A Step by Step Guide to Controlling Solvent Emissions

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Scientific evidence indicates that the global ozone layer is being depleted or thinned by chlorofluorocarbons (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. Many nations already have signed a pact to reduce CFC production levels immediately, with the ultimate goal of total CFC phaseout by the turn of the century. Legislation undoubtedly will be forthcoming. Industry is responding by searching for alternatives to CFC based chemicals.

Solvents used for cleaning processes represent about 20% of the CFCs produced annually. Refrigerants, found in every home, and air conditioners in homes, cars, and places of business, are by far the greatest users, but the problem belongs to all of us. Regulation will affect all users.

A calm and forward thinking approach toward environmental protection is needed. Although solvent alternatives are being developed and some with less CFCs 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

Solvent loss in the cleaning process can be attributed to three areas:
- Operation
- Equipment design
- Equipment maintenance

OPERATION

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 scores 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.

Test measurements of emissions show that a vertical speed of 20 feet per minute in the cleaning process can consume 30 to 50% more solvent than a vertical speed of 10 feet per minute. A controlled vertical speed of no more than 10 feet a minute is recommended 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.

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 dragout 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.

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% less emis-
Fig. 1. Drafts increase solvent losses. A cover will reduce emissions 15 to 20%.

Fig. 2. A hinge or vertical cover will have a piston effect when opened, creating turbulence and increasing solvent emissions.

sions than a machine left uncovered as in Fig. 1. Attached sliding covers are best, not only for convenience, but also because by moving horizontally, they do not create disturbance of the vapor/air interface and thereby reduce emissions. Vertical lift off and hinged covers, when opened, cause disturbances in the interface as shown in Fig. 2 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% freeboard unit are 15-20% higher than 100% freeboard.

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.

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, improper degreaser practices can be minimized, but to get dramatic results in solvent loss reduction, 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.

Biography
Elyse Burstein is the metalworking industry segment manager for Branson Ultrasonics Corp. She is based at Branson's international headquarters in Danbury, CT. In key export sales and marketing positions at Branson since 1980, Burstein most recently was Asia/Pacific market development manager before heading the metalworking segment. She earned a bachelor's degree from Connecticut College and a masters degree from the University of Chicago.
FEATURES

19 Electrodeposited Black Cobalt-Tin Alloy Coatings for Solar Applications
S. John et al. provide optimum plating conditions to produce a solar selective deposit of a cobalt-tin alloy.

29 A Look at Yesteryear in Electroplating
John W. Horner takes us back in time and describes the silver plating of rifle collectors used in the recovery of precious metals from stream residues and finely divided ores.

47 Occlusion of Particles in Electrodeposits
Arthur Wasserman describes a fixture for occluding particles in electrodeposits which permits use of rapid flow rates.

Pretreatment

15 A Step by Step Guide to Controlling Solvent Emissions
Proper operation along with suitable equipment design and maintenance of solvent degreasers are discussed by Elyse Burstein.

24 The New Age in Pretreatment
Bill Winke addresses the revolution in paint finishing which has brought about an array of improved pretreatment processes.

37 Preventing Problems in Five-Stage Zinc Phosphate Spray Systems
Stanley Scislowski presents guidelines for proper maintenance of the various stages of a zinc phosphate pretreatment system.

COLUMNS

33 Transatlantic Letter
The European Community and 1992
by Harold Silman

41 Good Days & Bad Days
People in Finishing
Part EE.—Engineering Platers
by Milton Weiner

45 Personal Computers
Extending the Compatibility of Your Computer
by Robert D. Athey Jr.

DEPARTMENTS

2 Editorial
49 Shop Problems
50 Professional Directory
51 Recent Developments
61 Manufacturers’ Literature
65 Patents
67 Industry Activities
69 Associations & Societies
69 Meeting Wrap-Up
70 Continuing Education
72 Calendar
77 Distributors
79 Advertisers Index

COVER

Spray cleaning is one of the processes discussed in “The New Age of Pretreatment” by Bill Winke on page 24. Photo courtesy Parker + Anchem, Henkel Corp., Madison Heights, MI.