Reducing solvent emissions from vapor degreasers

This fact sheet outlines strategies for reducing solvent emissions from drag-out, drafts, diffusion and sprays.

Reducing solvent emissions can benefit your company in many ways. Traditional solvents like trichloroethylene (TCE), methylene chloride (MeCl) and perchloroethylene (perc) are expensive to use. Regulations require equipment features, operating practices, reporting, and monitoring, which cost time and money. Newer halogenated replacement solvents are more expensive than the traditional solvents.

In addition to the regulatory and cost concerns of solvents, worker exposure is also a concern. Of traditional solvents, the Occupational Safety and Health Administration (OSHA) regulates MeCl heavily and the Employee Right-to-Know rule requires training for staff using chlorinated degreasing solvents.

A National Emissions Standard for Hazardous Air Pollutants (NESHAP) limits emissions from degreasers using traditional solvents. The NESHAP requires specific design features and procedures be used with all new and existing degreasers and additionally requires permits when potential to emit exceeds 20,000 pounds per year (or more than 50,000 pounds for all HAP emitted by the facility for any purpose).

Using large amounts of traditional solvents, over 10,000 pounds per year, requires reporting under the Superfund Amendments and Reauthorization Act/Toxic Release Inventory regulations and pollution prevention planning under the Minnesota Toxic Pollution Prevention Act.

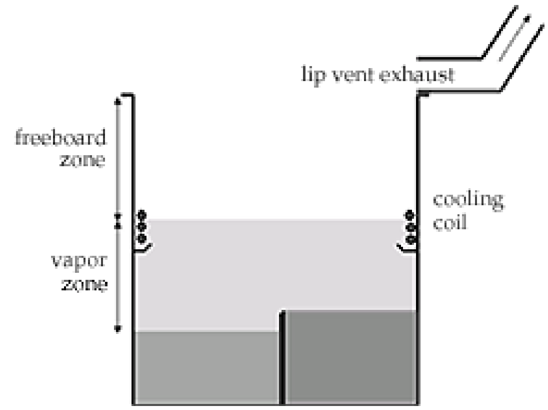
This fact sheet outlines strategies for reducing solvent emissions from drag-out, drafts, diffusion and sprays.

Emissions Due to Drag-out

Drag-out is the solvent film remaining on parts when they exit the degreaser. These losses are generally the largest source of degreaser emissions and are three to eight times greater than diffusion losses.

Reduction Techniques

Remove parts from degreaser once dripping stops completely. Solvent emissions are reduced



Vapor Degreaser

by 60% when parts are taken from the vapor zone when they are only moist compared to dripping with solvent. When removing parts, keep them in the vapor zone below the cooling coil until all dripping stops—one to two minutes for smaller parts. This procedure is required for TCE, MeCl and perc under the NESHAP.

In a standard vapor degreaser, a thin solvent film always remains on parts. When parts are in the vapor zone, hot vapors condense on cold parts, completely coating them in liquid. As parts warm and approach the vapor temperature, the liquid drips off parts faster than it recondenses. Keeping parts in the vapor zone longer will minimize solvent film thickness.

Hold parts in freeboard zone until completely dry. Holding parts for 30 to 60 seconds just above the cooling coil in the freeboard zone can reduce emissions by 40% compared to immediately removing parts from the vapor zone. If a facility chooses this freeboard dwell time as part of its control equipment compliance approach, the U.S. Environmental Protection Agency (EPA) requires parts be held in the freeboard zone for 35% of the total time needed for dripping to stop during the vapor hold.

If parts are immediately removed from the degreaser, the residual liquid film will quickly evaporate into unsaturated air and be lost. But, with a freeboard dwell time much of the vapor falls

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back into the vapor zone and is recaptured.

Use a mechanical transport to carry and move part loads. Transporting parts mechanically helps control drag-out losses caused by short holds in vapor or freeboard zones. Even excellent training on emission control methods cannot solve the physical challenges of holding heavy parts away from the body for 30 to 60 seconds. Programmable transport systems are the best solution because time and speed can be strictly controlled. A mechanical hoist is another option. It can be easily stopped for required holds. At a minimum, a mechanical hoist is required by the NESHAP for the control equipment use and idling loss control compliance methods.

If mechanical transport cannot be justified and the NESHAP emission cap compliance method is used, a stand for hanging parts or baskets at appropriate heights can be used. Timers can also be used to ensure minimum hold time requirements for your application. No estimated emission reduction for this strategy was found.

Use part-holding fixtures that promote good drainage. No reduction estimate is possible because of the wide variety in part design, orientation and fixtures. Try using a rotating or tilting basket to drain complex parts. Position parts to promote draining liquid from part recesses. Decrease the surface area, weight and heat capacity of the fixture or basket to reduce drag-out caused by the parts holder. Construct baskets and fixtures with as much open area for drainage as possible, and design in low points for drips to collect and fall away. Using fixtures that promote drainage is a NESHAP requirement.

Emissions Due to External Drafts

Reduction Techniques

Avoid lip vents. Using a degreaser without lip vents, or with the vents turned off, will release 15% less solvent emissions than a degreaser with a vent. If lip vents are required to meet workplace health rules, use covers on the degreaser and shut off the vent when the cover is closed. Try to locate the vent above the cover and limit air volumes in the vent to no more than six cubic-feet-per-minute per square foot of degreaser opening. The NESHAP requires carbon absorbers be used to capture solvent emissions when lip vents are used.

Odors or high concentrations of solvent in the workplace can be a result of solvent drag-out on parts, splash out by sprays or leaks in external fittings. A lip vent will not capture these emissions. Correct your procedures first and use a lip vent only if additional employee protection is needed. Then, if possible, compensate for the higher vapor losses by adding freeboard to your degreaser.

Eliminate external drafts around degreaser. The total emissions released from a degreaser in a room with still air compared to a degreaser exposed to external drafts from fans and ventilators varies widely. The emissions depend primarily on the speed and direction of the draft. To minimize emissions from external drafts, eliminate downward drafts directed at a degreaser and keep air velocity above the degreaser below 30 feet-per-minute (fpm). The NESHAP limits air speeds above a degreaser to less than 50 fpm unless idling covers are used.

Try reducing the effect of external drafts by redirecting fans away from degreasers and placing baffles or shield panels between the degreaser and draft source. Reducing room air speed above a degreaser from 100 fpm to 50 fpm can reduce solvent losses by 20%.

Emissions Due to Internal Drafts

Reduction Techniques

Move parts at slower speeds. Parts moving through the vapor zone at 10 fpm vertically will have 30% less emissions than parts moving at 20 fpm. The speed of moving parts by hand typically ranges from 30 to 100 fpm. The NESHAP limits part speeds to less than 11 fpm and requires that a mechanical hoist move parts under most circumstances.

When moving parts with large cross-sections between sumps using a complex cleaning cycle, horizontal speeds may create drafts. Slower speeds are recommended for very heavy loads to prevent the vapor level from collapsing.

Keep large cross-sections of part loads 50% smaller than corresponding degreaser cross-section areas. The velocity of vapor moving around large parts is high, creating more turbulence and increasing the chance of concentrated vapor being carried high into the degreaser or out of the unit. Keep part loads small to help prevent solvent loss. This is a NESHAP requirement, unless part speeds are reduced below three fpm.

Use sliding covers to reduce drafts and turbulence. The effect on emissions released when using a sliding cover compared with using a hinged or lifting cover varies widely. Each time a hinged cover is opened drafts and turbulence carry out vapor. The amount of vapor released depends primarily on how often the degreaser is uncovered and how fast air moves above the degreaser. If lip vents are used, place the sliding cover between the vent and the vapor. Covers must slide to be a control measure under the NESHAP.

Enclose open-top degreasers. Full enclosures eliminate external drafts and greatly reduce the opening for diffusion losses. Enclosures also reduce worker exposure by creating separation between the solvent and operator. Enclosures will reduce solvent loss by up to 40%.

Emissions Due to Diffusion

Diffusion losses occur when solvent vapors move from an area of high concentration—the degreaser—to areas of low concentration—the surrounding air. Although diffusion losses occur when the degreaser is cleaning parts, losses are much smaller than those due to drag-out or drafts. Once all other sources of loss have been fully examined, look at diffusion losses when the degreaser is running idle. Take steps to reduce losses due to diffusion only when they can be done cheaply and easily.

Reduction Techniques

Add freeboard height to degreaser. A degreaser with 75%

freeboard will have approximately 30% less idling emissions than degreasers with 45% freeboard when both are idling and open. The NESHAP minimum requirement is 75% freeboard, while 100% is a control option. And, a degreaser with 100% freeboard will have about 15% less solvent emissions when idling than one with 75% freeboard.

Use the following equation to figure percent freeboard.

$$\text{percent freeboard} = \frac{\text{(height from top of cooling coils to lip) x 100}}{\text{width (shorter dimension) of degreaser mouth}}$$

Keep an idling degreaser covered. A covered, idling degreaser will reduce emissions about 15% compared to an uncovered degreaser. Drafts and inadequate freeboard or chiller capacity can greatly increase the benefit of covers. If the NESHAP compliance is accomplished through an idling test where a cover was used during the test, then the cover needs to be closed whenever parts are not positioned in the degreaser for cleaning.

Reduce vapor displacement. The effect on emissions caused by parts displacing vapors above the cooling coils varies based on the size of the parts load. If the vapor level changes significantly when parts are put in the degreaser, slow the hoist speeds or use a stop-and-go technique. A speed of less than 10 fpm may be required for large loads.

Vapor displacement works on the same principle that causes the water level in a tub to rise when a solid object is placed in it. Vapors above the coils are more likely to diffuse as they warm, and can be carried out by drafts or as parts are removed.

Lower condenser temperature. Lowering the condenser temperature from 50°F to 30°F can reduce diffusion losses from chlorofluorocarbon (CFC) 113 by 40%. Decreasing condenser temperatures from 50°F to 0°F can reduce diffusion losses by 80%. Emission/temperature impacts for other chlorinated solvents are believed to be comparable.

Emissions Due to Sprays

Using sprays may indicate that vapor degreasing is inadequate for your cleaning task. Sprays can augment vapor degreasing by physically loosening or removing tough soils.

Reduction Techniques

Minimize spray use and keep spray temperature near the boiling point. Eliminating solvent sprays inside a degreaser reduces emissions by 30% to 50%. The spray stream carries air or vapor with it, creating drafts inside the degreaser which increases emissions. Cool or cold spray will condense vapors, collapsing the vapor blanket and sucking air below the cooling coils. As the vapor blanket is reestablished, air will be pushed out of the degreaser, carrying vapor with it. If sprays are used, use hot solvent drawn from the boiling sump. Hot sprays will warm parts quickly and decrease the amount of vapor cleaning that will occur. Careless spraying can result in liquid solvent being splashed out of the degreaser.

Keep the spray nozzle below cooling coils. Holding the spray nozzle below the cooling coils results in 30% less emissions compared to keeping the nozzle above the vapor blanket. Try permanently positioning the spray nozzle below the coils and manipulating parts for cleaning. Drafts above the cooling coils in the degreaser—including those from spraying—are likely to carry vapors out of the unit. Spraying in the vapor zone is a NESHAP requirement.

Use short spray bursts. Keeping spray bursts short reduces solvent emissions by 15% compared to spraying at intervals longer than 10 seconds. Long bursts of spray cause larger drafts and are more likely to collapse the vapor blanket.

Equipment Changes

Reduction Techniques

Superheat vapor. Raising the vapor temperature above its normal boiling point—superheating—reduces emissions by 90% compared to maintaining the vapor temperature at the solvent's boiling point. Superheating vapor to 10°F above its boiling point is a NESHAP control option. 50°F superheat may be needed for drying in a reasonable time period.

The elevated temperature allows parts to dry quickly and completely in the vapor zone. In a standard degreaser design, parts remain wet with solvent as long as they remain in the vapor zone. Drying eliminates the need for a freeboard hold.

Install freeboard cooling coils. Adding freeboard cooling coils at 0°F near the top of the degreaser will reduce solvent loss during idling by 15%. Chilling the freeboard to 30% or less of the Fahrenheit boiling point is a NESHAP control option.

Freeboard coils are a second set of cooling coils placed in the freeboard zone and are usually refrigerated. They decrease diffusion by keeping vapors cold and heavy. Heavy vapors are less susceptible to drafts. But, these coils add cost and dehumidify air in the freeboard zone. The additional water can overwhelm standard water separators, which can cause solvent acidification, equipment damage and high waste disposal costs. Be sure your water separator is adequate, or provide a second, large water separator for the freeboard coils.

Install secondary condenser coils. For solvents with very low boiling points (70 to 100°F), adding secondary coils at 0°F just above the primary condenser coil at 45°F reduces idling losses by 70%.

The same can be achieved by lowering the primary condenser temperature to 0°F. But, the higher temperature allows for inexpensive cooling water to be used as the primary cooling medium. The chiller for the secondary condenser can then be down-sized.

Install third dehumidification coil. Adding a third dehumidification or freeboard coil at 0°F near the degreaser lip reduces idling losses by an additional 80%.

DuPont recommends a three-coil system to control idling emissions from the new low boiling point solvents (Ramsey, 1991). A main coil at 50°F condenses most solvent. A second coil at 0°F overlaps or is slightly above the main coil to capture additional solvent. A third coil located near the lip of the unit dehumidifies the air, which prevents ice buildup on the secondary coil. It also eliminates convection currents in the freeboard.

Based on this, assume that for higher boiling point halogenated solvents such as TCE, the best coil configuration would be a dehumidification coil operating at the same temperature as the main condenser coil to eliminate internal convection currents.

Closed-loop solvent cleaning systems. These systems have the potential to reduce emissions up to 95%. Parts are placed inside an airtight vacuum chamber and vapor or liquid solvent is pumped in to clean the parts. Then, the solvent is removed and recycled in an internal still with a carbon adsorption system. The parts are dried under vacuum and removed. Because these systems are constructed to maintain a vacuum, they cost as much as five to ten times more than similar sized open-top solvent cleaning machines (California EPA, 1997).

Additional Resources

Ask your equipment manufacturer or vendor for help reducing emissions from your unit. Information about alternative solvent degreasers can be found in MnTAP's reference list *Alternative Solvent Degreasers* online at <mntap.umn.edu/metalfinish/resources/27-AltSolvDeg.htm>. For regulatory information consult the Minnesota Pollution Control Agency fact sheet, *Final Standards for Halogenated Solvent Cleaning Equipment,* online at <www.pca.state.mn.us/air/pubs/5-05.pdf>.

Information in this fact sheet is based on tests run by industry and regulators. Specific references are listed in the online fact sheet.

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For More Information

MnTAP has a variety of technical assistance services available to help Minnesota businesses implement industry-tailored solutions that maximize resource efficiency, prevent pollution, increase energy efficiency, and reduce costs. Our information resources are available online at <mntap.umn.edu>. Please call MnTAP at 612.624.1300 or 800.247.0015 for personal assistance.