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Ultrasonic Cleaning

Solvent Emissions Control: A Technical Guide

Branson Ultrasonics Corporation recognizes the need for environmental responsibility in manufacturing today. As an international corporation whose cleaning equipment is used widely in industry, Branson holds an obligation to address environmental concerns.

Branson is committed to fulfilling this obligation by designing solvent and aqueous cleaning equipment with environmental safeties as integral elements, by sharing our research into emissions control with industry, and by participating actively with government and corporate groups to find ways to protect earth's environment.

Branson therefore calls for responsibility in chemical handling and conservation and offers methodology for substantially decreasing emissions in the cleaning process.

Our Commitment

As a manufacturer of aqueous as well as solvent equipment, Branson is bias-free in its recommendations.

Our commitment becomes action as we at Branson:

- Work with environmental & legislative groups.
- Test solvent alternatives in our Cleaning Applications Laboratory.
- Incorporate emission control design into product concepts.
- Promulgate solvent emission control information & techniques.

Solvent Emissions

Scientific evidence indicates the global ozone layer is being depleted or thinned by chloroflurocarbons (CFCs) released into the atmosphere. Holes in the layer allow the penetration in large doses of ultraviolet radiation which can be harmful to human health and environmental balance. Automation of a cleaning process is the optimal way to substantially reduce solvent emissions.

Whose Problem Is It?

Although solvent alternatives have been developed and some with less CFCs

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already are available, the issue of environmental responsibility will remain. Never again can we consider any chemical completely 'safe' for the environment or human health. Therefore we must institute good work practices now to decrease emissions of any chemical as much as possible.

How Solvent Vapors Escape

Solvents loss in the cleaning process can be attributed to three areas:

- Operation
- Equipment Design
- Maintenance

Operation

Our research has shown that **improper operation of the cleaning process is the primary source of solvent emissions** from open-top degreasers. Operation is the leading cause because human physiology makes exact process control nearly impossible.

For example, lowering part fixtures into a degreaser faster than 10 feet per minute will forcefully displace solvent vapors above the cooling coil and out of the tank. Yet data collected by industry shows that the 'typical' operator lowers the parts between 30 and 100 feet per minute. Even the most conscientious operator will tend to violate this parameter and contribute to unnecessary emissions. With part loads ranging from a few pounds to tens of pounds, precise and slow speeds are very difficult to perform. Even if a mechanical hoist is used, proper vertical speeds often are exceeded in the interest of increased production.

Our test measurements of emissions show that a vertical speed of 20 feet per minute in the cleaning process can consume from 30 to 50 percent more solvent than a vertical speed of 10 feet per minute. **Branson recommends a controlled vertical speed of no more than 10 feet a minute when parts enter or exit a solvent cleaner.**

Correct residence time within the vapor zone is another aspect of solvent cleaning that often falls short. Proper procedure calls for holding the parts in the vapor zone for a final vapor dry until condensation on the part ceases. Condensation will cease when the temperature of the part is in equilibrium with the temperature of the vapors. It is critical that the time required for this step be carefully observed since it is difficult for the human eye to determine where condensation ceases. If the part is pulled out too soon, liquid solvent will vaporize and escape from the equipment. Depending on the mass and complexity of the part, the vapor dry time could range from 30 seconds to several minutes. If this is done manually, extended vapor dry times can be physically demanding and, therefore, often shortened

Correct freeboard residence time also is important. As the parts are removed from the vapor zone to the freeboard area, the remaining solvent condensation will vaporize and, being heavier than air, will fall back into the vapor zone. If the parts are held in the area of the cooling coils in the freeboard area while still above the vapor zone, more vapors are returned. But, as with the vapor zone, it is physically demanding to suspend the parts in the freeboard area manually.

Operation - Solution

Branson recommends automating for precise control of the correct process speeds and residence times. Our research shows that **solvent emissions can be decreased 70% by automating the process.**

In a test conducted to measure the effect of certain working conditions on solvent emissions, our base data was generated with a covered, idling, Branson BSD Model 1216 solvent cleaner The base measurement was assigned a value of one.

A representational workpiece load was processed under

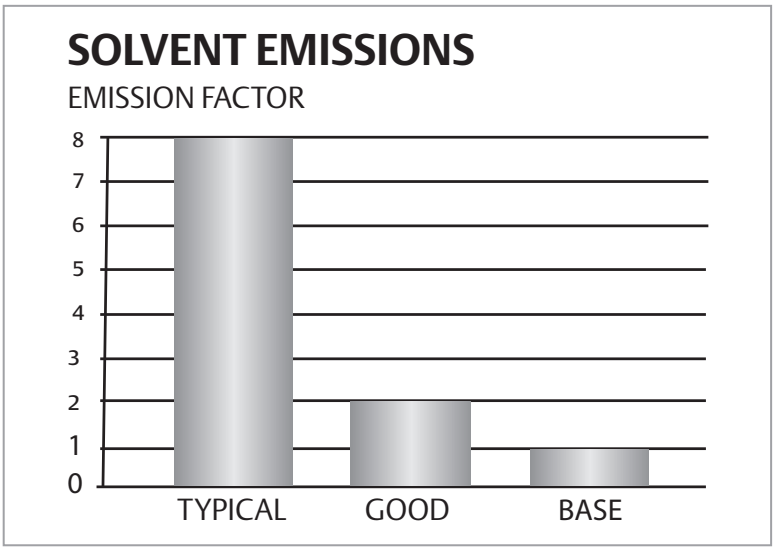
optimal conditions, that is following all of the recommended procedures to minimize solvent emissions.

Processing was controlled through use of a Branson TDR automated transport system Production parameters were a slow vertical transport speed, 30-second vapor zone time above the boiling sump, 30 seconds of ultrasonic immersion, 60 seconds in the vapor zone for drying and 30 seconds in the freeboard zone Good processing achieved a value of two.

Industry norm, however, of the actual solvent cleaning process generates an emission value of eight. Typical operations include practices such as fast vertical speed of the parts into the equipment, reduced residence times, liquid drag-out, and uncontrolled spraying.

Solvent emissions can be reduced from eight to two on the value scale by automating for precise process control.

Summary: Regardless of how efficient the design of a cleaning system, improperly operated equipment is the biggest source of emission. Through proper operator training and awareness programs, the industry norm of "eight" can be reduced. But to get dramatic results of a reduction from "eight" to "two", a programmable transport is necessary to control residence times and proper processing speeds. In addition, production benefits are realized — an automated system can increase throughput by running unattended and it minimizes health concerns for operator safety near solvents.



Equipment Design

Many features in properly designed cleaning equipment will work toward decreasing solvent emissions. Some aspects to look for are:

- **Attached sliding cover.** Actual measurements of operating equipment show that an idling covered machine will have 15-20 percent less emissions than a machine left uncovered. Attached sliding covers are best, not only for convenience, but also because by moving horizontally, it does not create disturbance of the vapor/air interface and thereby reduces emissions. Vertical lift-off and hinged covers, when opened cause disturbances in the interface by creating turbulence within the machine and increasing solvent emissions.
- **100% freeboard.** The greater the distance between the top of a stable vapor/air interface and the top of the unit, the greater the diffusion distance that solvent vapors must travel to escape the machine. Measurement has shown that the diffusion losses from a 75-80 percent freeboard unit are 15-20 percent higher than 100 percent freeboard.
- **Coolant flow meter/temperature sensor.** Solvent emissions can occur through failure of the cooling coils, which would be caused by either insufficient coolant flow or inappropriate

coolant temperature. A coolant flow meter and a temperature sensor should be designed into the equipment to shut down the heaters immediately if either condition should occur. Such safety devices prevent emissions.

- **Low liquid level float.** Once the liquid level in the boiling sump of a solvent cleaner falls low enough to expose the heating elements, the temperature of the elements could rise to the point where solvent decomposition could take place causing an acid condition. That contaminates the remaining solvent, which requires disposal as hazardous waste. A liquid level float would guarantee a minimum level of solvent above the heating elements.

Some cautions

- **Lip vent exhausts** actually create drafts over the top of the machine. This device draws air across the top of the solvent cleaner, which acts as a vacuum to draw additional solvent vapor out. As much as 20 percent more solvent will be consumed by a system with a lip vent exhaust.
- **Carbon adsorption systems,** fed by the lip vent exhaust, collect solvent escaping the machine. Since the lip vent increases emission by 20 percent, the carbon adsorption system must be efficient enough to recover this additional solvent if it is to be advantageous. However, a major weakness of the lip vent carbon adsorption systems is that they are effective only on the solvent they see. If liquid solvent is being dragged out of the machine, then the lip vent exhaust and carbon adsorption would provide limited benefit.
- **Sprays** are a commonly accepted part of the cleaning process, but they aggravate solvent emissions and should be avoided when possible. If sprays are required, they should be used under the vapor blanket with fixed spray manifolds angled downward. An uncontrolled hand-held spray will increase emissions significantly above the manifold spray.

Equipment Maintenance

Where solvent cleaning equipment is placed and how it is maintained are important factors in solvent emission control.

- **Leaks.** All joints should be checked for tightness routinely to ensure no solvent is leaking. Because the solvent will vaporize, visual inspection often is not enough to detect leaks. Proper gasketing material should be used for the same reason.
- **Location.** Avoid placing equipment near drafts, such as from fans or air conditioners, which cause disturbances in the vapor/air interface. Direct expansion refrigeration systems on cleaners can contribute to emissions through air movement from the fans used to cool the compressor. These drafts can be eliminated with a remotely-located chiller.
- **Maintenance.** Solvent loss can occur from spills when the degreasing system is cleaned during routine maintenance. Avoid this possibility by selecting equipment that includes features to simplify maintenance, such as clean-out doors that are easy to use, easily accessible sump drains, and pump-out kits.

A Systems Approach

An important step towards solvent emissions management is treating the solvent cleaning process as an integrated system rather than a piece of equipment operating independently.

A well-designed emission efficient system is comprised of an environmentally-sound solvent cleaner and solvent recovery still, a remotely-located chiller, and an automated material handling system, with all pieces integrated to communicate with each other for safety and production efficiency.

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An **automated transport** system is the most effective means of achieving exact control of the process speeds and times. That control reduces solvent emissions dramatically. The proper process speed attainable only through automation prevents the piston effect of displacing solvent and eliminates drag-out losses from vapor/air interface disturbances when workloads enter or exit the solvent cleaner. Correct residence time within the vapor zone and the freeboard area is achieved with an automated transport system. An efficient system is easily programmed with exact parameters for repeatability in the cleaning process.

A solvent recovery still concentrates contaminants from the workpiece cleaning in the still boil sump. This reduces the need of frequent solvent cleaner maintenance, which reduces the chances of spills or leaks. A still can be hard-plumbed to the solvent system and waste disposal drums through the use of pumps, so all solvent can be transferred mechanically, eliminating the need for manual handling, reducing spillage opportunity and worker exposure. By concentrating the contaminants in the still, the solvent cleaner works more effectively.

A remotely located **chiller** avoids drafts created by direct expansion systems.

With this system you can minimize solvent emissions while gaining predictable, consistent cleaning.

Branson Ultrasonics can help you with emission control techniques. We are prepared to work with you to reduce solvent emissions through operation awareness, process control, system automation, or equipment specifications. We can supply you with a self-audit to check operations in your own plant for solvent emissions Information on the effectiveness of solvent alternatives on specific applications also is available from our Cleaning Applications Laboratory.

For the self-audit Emissions Checklist, a Solvent Efficiency Package of equipment literature, or for a Cleaning Applications Laboratory form, call us at 203-796-0349 or write to Branson Ultrasonics Corporation, Solvent Efficiency Information, 41 Eagle Road, Danbury, CT. 06813-1961.

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Sources of Emissions in the Cleaning Process

Improper Operation	**Primary cause —** Proper operation is inconsistent with human physiology. Carefully calibrated entrance & exit speeds of parts cannot be achieved by hand. **Solution —** Automation provides consistency, proper speed.
Dragout	**Primary cause —** Liquid on parts, inadequate vapor dry phase. **Solution —** Automation for reliable timing.
Drafts	**Primary cause —** Disturbances in vapor/air interface caused by currents from heating, air conditioning, fans from refrigeration units or lip vent exhausts. **Solution —** Equipment covers, draft-free environment.
Piston Effect	**Primary cause —** Displacement of vapor/air interface by too rapid movement of parts. **Solution —** Slower or regulated entrance/exit speed.
Accidental Emission	**Primary cause —** Failure of cooling coils, vapors escape before heat is shutdown. **Solution —** Redundant cooling coil temperature/flow measurement in equipment.
Liquid Waste	**Primary cause —** Acid breakdown contaminates entire sump volume producing hazardous waste. **Solution —** Backup safety features to reduce chance of acid formation, periodic check of stabilizers in chemistry.
Leaks	**Primary cause —** Routine maintenance cycles. **Solution —** Check all joints for tightness, use appropriate gasket material, look for easily accessible maintenance features in equipment.

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