few years

Aqueous Cleaning Works!

The case studies featured in this document are from P2 evaluations conducted in Colorado between 1995 and 2001. These case studies demonstrate that aqueous cleaners are capable of cost effectively meeting or exceeding parts cleaning requirements encountered in a wide variety of operations

payback period for the conversion from a solvent to aqueous sink-top washer was about 1.5 years. For more information, visit www.coloradop2.org.

Case Study #1:

Loral Corporation Pueblo, Colorado

Loral manufactures electrical components for military computers. Previously, Loral used a trichlorotrifluoro-ethane (solvent) vapor degreaser to clean dirt, oils, and debris from electronic equipment. Loral replaced this solvent vapor degreaser with a new Dupont Axarel-32 in-line spray cabinet with wash, rinse, and dry cycles. The new system was custom built for Loral by Van Waters and Rogers and installed at a cost of \$210,000, which included costs to install a new venting and piping system. The new system reduced the amount of cleaning solutions used per year from 96 55-gallon drums of solvent at a cost of \$180,000, to 19 55-gallon drums of aqueous cleaning solution at a cost of \$27,465 per year. The cleaning solution cost savings alone were \$152,500 in the first year and ozone depleting solvent emissions were eliminated by 100 percent. The payback period for the unit was less than 1.5 years. Also the use of the in-line aqueous cleaner eliminated employee exposure to harmful fumes and improved the business image of Loral. For more information, visit www.coloradop2.org.

Case Study #2:

All Tune and Lube Boulder, Colorado

All Tune and Lube is a small auto repair shop. Previously, a conventional solvent parts washer was used to clean auto parts. The solvent washer dispensed mineral spirits or petroleum naphtha from a flow-through brush and the parts were scrubbed on a sink-top. The solvent was recovered in a spent solvent drum located beneath the sink and the spent solvent was manifested and disposed or recycled off the site as hazardous waste. A Profile Plus parts washer, a non-microbial aqueous sink-top unit, replaced the solvent parts washer for \$800. The detergent solution is collected beneath the sink, filtered, and reused. Sludge settles out in the bottom of the spent detergent and must be removed about once per year. Cleaning solution cost for the aqueous parts cleaner is \$122 per year, compared to \$780 per year for the solvent parts washer. The

Case Study #3: Quality Metal Products Lakewood, Colorado

Quality Metal Products is a sheet-metal manufacturer, that produces aluminum sheet-metal for cabinets and electronic components. Previously Quality Metal Products used a solvent vapor degreaser to clean metal components before coating operations. The solvent vapor degreaser was replaced with a custom-built, aqueous immersion unit, heating unit, filter, pump, and oil skimmer at a cost of about \$14,700.

The implementation of the aqueous parts washer reduced the amount of solvent-based hazardous waste generated by nearly 375 gallons per year. In addition, solvent air emissions were reduced by up to 19,000 pounds per year. The elimination of solvents used in the facility eliminated costs associated with hazardous material disposal and with treating air emissions by nearly \$13,000 per year. The payback period for the conversion to aqueous cleaning was about 1.3 years. For more information, visit www.coloradop2.org.



Case Study #4:

Mastercraft

Aurora, Colorado

Mastercraft produces commercial wood products and cabinetry. The original cleaning system employed solvent-based thinners to remove excess paint from spray guns, nozzles, and associated painting equipment. The use of this solvent cleaning system produced hazardous air pollutants and spent materials that were disposed of as hazardous waste. The former system was replaced by an enclosed aqueous spray cabinet cleaning system that uses high temperature and pressure to remove debris from the associated painting equipment. The water is captured and recycled for reuse. This enclosed aqueous unit was engineered in house. The former system used 15,000 gallons of solvent thinner at a cost of \$54,545 per year compared to 7,500 gallons of aqueous cleaning solution at a cost of \$68,181 per year, an increase of \$13,636. However, the cost associated with disposal of the spent solvent was eliminated. According to the plant manager, hazardous waste disposal costs were reduced by \$100,000 per year. In addition, solvent air emissions were reduced by about 40 tons per year. For more information on P2 opportunities related to the wood products sector, please refer to the bulletin titled [Pollution Prevention Ideas for the Wood Products and Furniture and Fixtures Industries](#). For more information on this case study, visit coloradop2.org.



Case Study #5

Buttermilk Mountain Maintenance Shop

Aspen, Colorado

Buttermilk Mountain maintenance shop services vehicles and equipment used at a ski area. The maintenance shop used solvent (mineral spirits) sink-top units to clean vehicle parts of oil, grease, and debris. A \$4,245 Landa SJ-15 aqueous spray cabinet replaced the solvent unit. By converting to the spray cabinet, Buttermilk Mountain reduced the labor hours needed to perform the parts cleaning from 728 hours per year to 143 hours per year. Heating requirements of the spray cabinet increased electrical costs by about \$1,200 per year; however, facility managers considered the dramatically improved labor productivity to outweigh this increase. In addition, the cost for disposal of spent solvent was eliminated. The payback period for the conversion from solvent to aqueous cleaning was about 4 months.



Information Sources and Links

The following resources contain further information regarding aqueous parts cleaning.

RESOURCE	DESCRIPTION
Aqueous Parts Cleaning www.epa.gov/region09cross_pr/p2/autofleet/autoclean.pdf	Aqueous cleaning fact sheet focusing on auto repair industry created by EPA Region IX. Subjects include how aqueous cleaning works, type of aqueous cleaning units, maximizing solution life, managing wastes, an aqueous cleaning cost comparison worksheet, and case studies.
Alternatives to Hazardous Solvents, Switching to Aqueous Parts Cleaning www.ecy.wa.gov/pubs/96425.pdf	Fact sheet created by the Washington State Department of Ecology. Subjects include considerations in selecting an aqueous cleaning unit, optimizing the system, and extending cleaner life.
Ohio Office of Pollution Prevention www.epa.state.oh.us/opp/solvents/fact31.html	Web page with discussion of extending the life of aqueous cleaning solution life. Includes information regarding extending bath life, recycling, filtration, case studies and references.
Switching to Water Based Cleaners in Repair and Maintenance Parts Cleaning www.westp2net.org/news/IRTA/third.pdf	Fact sheet written by the Institute for Research and Technical Assistance's Pollution Prevention Center. Discusses types are parts cleaning systems and contains a list of frequently asked questions.
Managing Aqueous Parts Washers www.pca.state.mn.us/waste/pubs/4_44.pdf	Fact sheet discussing management of spent aqueous cleaning solution.
Switching to Water-Based Solutions for Parts Cleaning http://www.baaqmd.gov/enf/compliance/aq_clr.pdf	Fact Sheet written by the Bay Area Pollution Prevention Group. Discusses types of units, managing waste generated by aqueous units, and information to request from vendors and referral shops.

Aqueous Parts Cleaner Vendors

The following table contains a list of aqueous parts cleaner vendors.

VENDOR	PHONE NUMBER
Better Engineering	(800) 229-3380
CAE Ultrasonic	(800) 437-7117
Clayton Associates	(800) 248-8650
EcoClean Corporation	(800) 797-4050
Equipment Manufacturing Company	(888) 833-9000
Kleen Tec	(800) 435-5336
Landa	(800) 547-672
Mirachem	(800) 847-527
Renegade	(800) 774-7900
Rocky Mountain Cleaning Systems	(970) 848-0819

UniKleen	(800) 930-4729
Van Waters and Rogers	(303) 388-5651
Water Star Inc.	(303) 337-1905