OhioEPA
State of Ohio
Environmental Protection Agency
Fact Sheet
Pollution Prevention
Number 23
September 1994

replaces 17187.pdf
4/6 40

Pollution Prevention in Painting and Coating Operations

VOC and toxic air emissions from paint and coating lines are among the leading environmental concerns ...

**Carol Browner, Administrator, U.S. EPA
(July 1994 announcement on
the *Common Sense Initiative*)**

Many products require some type of coating such as paint, lacquer, or varnish. Because the use of coatings is widespread, there is great potential for environmental benefit and for cost savings in pollution prevention techniques that are part of a coating application process. Source reduction and recycling techniques can reduce hazardous and solid waste generation and reduce air emissions, not to mention reduce use of raw materials and conserve water. An assessment of a coating operation may reveal ways to reduce waste generation through pollution prevention.

Start with Surface Preparation

Many products require a preparation step prior to painting. This step is commonly called pretreatment for new products, and paint stripping for products that need to be reworked.

Pretreatment

For waste reduction in pretreatment of new parts, the first step is assessing cleanliness of the parts: to what degree are the surfaces contaminated with substances such as oil from machining, dirt from the manufacturing environment, and finger oil from shop personnel? An important part of the assessment is to determine the sources of contamination.

The next step is to determine the cleanliness level or standard needed to satisfy the pretreatment process. Once the contamination sources are identified and cleanliness standards are set, determine whether some or all contamination sources can be eliminated. For example, it may be possible to eliminate finger oil contamination through the use of gloves in areas of parts handling. Gloves can be made of lint free material, or lint can be removed with a dry cloth.

If contamination cannot be reduced enough through process changes, cleaning methods must be assessed.

Ozone layer-depleting solvents have been commonly used as cleaning agents. But environmental concerns and regulations affecting production and use of these solvents have caused many companies to reassess their use of this type of solvent as a cleaning agent.

There is seldom a "drop-in" replacement for a halogenated organic solvent in a cleaning operation. Substitutes may include: non-halogenated solvents; aqueous cleaners, such as alkaline or acid cleaners, or detergent/water solutions; and abrasive cleaning systems. In general, "like removes like." Ionic contaminants (finger prints, flux, etc.) can best be removed with ionic solvents, such as water or alcohol. Contaminants that are organic in nature (oils) can be best removed either with organic solvents or with water that has had surfactants added to make the oil and water miscible. Important factors in the design of the new cleaning system include the nature of the contamination, the substrate to be cleaned, and the degree of cleanliness required. The best alternative method can be determined only through testing.

Another pretreatment method often used in the surface preparation of metal parts is phosphatizing. The primary waste reduction option for phosphatizing is reduced water use. The water added to maintain the solution in the phosphatizing bath can be reduced by analyzing and controlling each solution's temperature, chemical concentration, and pH level in each step, and by recirculating solution or rinse water from one bath to others where possible. An added benefit is the potential for reduced chemical use.

Paint Removal

When repainting a part, the old paint often must be

Office of Pollution Prevention, Ohio Environmental Protection Agency, 1800 WaterMark Dr., P.O. Box 163669, Columbus, OH 43216-3669, (614) 644-3469

removed prior to application of the new paint coat. The waste reduction assessment should start by examining what causes the need for repainting: inadequate initial part preparation; defects in coating application; equipment problems; or coating damage due to improper handling.

While no process is perfect, reducing the need for repainting has a direct effect on the volume of waste generated from paint removal. Once the need for paint stripping has been reduced to a minimum, alternate paint stripping approaches can be considered.

Key concerns are the type and volume of waste produced. Chemical stripping commonly has been used in a number of applications, but alternate methods that are less toxic and less costly are available. For example, a barrel reconditioning operation was able to replace chemical stripping with mechanical stripping using metal and nylon brushes.

Paint-stripping technologies that are alternatives to chemicals include: abrasive blasting with a variety of materials; mechanical removal using scrapers, wire brushes and sand paper; pyrolysis (vaporization of the paint coating in a furnace or molten salt bath); cryogenics ("freezing" the paint off); and extremely high-pressure water or air.

Key factors that must be considered when selecting a paint-stripping method include: potential for cross-media transfer; the characteristics of the substrate to be stripped; the type of paint to be removed; and the volume and type of waste produced. Waste type and volume can have a major impact on cost-benefits associated with a change. Often, a combination of removed paint and chemical stripper requires disposal as hazardous waste.

Paint and Painting Equipment

Once parts are ready to be painted, the type of coating material and application method selected have an impact on transfer efficiency. Transfer efficiency is the amount of paint applied to the object being painted, divided by the amount of paint used. High transfer rates offer financial incentives by reducing the amount of paint wasted while minimizing solid, liquid, and air emissions. Simply stated, transfer efficiency measures how much paint makes it from the paint can onto the surface being painted.

In spray-painting applications, liquid paint is converted to an atomized spray in order to coat the object being painted. Differences in spray painting equipment are based on how the equipment atomizes paint. The more highly atomized the paint, the more likely transfer efficiency is to decrease. Highly atomized paint spray can more readily drift away from the painting surface due to forces such as air currents and gravity.

To achieve the best transfer efficiency, it is advisable to study the application equipment available and actually evaluate equipment performance using each coating material considered acceptable for your application. Because each application equipment combination has its own characteristics, the advantages and disadvantages must be weighed against the coating specifications set for a particular product.

The viscosity of the paint may need adjustment before it can be sprayed. This is accomplished by reduction with organic solvents, or with water for certain water-based coatings. Using solvents for reduction requires the purchase of additional materials and increases air emissions. An alternative method of reducing the viscosity is to use heat. Benefits from the purchase of paint heaters include lower solvent usage, lower solvent emissions, more consistent viscosities, and faster curing rates.

Spray Application Equipment

Conventional Spray - This technology, in use for over 40 years, uses air at high pressure (40 - 70 pounds per square inch [psi]) to atomize a liquefied stream of paint. The high-energy air stream that is mixed with the paint causes atomization that is generally very fine and easily applied. This yields very good finishes with high-quality visual characteristics.

A disadvantage is that along with a high degree of atomization comes a spray that is very fine and highly susceptible to overspray, resulting in more paint waste and less transfer efficiency. The solvent in the paint is also highly atomized along with the paint solids, meaning that volatile organic compound (VOC) emissions from the solvent in paint are increased.

High-Volume/Low-Pressure (HVLP) - As the name suggests, a high volume of air at low pressure is used to atomize paint. The defined air-pressure limit for HVLP is 10 psi at the center of the air cap on the spray gun. It is this reduced gun spray energy level that reduces overspray and improves transfer efficiency. Generally, fluid delivery rates up to 10 ounces per minute with low viscosity paint will work best with the HVLP gun. However, continued development is underway to accomplish faster delivery rates to accommodate higher production. At higher fluid-delivery rates and with heavier materials, HVLP may not atomize well enough to achieve an acceptable finish.

Airless - This is a method of atomizing paint without the use of compressed air. The paint is pumped at high pressure through a small opening at the spray tip to achieve atomization. Adjustments in airless spraying are made by adjusting the viscosity or the system pressure. This method has higher transfer efficiencies than conventional spray. Many high-viscosity coatings can be applied without costly solvent thinning. Also, this method allows for rapid application of a heavy paint coat, which is useful for keeping up with a fast-moving painting line.

Air-Assisted - This is a spraying system that helps or "assists" airless systems by using supplemental air jets to guide the paint spray and boost the level of atomization. Air-assisted airless technology combines the best characteristics of both air and airless spray. Benefits include substantial material savings and reduced overspray when compared to conventional air spray, and improved transfer efficiency and finishing appearance when compared to airless technology. The ability to reduce the fluid pressure from airless is the primary factor in the increased finish quality. Operator technique also is enhanced as the application rate is reduced and the operator can more easily coat the product uniformly.

Electrostatics - With this method, the paint and the part are given opposite electrical charges. The result is that transfer efficiency is increased because the paint is drawn to the part by an electric field. As a result, paint spray is less susceptible to drafts and air currents that increase overspray. Even water-based paints can be applied with a high-voltage electrostatic charge in some cases.

Rotary Atomization - This application system atomizes paint by dropping a stream of liquid on a disk or bell-shaped object spinning at high speed. Rotary atomizers utilize electrostatics to attract paint to the part. Rotary atomization is useful for high-viscosity paints. This process can create a spray without use of thinner and tends to have high transfer efficiency. However, the equipment needed for this type of application is very specialized and usually requires a major conversion of a painting line.

Spray Booths - Two basic types of enclosures are used in most painting applications: dry booths and wet booths. The key difference is that a dry booth depends on a filter of paper, fiberglass, Styrofoam®, or metal to collect overspray, while the wet booth uses water with chemical additives. The type of booth selected can affect the volume and type of paint waste generated. Decisions made about this equipment should be made based on the type and volume of painting done and the volume of waste generated.

Generally, small-volume painting operations will find the lower purchase cost of a dry filter booth will meet their requirements. One disadvantage in the use of a dry-filter booth is in the disposal of the waste. Typically the majority of this waste is the filter media itself which has been contaminated by a relatively small amount of paint. Reusable filters may decrease waste volume and reduce disposal cost. In some applications, overspray can be collected for reuse.

If overall painting volume can justify the investment, a wet booth may work to your advantage. This type of booth eliminates disposal of filter media and allows waste to be reduced in weight and volume. This is achieved by separating the paint from the water through settling, drying, or using a centrifuge or cyclone.

Coating Types

Organic Solvent-Based
This is the traditional type of painting material, typically containing about 40 percent solids with a relatively high organic-solvent content. While this coating material is one of the most versatile, its low solid content and high percentage of solvent carrier can cause it to have low overall (solids) transfer efficiency. To get the required coverage, more material must be sprayed compared to materials with higher solids content and lower VOC emissions.

High-Solids - This paint type has a higher percentage of paint solids and a lower percentage of solvent carrier. Overall transfer efficiency tends to be better than traditional solvent-based paint. The increased solids content means that fewer applications are needed to get the required film thickness. Air emissions from the solvent are generally lower due to reduced organic solvent content. However, a paint heater may be required to reduce viscosity and the film thickness is more difficult to control.

Water-Based -These paint types typically have a high solids content, utilize water as the solvent, and have very low or no organic-solvent content. Advantages of these paint types include reduced VOC emissions, reduced fire hazard, minimized or eliminated hazardous waste disposal, and easy cleanup. However, using a water-based coating may require stainless steel components in the preparation and delivery areas, a cleaner surface, longer drying times, increased oven temperatures, and a temperature-controlled paint storage area. The switch to water-based materials must be done carefully. Water-based coating technology is the fastest changing in the market today.

Catalyzed or Two-Component -These coatings are created by mixing two low-viscosity liquids just before entering the application system. One liquid contains reactive resins, and the other contains a catalyst that promotes polymerization of the resins. These coatings eliminate or reduce solvents and cure at low temperatures.

However, it is important to remember that catalysts and paint components may be hazardous themselves and create a different set of emission and exposure problems than those of organic solvents. Catalyzed painting also means that more material may be used if strict attention is not paid to the pot life.

Powder Coating -These coatings use 100 percent resin in dry, powdered form which must cure in an oven. Powder-coating materials can provide a high-quality, durable, corrosion-resistant coating. There are little to no VOC emissions, hazardous overspray wastes, or waste-water sludges. With powder coating it is also possible to collect the dry coating material that doesn't stick to the part and reuse it. Reuse allows powder coaters to achieve very high transfer efficiencies.

Powder coating requires specialized application equipment using electrostatic charges to apply the material. Its use also means that the substrate must be able to tolerate the curing temperature of the oven (typically 300 - 450° F). However, advancements in powder coating formulations are occurring at a rapid pace, and new coating powders are increasingly becoming available to meet special manufacturing needs.

Radiation Cured - Ultraviolet (UV), Electron Beam (EB), and Infrared (IR) coatings use electromagnetic radiation to cure. These coatings typically have lower VOC content than conventional coatings, require smaller ovens, and allow for increased production rates due to shorter curing period. The shape of the part will effect the curing; flat surfaces are easiest to cure. Capital investments are usually higher than conventional ovens and the cost of the raw material coating is higher.

This partial listing of equipment and coating options is only a summary of the technology available. Ohio EPA's Office of Pollution Prevention (OPP) can provide reference materials on these topics. Valuable information and hands-on training also can be obtained from your equipment vendors and suppliers.

Operator Techniques

The techniques spray painters use during application have a definite effect on transfer efficiency and have waste reduction potential. The fundamentals of good spray technique consist of: the proper overlap of the spray pattern; the proper gun speed; the proper distance of the gun from the part; holding the gun perpendicular to the surface of the part; and triggering the gun at the beginning and end of each stroke.

The proper overlap of the spray patterns will be determined by the coating. Proper overlap may range from 50 percent to 80 percent. Greater overlap may result in wasted strokes, and less overlap may result in streaks.

Since the flow of coating from the gun is consistent, the speed of the gun as it is moved across the part should be consistent also. Steady gun speed will help obtain a uniform thickness of coating. A gun speed higher than manufacturer specifications can distort the spray pattern and not permit the maximum amount of material to reach the surface.

The distance of the gun from the part must be consistent, since, again, the flow of material from the gun is consistent. Generally, this will be six to eight inches for non-electrostatic systems. Spray losses increase with the distance as does solvent loss. This solvent loss is often corrected by the addition of more solvent. This does not correct the spray loss, and overspray still ends up in the spray booth.

Except for special conditions, the gun should be held perpendicular to the surface of the part. Arcing the gun for hard to reach areas wastes material by applying an uneven coat. This also may result in streaks. These areas should be compensated for by changing the positioning of the gun or of the operator.

If the trigger of the gun is not released at the end of a stroke, the material continues to flow and, when the gun changes direction, the momentary stopping of the gun results in an accumulation of coating material. To avoid this piling, the operator may spray past the edge of the surface, spraying material into the spray booth and wasting coating.

All manufacturer specifications should be checked to ensure that operators are using the proper technique for their equipment. Operator training and experience will provide operators with knowledge of the various painting techniques needed to paint parts of different configurations. Different techniques are helpful when painting inside corners, outside corners, slender parts, round parts, flat parts, large parts, or small parts.

A training program for spray operators should take advantage of their pride in the finish they produce. The program should be presented as a means for them to obtain a higher quality of finish. The various fundamentals should not only be taught, but also explained, so operators understand the advantages of good technique.

Standard operating techniques will not be fully successful if other problems exist, such as the room temperature changing throughout the day (which changes the viscosity of the paint), or if equipment needs repair. Operators cannot be expected to compensate for broken gauges, worn fluid tips, or other equipment problems.

Whenever adjusting the spray technique of operators, it is important to note that over a period of time the coating and the selection or use of equipment may have been made to conform to the present incorrect technique. Equipment settings and materials may need to be changed to conform to the improved technique (DeVilbiss).

Equipment Cleaning

When a painting process is completed, a color change is needed, or maintenance is required during regular operation, equipment cleaning is required. Equipment cleaning offers opportunities for waste reduction and for reductions in air emissions.

When assessing the cleaning process, all the typical cleaning tasks should be reviewed to learn whether cleaning is necessary. While it is assumed that spray guns, tips and lines must be cleaned for reuse, cleaning some low cost items may not be advisable. Costs from cleaning solvent purchases, solvent waste disposal and solvent emissions could be higher than simply replacing the item being cleaned. However, the cost of proper disposal must be taken into account.

Next, the ways in which cleaning solvents are handled should be reviewed. All solvents should be in covered containers when not in use. Leaving solvents in the open air creates unnecessary solvent waste and VOC emissions. In addition, a standard should be set to assure that used solvent is disposed of or recycled only when it loses its cleaning effectiveness, not just because it looks dirty.

For equipment that requires cleaning, methods that minimize solvent use and reduce evaporation should be implemented wherever practical. Using a gun washer to clean spray guns is one example. A gun washer is a piece of equipment similar to a dishwasher. It is designed to hold a number of spray guns and related equipment and cleans by circulating solvent inside a closed chamber. The result is rapid cleaning and extended solvent cleaning life while reducing solvent waste and the emissions from evaporation. Line cleaning is another area where use of special equipment can decrease cleaning time, improve efficiency of solvent use, and decrease waste. One method used to improve line cleaning efficiency is to introduce turbulence into the solvent going through the line during cleaning. Equipment that forces alternating pulses of solvent and compressed air is one way to accomplish this. Payback on this equipment can come from increased production output through more rapid color changes as well as from material savings through decreased solvent use.

Solvent Reuse Alternatives

On-site recycling of used solvent is another way to reduce waste and save money. First, savings come from reducing the amount of solvent purchased. Second, savings come from reduced disposal cost by reducing the volume of spent solvent that must be sent off-site. Three common methods of solvent recycling are settling, filtering, and distilling.

Settling is putting used solvent in a container and

Pollution Prevention in Painting and Coating Operations

letting the particulate matter settle out. The container should be designed to allow removal of solvent without shaking up the sludge which has settled out. Filtering equipment, which removes the particulate matter from solvents, is also available. Distillation is an attractive option for many organic solvent users. Equipment is available in a variety of sizes. For more information, request OPP's fact sheets "On-site Solvent Recycling Equipment" and "Legal Considerations for On-site Solvent Recycling."

Alternative Solvents

Due to the increased need to reduce VOC emissions, alternative cleaning solvents are being used. They include dibasic esters (DBE) and dimethyl sulfoxide (DMSO). Although toxicology information specific to these chemicals is relatively limited at this time, it is believed that the relative safety of similar chemicals means that they might be viable alternatives to organic solvents in certain applications.

References and Sources of Information

Browner, Carol. 1994. *The Common Sense Initiative: A New Generation of Environmental Protection*. Presented at the July 20, 1994 Center for National Policy Newsmaker Luncheon. U.S. EPA, Washington, DC.

DeVilbiss Educational Services. *The Efficient Utilization of Material in the Finishing Room*. DeVilbiss. Maumee, Ohio. Material used with permission.

The Minnesota Technical Assistance Program. 1993. *Waste Reduction Alternatives for Spray Painting and Coating*. The Minnesota Technical Assistance Program, Minneapolis, Minnesota. Material reprinted with permission.

The Powder Coating Institute. 1994. *Powder Coatings: Technology of the Future, Here Today*. The Powder Coating Institute, Alexandria, Virginia.

U.S. EPA. 1990. *Guides to Pollution Prevention - The Fabricated Metal Products Industry*. EPA/625/7-90/006. U.S. EPA, Washington, DC.

Wolf, Katy. 1994. *The Truths and Myths about Water-Based Cleaning: A Systems Approach to Choosing the Best Alternatives*. Pollution Prevention Review. Vol. 4, No. 2, Spring, 1994.

This is the twenty-third in a series of fact sheets Ohio EPA has prepared on pollution prevention. For more information call the Office of Pollution Prevention at (614) 644-3469.

The Office of Pollution Prevention was created to encourage multi-media pollution prevention activities within the state of Ohio, including source reduction and environmentally sound recycling practices. The office analyzes, develops, and publicizes information and data related to pollution prevention. Additionally, the section increases awareness of pollution prevention opportunities through education, outreach, and technical assistance programs directed toward business, government, and the public.