Reducing VOCs from Industrial Solvents

Solvents that contain high levels of volatile organic compounds (VOC) can be very effective, but at a cost to our environment. A portion of all solvents evaporate during use, which can result in VOC emissions. Industrial solvents individually may result in relatively small amounts of VOC emissions but, in the aggregate, contribute significantly to ozone formation. As awareness and understanding of how solvents affect the environment and human health grow, so do the regulations that govern their use. Colorado’s front-range has a history of violating the national ozone standards and has been classified as an ozone nonattainment area for more than a decade. Colorado continues to explore options to reduce ozone air pollution. Colorado’s adoption of new and more stringent requirements for industrial cleaning solvents based on the Environmental Protection Agency’s (EPA) Control Techniques Guideline (CTG) is part of this effort. This guidance summarizes the industrial cleaning solvent requirements that are meant to reduce the amount of VOC emissions from the use of industrial solvents within the ozone nonattainment area.

VOC emissions from industrial solvents can be reduced by pollution prevention work practices, solvent substitution, and/or add-on control equipment.

With advances in technology, there are now many options available for effective low-VOC solvent alternatives, which can be substituted for traditional solvents to reduce VOC emissions. There are many factors to consider when looking at transitioning to a lower VOC solvent, which will be covered by this fact sheet.

This fact sheet also provides information on control requirements associated with industrial cleaning solvent use in the ozone nonattainment area, as well as considerations for selecting a low-VOC solvent alternative or other applicable cleaning methods for reducing VOC emissions. Residential and janitorial supplies used for cleaning offices, bathrooms, or other non-work production related areas are not covered by Colorado’s Regulation Number 7, Section X. or this factsheet. There is another factsheet that covers the basic air and waste requirements for the use of industrial solvents that is available on the website.

Requirements for VOCs in Industrial Solvents

If a facility in the ozone nonattainment area has actual uncontrolled VOC emissions of 3 tons per year (tpy) or more from the use of industrial cleaning solvents, the facility must comply with the requirements of Regulation Number 7, Section X. to reduce VOC emissions from the use of industrial cleaning solvents.

Industrial cleaning solvent operations are not subject to these VOC control or work practice requirements if they are subject to RACT requirements found in other federally enforceable regulations. Small aerospace facilities may comply with the cleaning requirements in 40 CFR Part 63, 63.742 (National Emissions for Hazardous Air Pollutants for Aerospace Manufacturing and Rework Facilities) in lieu of complying with the VOC control and work practice requirements in Regulation Number 7, Section X. Additionally, the following activities are exempt from the industrial cleaning solvent VOC control requirements in Regulation Number 7, Section X., but not the work practice requirements:

- Cleaning of electrical and electronic components;
- Cleaning of precision optics;
- Cleaning of numismatic dies;
- Stripping of cured inks, coatings, and adhesives;
- Cleaning of resin, coating, ink, and adhesive manufacturing, mixing, molding, and application equipment;
- Cleaning of research and development laboratories;
- Cleaning of medical device or pharmaceutical manufacturing equipment;
- Performance testing to determine coating, adhesive, or ink performance;
- Cleaning of equipment and materials used in testing for quality control or quality assurance purposes;
- Cleaning of digital printing operations; and
- Cleaning of screen printing operations.

Work Practice Requirements

The following work practices are required by Regulation Number 7, Section X. to reduce fugitive VOC emissions from industrial cleaning solvent operations:

- Cover open containers and used applicators in a manner that minimizes evaporation into the atmosphere;
- Properly dispose of used solvent and shop towels;
- Implement good pollution prevention practices that minimize emissions, including, but not limited to, using only volumes necessary for cleaning and maintaining cleaning equipment to be leak free.

VOC Control Requirements

Regulation Number 7, Section X. requires facilities to:

- Limit the VOC content of the cleaning solvents to ≤0.42 lb of VOC/gallon; or
- Limit the vapor pressure of the cleaning solvent to ≤8 mmHg at 20°C; or
- Reduce emissions with an emission control system having an overall control efficiency of 85% or greater.

If using a composite or a custom blended solvent, sum the partial vapor pressures of each constituent to calculate compliance with the vapor pressure limit. To calculate the vapor pressure, use the following formula:

\[ PP_c = \sum_{i=1}^{n} \left( \frac{W_i}{MW_i} \right) \left( \frac{V_i}{MW_i} \right) \]
\( W_i \) = Weight of the “i”th VOC compound (grams)
\( W_w \) = Weight of water (grams)
\( W_e \) = Weight of exempt compound (grams)
\( MW_i \) = Molecular weight of the “i”th VOC compound (g/mole)
\( MW_w \) = Molecular weight of water (g/mole)
\( MW_e \) = Molecular weight of exempt compound, in g/mole
\( P_{PC} \) = VOC composite partial vapor pressure at 20°C (68°F), in mm Hg
\( V_{P_i} \) = Vapor pressure of the “i”th VOC compound at 20°C (68°F), in mm Hg

- **Solvent Alternatives to Reduce VOC Emissions**

Switching solvents may reduce a facility’s environmental regulatory burden. Facilities have increasingly more options for cost-comparable, low-VOC solvent substitutions as “green” solvents have become more popular. These low VOC solvent alternatives can also be a compliance solution to the new industrial cleaning solvent requirements in Regulation Number 7.

Knowledge of cleaning needs and options will help in selecting the best solution for your process without compromising effectiveness, health, safety, or environmental protection. There is no one size-fits-all solution; no single process or product will work in every case. When choosing a solvent, consider the potential environmental, health and safety impacts, solvency, flammability, stability, cost, and whether it contains regulated chemicals (e.g., VOCs or hazardous pollutants). Alternatives should be tested for compatibility before implementation, not only with the components to be cleaned, but also with the cleaning equipment. Careful selection and deliberate implementation are the keys to success with any new process or product.

When considering making a solvent substitution, first assess your cleaning needs. Ask yourself:
- What is being cleaned and why?
- What contaminants are being removed and how did they get there?
- What are the cleaning requirements?

Once cleaning needs have been assessed, evaluation of the alternatives can begin. The remainder of this guidance will assess the pros and cons of alternative cleaning methods.

- **Water-Based Solvents**

When seeking low-VOC industrial cleaning solvent alternatives, looking into water-based solvents is a good starting point.

Water-based cleaners can perform just as well as other solvents under the right conditions. Water-based solvents offer companies several advantages over traditional cleaning choices, including:
- Little to no VOCs and/or Hazardous Air Pollutants (HAPs)
- Reduced waste and waste disposal cost
- Non-flammable
- Decreased labor
- Lower operational costs
- Limited exposure to hazards
- Meets compliance standards (less regulated)
- Environmentally safe

There are two main types of water-based solvents: acidic and alkaline. Acidic solvents are routinely used to remove scale, rust, and oxides from metals. Alkaline solvents are more common and are used to remove salts, organic soils, oxides, metal chips, grease, and just about anything a chlorinated solvent can remove.

Water-based cleaners often rely on heat and agitation to break contaminants down into smaller particles for more effective cleaning. As a result, one disadvantage of transitioning to a water-based solvent is that new or additional cleaning equipment may be necessary in order to apply the appropriate amount of heat and force for effective cleaning, which may lead to a higher capital cost. Equipment needs will be unique to your facility’s process and should be assessed on a case-by-case basis. Another potential downside to water-based cleaning is that it may create new waste streams that may contain new waste streams that may create new waste streams. As a result, one disadvantage of transitioning to a water-based solvent is that new or additional cleaning equipment may be necessary in order to apply the appropriate amount of heat and force for effective cleaning, which may lead to a higher capital cost. Equipment needs will be unique to your facility’s process and should be assessed on a case-by-case basis. Another potential downside to water-based cleaning is that it may create new waste streams that may contain regulated chemicals (e.g., VOCs or hazardous pollutants). Alternatives should be tested for compatibility before implementation, not only with the components to be cleaned, but also with the cleaning equipment. Careful selection and deliberate implementation are the keys to success with any new process or product.

If pure water-based cleaning is not feasible for your operation, you might consider switching to a semi-aqueous solvent. Semi-aqueous solvents are semi-stable mixtures of water and solvents. These cleaners are often used with immersion or ultrasonic systems and are effective for removing waxes, heavy greases, tar, and baked-on organic materials and can be effectively recycled.

Semi-aqueous cleaners use water as a filler to reduce VOC content. Common semi-aqueous cleaners include low-molecular weight alcohols, ketones, esters, and organic amines. The semi-aqueous cleaning process usually includes a process where the used solution is collected and recycled. Semi-aqueous cleaning may also entail new wastewater discharge requirements.

Be aware that not all “green” solvents are created equally. There are a few factors to consider when evaluating alternatives. Product cost is usually comparable but effectiveness can vary. Disposal costs are another factor. Also, just because one harmful ingredient is reduced or eliminated, does not mean that the “green” solvent is exempt from regulatory requirements. Sometimes “green” solvents replace one ingredient with another that is subject to different regulations.

Do your homework before you decide to convert to a specific solvent alternative; make sure the alternative accomplishes your goals. Consider the equipment requirements, proper disposal requirements, VOC and HAP content, effectiveness, etc. when making your decision. There is a lot of information available on alternative solvents on the web.

- **Other Solutions, Not Solvents**

If pure and semi water-based cleaning is not feasible for your operation, you should still research and consider other cleaning alternatives for reducing VOC emissions.

Colorado Small Business Assistance Program 12/2016
One solution is the use of supercritical fluids (SCFs), which can rapidly penetrate substrates and small spaces, dissolve the contaminants, and then are easily and completely removed since the SCFs lack surface tension. SCFs are produced from subjecting substances to temperatures and pressures above their critical points to the point of possessing properties in-between liquid and gases. This makes it very good for cleaning complex parts with tight tolerances. Carbon dioxide (CO₂) is the most commonly used supercritical fluid in cleaning applications. This process is relatively new and expensive.

Another cleaning process that utilizes CO₂ is carbon dioxide blasting which uses either “pellets” or “snow” as a blasting medium to physically remove contaminants such as paints, oils, and grease. It has been used for removing small particles from optical components, gyroscopes, thin film mirrors, and other delicate surfaces. Little waste is generated because the CO₂ evaporates, but it is more expensive than other options.

If the surface to be cleaned is not delicate, abrasive blasting may be an alternative cleaning option for reducing VOC emissions from solvent use. The abrasive blasting process combines an abrasive media, a pressurized delivery system, and possibly a cleaning chamber to physically remove contaminants from a surface. It is also used for removing paint and surface corrosion. Typically, this method is not appropriate for highly contaminated surfaces since the contaminants can cause the blasting media to stick together. Glass beads and sand are most commonly used as blasting media. Abrasive blast waste, however, may need to be tested for hazardous waste determination and may increase waste disposal responsibilities.

It is essential that all environmental impacts be evaluated before switching to a new cleaning process or product. The new process may reduce certain types of pollutants, but create new ones. Each alternative should be evaluated for its impact on total materials usage, air emissions, solid and hazardous waste generation, wastewater discharges, energy and water use, and the associated costs of managing these impacts.

Often when VOCs are reduced in products, HAPs are increased. Or when the HAP content is decreased, the VOC content is higher. For example, D-limonene is extracted from the rinds of citrus fruit and can be used in industrial-grade cleaning products, adhesive removers, hard surface cleaners, oil field solvents, and as an ingredient in aerosols. D-limonene acts as a substitute for methyl ethyl ketone (MEK), acetone and toluene (HAPs). Although D-limonene is considered to be a “green” solvent because of the elimination of HAPs, it contains high levels of VOCs and must still be treated as hazardous waste due to its characteristics.

**Definitions**

*Industrial Cleaning Solvent* means a VOC-containing liquid used to perform industrial cleaning solvent operations.

*Industrial Cleaning Solvent Operation* means the use of an industrial cleaning solvent for cleaning industrial operations such as spray gun cleaning, spray booth cleaning, large manufactured parts cleaning, equipment cleaning, floor cleaning, line cleaning, parts cleaning, tank cleaning, and small manufactured parts cleaning. Residential and janitorial cleaning are not considered industrial cleaning solvent operations.

*Residential and Janitorial Cleaning* means the cleaning of a building or building components including, but not limited to, floors, ceilings, wall, windows, doors, stairs, bathrooms, furnishings, and exterior surfaces of office equipment, excluding the cleaning of work areas where manufacturing or repair activity is performed.

*Uncontrolled Actual Emissions* means the annual emission rate corresponding to the actual annual process rate listed on the Air Pollutant Emission Notice form, without consideration of any emission control equipment or procedures.

*Volatile organic compounds (VOCs)* are organic compounds that are found in many products. VOCs easily become vapors or gases at room temperature due to their low vapor pressure.

**Additional Internet Resources**

Colorado’s Guidance on Air Requirements for Industrial Solvent Use:

This fact sheet reviews basic air and waste requirements for the use of industrial solvents.

Colorado Air Quality Control Commission Regulation Number 7, Section X.E.: [www.colorado.gov/pacific/cdphe/agcc-reg](http://www.colorado.gov/pacific/cdphe/agcc-reg)

RTI’s Solvent Alternatives Guide (SAGE):
[infohouse.p2ric.org/ref/19/18161/index.cfm.htm](http://infohouse.p2ric.org/ref/19/18161/index.cfm.htm)

SAGE is a comprehensive guide designed to provide pollution prevention information on solvent and process alternatives for parts cleaning and degreasing.

**Small Business Assistance**

The Small Business Assistance Program (SBAP) is available to answer questions you may have regarding environmental issues at your site. The SBAP can help you understand regulations, fill out required forms, calculate your emissions, or provide information by presenting a workshop for your company or for your industry. We are here to help, and our services are always free.

Contact the Small Business Assistance Program (SBAP) at (303) 692-3175 or 3148 or visit our website at [www.colorado.gov/pacific/cdphe/small-business-assistance-program-sbap](http://www.colorado.gov/pacific/cdphe/small-business-assistance-program-sbap).

**Contact the Air Division**

Phone: (303) 692-3150

Email: [cdphe.commentsapcd@state.co.us](mailto:cdphe.commentsapcd@state.co.us)