

How Aqueous Cleaning Solutions Drive Safety and Profitability in MRO and Production Processes



Perchloroethylene and trichloroethylene — two commonly used industrial solvents — are volatile organic compounds (VOCs) that have been linked to a number of health problems.

For more than a century, maintenance and repair operations as well as industrial production processes have used toxic solvents to clean contaminants from metal parts. However, as trichloroethylene (TCE) and other solvents have come under increased scrutiny for their health and environmental risks — and as more companies have come to understand the benefits of safe and sustainable operating practices — solvent users have been seeking greener alternatives.

With the emergence of aqueous (water-based) technology, there's a cost-effective, environmentally friendly option for cleaning and degreasing metal parts and components. Green solutions — such as Bio-Circle cleaning products — protect the environment, improve workplace safety and reduce industrial waste and operating costs. This whitepaper will explain how aqueous cleaning agents work, and why switching to these technologically advanced, environmentally friendly cleaning solutions can help contribute to a safer, more sustainable and more profitable workplace.

What Is Aqueous Cleaning?

Over the years, manufacturers have used a variety of hydrocarbon/organic solvents to clean and degrease metal parts. Some of the most commonly used solvents include trichloroethylene, methylene chloride, toluene, benzene, mineral spirits, methyl ethyl ketone and other hydrocarbons.¹

While chemical solvents are effective at removing grease and other fluids from metal parts, many of these solvents are harmful to workers and the environment. For example, perchloroethylene and trichloroethylene — two commonly used industrial solvents — are volatile organic compounds (VOCs) that have been linked to a number of health problems, including an increased risk of cancer.

¹ Toxics Use Reduction Institute, University of Massachusetts Lowell



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Toxic Solvents at a Glance

Here is what we know about the health and environmental hazards associated with some of the most commonly used industrial cleaning solvents.

⚠ Benzene

The U.S. Environmental Protection Agency has classified benzene as a “known human carcinogen for all routes of exposure.” Short-term inhalation exposure can cause drowsiness, dizziness and headaches; eye, skin and respiratory-tract irritation; and, at high levels, unconsciousness. Chronic inhalation of benzene has caused various blood disorders, including aplastic anemia, and has been linked to leukemia.

⚠ 1-Bromopropane or n-Propyl Bromide (nPB)

In July 2013, OSHA and the National Institute for Occupational Safety and Health issued a hazard alert noting that exposure to 1-bromopropane (1-BP), or n-propyl bromide (nPB), can cause irritation of the eyes, mucous membranes, upper airways and skin, and can damage the nervous system. In October 2014, the U.S. Department of Health and Human Services added 1-BP to its *Report on Carcinogens*, classifying the chemical as “reasonably anticipated to be a human carcinogen.”

⚠ Methylene Chloride

OSHA considers methylene chloride, or dichloromethane, to be “a potential occupational carcinogen,” while the Department of Health and Human Services has classified the chemical as “reasonably anticipated to be a human carcinogen.” In addition to the risk of cancer, OSHA asserts that exposure to methylene chloride can irritate the eyes and skin and can put workers at increased risk of damage to the heart, central nervous system and liver.

⚠ Perchloroethylene (PERC)

The EPA has classified perchloroethylene as “likely to be carcinogenic to humans,” noting that studies have found a linkage between workplace exposure to the chemical and several types of cancer, including bladder cancer, non-Hodgkin lymphoma and multiple myeloma. According to OSHA, inhaling perchloroethylene vapors can cause a number of other health issues, including dizziness, drowsiness, loss of coordination and mild loss of memory, while prolonged dermal contact can cause redness and blistering of the skin.

⚠ Trichloroethylene (TCE)

In a toxicological review published in September 2011, the EPA noted that trichloroethylene “poses a potential human health hazard for noncancer toxicity to the central nervous system, kidney, liver, immune system, male reproductive system and the developing fetus.” Symptoms of short- and long-term exposure to trichloroethylene can include dizziness, headaches, confusion, euphoria, facial numbness and weakness, according to the agency. The EPA also concluded that trichloroethylene is “carcinogenic in humans by all routes of exposure,” pointing to “convincing evidence of a causal association between TCE exposure in humans and kidney cancer.”

In sharp contrast, aqueous cleaning solutions — which use water as the primary solvent — contain no ozone-depleting chemicals and low or no levels of VOCs. Unlike many petroleum-based solvents, aqueous cleaners are nonflammable. Overall, aqueous cleaners are less toxic than solvents.

Common methods of aqueous cleaning include:

- **Immersion cleaning:** The parts are immersed in a cleaning solution, and some form of agitation and/or heat is added to supply the energy needed to remove contaminants.
- **Automated washing:** A high-pressure spray delivers more mechanical action to help remove soils from the parts.
- **The ultrasonic method:** A combination of water, a detergent and high-frequency sound waves creates bubbles that implode to dislodge particles from the parts.²

Although their cleaning methods differ from solvent-based systems, aqueous cleaners have proven to be just as effective. And because they're safer to use, aqueous cleaners offer a number of other advantages that can benefit the bottom line.

When Inner-Tite Corp. switched from a vapor-degreasing parts-cleaning process to an aqueous cleaning system in 2007, the Holden, Mass.-based manufacturer of security equipment was able to eliminate its use of trichloroethylene entirely. Not only did this make Inner-Tite's factory safer — employees no longer were exposed to TCE, a suspected carcinogen — but it also saved the company nearly \$2,500 per year in TCE purchasing costs.

By eliminating the annual use of 2,675 pounds of trichloroethylene, the company no longer had to report its TCE usage to state environmental authorities, saving Inner-Tite an additional \$1,100 in annual regulatory

² State of Oregon Department of Environmental Quality, “Alternative Cleaning Solvents and Processes” fact sheet



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reporting fees. And removing trichloroethylene from its facility reduced the amount of time dedicated to preparing for emergency response and complying with OSHA and environmental regulations, while lowering the facility's air emissions below the threshold for a minor-source generator.³

Bio-remediation

Bio-remediation is another twist on aqueous cleaning. The bio-remediation process has been occurring in nature for millions of years, and has been harnessed recently to provide a safe, effective alternative to solvent-based cleaning systems.

In the bio-remediation process, live micro-organisms within aqueous cleaning fluids break down oil, grease and other organic contaminants. Typically, the process takes place in a parts-cleaning sink, and the bio-remediating fluids require heat for optimal performance.

In much the same way that humans live by eating, breathing and producing waste, the micro-organisms consume and digest the contaminants and convert them to harmless by-products: mostly water and carbon dioxide.

"It's a very simple chemical reaction," explains Patrick Lapointe, Vice President of Research and Development for Walter Surface Technologies Inc., which manufactures the Bio-Circle line of aqueous cleaning products. "The micro-organisms derive energy from breaking the chemical bonds in the hydrocarbon chain, releasing molecules of water and carbon dioxide. It's a totally natural process."

By converting oil, grease and other contaminants into harmless by-products, bio-remediation can help companies reduce their chemical-waste footprint — and not just on the factory floor. Bio-remediation has been used to help clean up large-scale environmental accidents, including the 2010 BP Deepwater Horizon disaster, which discharged nearly 5 million gallons of oil into the Gulf of Mexico.



"Oil-degrading indigenous micro-organisms played a significant role in reducing the overall environmental impact of both the Exxon Valdez and BP Deepwater Horizon oil spills," Ronald Atlas and Terry Hazen note in an article that appeared in the Aug. 15, 2011, edition of the journal *Environmental Science & Technology*.⁴

In Lapointe's experience, most manufacturers shift to aqueous cleaners because they want to adopt products and processes that are safer for their workers and the environment. However, new customers are pleasantly surprised to learn that bio-remediating fluids — and aqueous cleaning fluids in general — maintain their full cleaning power over a longer time period than solvents.

"The beauty of bio-remediation is it's self-renewing," Lapointe explains. "When you 'feed' these micro-organisms with hydrocarbons, the micro-organisms live on, and their remediation power stays the same for several weeks. Also, the cleaning agents in the solution will saturate at a much slower rate than solvents."

While solvent cleaners begin losing strength soon after their first use — requiring users to replenish their supplies after eight to 12 weeks — bio-remediating cleaners

³ Massachusetts Office of Technical Assistance and Technology, "Inner-Tite Corporation Toxics Use Reduction Case Study"

⁴ Ronald Atlas and Terry Hazen, "Oil Biodegradation and Bioremediation: A Tale of the Two Worst Spills in U.S. History," *Environmental Science & Technology*, Aug. 15, 2011



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maintain their efficacy over the course of one to two years, according to Lapointe.

“When you factor in the total cost [of solvents vs. aqueous cleaners], that’s a very important variable to keep in mind,” Lapointe adds.

A Healthier Bottom Line

Repeated use of solvents can cause skin irritation, neurological disorders and damage to the liver, kidneys and reproductive system. Because of these hazards, companies that use solvents try to minimize worker exposure by purchasing personal protection clothing and equipment for their employees. **They also might incur costs from:**

- Installing and maintaining ventilation and vapor-extraction equipment.
- Contracting with a third party for management and disposal of spent solvents.
- Paying higher fire-insurance premiums associated with the use of flammable, petroleum-based solvents.
- Investing in fire-suppression equipment and emergency-response training.
- Paying regulatory reporting fees and OSHA/EPA noncompliance fines.

Aqueous cleaning products, which are safe to handle, nonflammable and emissions-free, remove those costs from the equation.

One of the key benefits of aqueous cleaning liquids such as Bio-Circle is the fact that employees can use them without wearing burdensome personal protective equipment such as respirators, explains Howard Case, Maintenance Manager for Leesta Industries Ltd., a Montreal-based manufacturer of aerospace components.

“It’s an excellent concept,” Case says. “The [Bio-Circle] liquid leaves no residue on the parts. It’s



environmentally friendly. It’s warm, instead of leaving a cold feeling on the hands, so it’s easy to use. Its health rating is excellent so you don’t need to take special precautions [such as using a fume hood.]”

By making the workplace safer, aqueous cleaning systems also mitigate the hidden costs associated with exposure to harmful solvents – such as the missed workdays and lost productivity resulting from chemical-related illnesses and injuries. Over the years, high-performing organizations have demonstrated that strong environmental health and safety programs are linked to higher employee productivity, morale and job satisfaction, as well as lower turnover.

“When you switch to an aqueous cleaning system, you’re not exposing your workers to a hazardous solvent anymore,” says Jason Marshall, Laboratory Director for the Toxics Use Reduction Institute’s cleaning laboratory at the University of Massachusetts Lowell. “Their stress levels will be a lot lower. Their PPE requirements will be a lot less. They’re going to feel a lot of the psychosocial benefits [of safety] that you really can’t put a price tag on.”



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A Competitive Edge

Even harder to quantify – but no less important – is the business value of investing in technology that supports workplace safety and environmental stewardship. As investors, customers and suppliers are placing an increasingly higher premium on environmentally friendly business practices, maintaining a robust safety and sustainability program can be a competitive advantage.

Hudson Technologies, which makes precision metal enclosures for industrial applications, invested \$2 million to install and train its workers on an aqueous cleaning system in its Ormond Beach, Fla., manufacturing facility. The investment in aqueous cleaning equipment and “environmentally sound, state-of-the-art lubricants” is helping to position the company as “a leader in green manufacturing.”⁵

“Our environmentally superior products are made using biodegradable lubricants and an aqueous cleaning system,” the company boasts on its website. “No chlorinated lubricants or solvents are ever used to manufacture our products. Our manufacturing process produces no hazardous waste.”

The company’s aqueous cleaning system uses vertical agitation, basket rotation, high-pressure submerged spray and ultrasonics to clean its metal parts, and a recirculating air dryer with HEPA filtration to dry the parts. Clearly, Hudson Technologies considers the environmentally friendly parts-cleaning process to be a competitive advantage.

“If building a green supply chain and creating more sustainable products is important to you and your customers, why would you buy . . . from any other manufacturer?” The company asks on its website. “Hudson Technologies takes its commitment to be a good steward of the environment seriously. And we’re walking the talk.”

Not a Niche Anymore

Aqueous cleaning has evolved into a mainstream technology over the past two decades. Walter Surface

Technologies, whose product portfolio includes bio-remediating and bio-renewable cleaning liquids and parts washers, now operates in seven countries, and includes J.M. Smucker Co., PepsiCo, Ford Motor Co., United Airlines, Volkswagen Group and other multinational corporations as customers.

“Green cleaning isn’t a niche anymore,” Lapointe says. “We’re not talking about the early stages of technology here. This is mainstream, and more and more companies are adopting this technology, as it’s proven to be a reliable, safe and cost-effective method to clean parts.”

What EH&S Leaders Can Do Right Now

As regulators and corporations ratchet up their expectations for safety and sustainability performance, the role of the environmental, health and safety (EH&S) leader will continue to become more important. Here are some steps that EH&S leaders can take today to make an immediate positive impact with aqueous solutions:

- Evaluate their MRO and/or production processes and consider all of the dangerous chemicals that can be replaced with nontoxic, VOC-free solutions.
- Find a supplier that can help conduct a chemical audit to estimate the total cost (or cost improvements) of replacing existing solvents with sustainable solutions.
- Pilot-test sustainable, aqueous-based solutions in one location to measure effectiveness and real-world cost reductions.
- Deploy solutions across the entire organization once the benefits are proven.
- Become an advocate for sustainability – upstream to suppliers and downstream to customers – demonstrating that their organization “walks the talk.”
- Document the use case and demonstrate the cost savings and contribution to profitability to build support for further sustainability and safety initiatives. ■

⁵ Hudson Technologies, www.hudson-technologies.com/about-us/green-manufacturer.html



A Boost from Nature

Windsor, Conn.-based Walter Surface Technologies Inc. is harnessing the power of nature to make parts-cleaning processes safer and more sustainable with its Bio-Circle parts-washing solutions.

Bio-Circle's aqueous cleaning products eliminate the hazards of solvents — and the costs of protecting workers from exposure to toxic chemicals.

Bio-Circle offers two types of powerful, sustainable parts-cleaning technologies:

- **Bio-remediating** parts-washing liquids, which contain live micro-organisms that break down oil, grease and other contaminants and convert them into water and carbon dioxide. These liquids are used in conjunction with bio-remediating parts-washing machines such as the Bio-Circle MAXI.
- **Bio-renewable** cleaners and degreasers, which contain Nature Boost, an exclusive ingredient derived from plant extracts. Powered by Nature Boost, bio-renewable cleaning liquids are ideal for removing heavy-duty, hard-to-clean contaminants, including ink, paint, tar, wax, resins and adhesives.

Bio-Circle cleaning solutions are 100 percent nonflammable and biodegradable, and are VOC-reduced or VOC-free. These solutions can help manufacturers meet their safety and sustainability goals and cut operational costs by:

- Reducing chemical waste.
- Eliminating the disposal costs associated with toxic solvents.
- Reducing the costs of PPE required to protect workers from toxic solvents.
- Eliminating the costs of installing and maintaining ventilation, vapor-extraction and fire-suppression equipment.
- Avoiding OSHA and EPA fines for noncompliance.
- Keeping workers safe and healthy, which boosts morale and productivity and reduces turnover and absenteeism.
- Avoiding increases in fire-insurance premiums associated with the use of flammable, petroleum-based solvents.

Users do not have to sacrifice cleaning power for safety and sustainability benefits. Patrick Lapointe, Vice President of Research and Development for Walter Surface Technologies, explains that Bio-Circle cleaning solutions perform just as well as solvent-based systems.

“Using the latest developments in biochemistry and microbiology, we have developed cleaners that are extremely effective at removing organic contaminants,” Lapointe says.

LEADING EDGE

Bio-Circle bio-renewable solutions, which contain the Nature Boost extract, are on the leading edge of green cleaning technology.

Derived from a by-product generated in the vegetable-processing industry, Nature Boost boasts excellent cleaning properties on oils, greases, adhesives and paint, and is nontoxic, nonflammable and bio-renewable.

The Nature Boost-based family of products includes:

- The CB 100 water-based cleaner and degreaser, which can remove heavy greases, paint, food residues, crude oil, pastes, glue, adhesive, graphite, silicone, waxes and other tough industrial contaminants from steel, stainless steel and other metals.
- The CB 100 ALU solution, which is designed to remove contaminants from aluminum and non-ferrous alloys, particularly in the automotive and aerospace industries. It can be used with parts-washing machines, immersion tanks and ultrasonic baths, and lasts five times longer than solvent- and petroleum-based cleaning products.

A GREENER FUTURE

By harnessing the power of nature, Bio-Circle cleaning solutions boost safety and sustainability — and the bottom line — in MRO and production-process cleaning.

“Our customers would never go back to the flammable, dangerous, costly, fast-saturating chemical solvents that they used in the past,” Lapointe says. “We strongly encourage all environmentally conscious companies to learn more about the safe industrial cleaning solutions that now are available — and urge them to adopt the new products and technology. That’s how we’ll all win.”

