OCAPP
Office of Compliance Assistance and Pollution Prevention

Fact Sheet

Number 23
December 2004

Pollution Prevention in Painting and Coating Operations

Most products require some type of coating such as paint, stain or sealer. Because the use of coatings is so widespread, there is great potential for both environmental benefit and cost savings through pollution prevention. Source reduction and recycling techniques can reduce hazardous and solid waste generation, reduce air emissions, reduce the use of raw materials and conserve water. An on-site assessment of a coating operation may be the best way to reveal opportunities to reduce waste generation and costs through pollution prevention.

Start with Surface Preparation

Most products require a preparation or cleaning 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 when pretreating new parts, the first step is to assess the cleanliness of the parts. To what degree are the surfaces contaminated with substances such as oil from machining or dirt from manufacturing? 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.

Petroleum-based solvents have traditionally been used as cleaning agents. However, environmental concerns and regulations affecting use of these solvents have caused many companies to find alternative cleaning agents.

There are numerous “drop-in” replacements for highly volatile organic solvents in a cleaning operation. Substitutes may include low VOC solvents, aqueous cleaners such as alkaline or acid cleaners or detergent/water solutions, and numerous abrasive cleaning systems. Abrasive cleaning systems offer a wide range of cleaning media from CO_2 pellets to baking soda. 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.

Another pretreatment method often used in the surface preparation of metal parts is phosphatizing. Some newer coating methodologies exist which may eliminate the need to phosphatize prior to subsequent coating steps. A secondary waste reduction option for phosphatizing is reduced water use.

Paint Removal

When repainting a part, the old paint often must be 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. 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 has been commonly used in a number of applications, but alternate methods that are less toxic and less costly are readily available. For example, an Ohio military facility was able to replace chemical stripping with plastic media blasting.

Paint-stripping technologies that are alternatives to chemicals include: abrasive blasting with a wide variety of materials; mechanical removal using scrapers, wire brushes and sand paper; 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. If material substitution is not considered carefully, a combination of removed paint and chemical stripper may require disposal as a hazardous waste.

Paint and Painting Equipment

Once parts are ready to be painted, the type of coating material and application method selected have a major impact on *transfer efficiency*. Transfer efficiency is the amount of paint solids that adhere to the object being painted, divided by the amount of paint applied or 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 or drum onto the surface being painted. One of the key considerations in paint selection should be the solids content. The solids content of a coating directly correlates to the surface area that the coating will cover. Therefore the true cost of a coating must be evaluated by the surface area/number of parts that a coating will cover (see PPRC under *References & Resources*).

In most 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 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. 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 waterborne coatings or with heat. Using solvents for viscosity reduction requires the purchase of additional materials and increases air emissions. Benefits from the purchase of paint heaters include lower solvent usage, lower solvent emissions, more consistent viscosities, and faster curing rates (see SBEAP under *References & Resources*).

Spray Application Methods

Conventional Spray - This technology, which has changed very little in the last 40 years, uses air at high pressure (40 - 70 pounds per square inch [psi]) to atomize a liquefied stream of paint.

A major disadvantage of this technique 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 any solvent in the paint are increased. Economically, the higher labor and material costs of this method have been the driving force in developing newer and more efficient technologies listed below.

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.

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 an 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.

Coating Types

Organic Solvent-Based - This is the older or traditional type of painting material, typically containing about 30 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 (see NEWMOA under *References & Resources*).

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.

Waterborne - These paint types typically have a high solids content, utilize water as the carrier, and therefore have much lower organic-solvent content. Many of the traditional solvent-based paints have been reformulated into waterborne alternative coatings. Advantages of these paint types include reduced VOC emissions, increased durability, reduced fire hazard, minimized or eliminated hazardous waste disposal and easy cleanup. However, using a water-borne 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. Waterborne coating technology is one of the fastest growing markets today.

Powder Coating - These coatings use 100 percent resin paint solids in dry, powdered form which must cure in an oven. Powder coating can provide a high-quality, durable, corrosion-resistant coating. There are little to no VOC emissions, hazardous overspray wastes or wastewater sludges. With powder coating it is also possible to collect the dry coating material that doesn't stick to the part and reuse it. Powder coaters often achieve very high transfer efficiencies and can gain a significant economic advantage over traditional coating operations.

Powder coating does require specialized application equipment using electrostatic charges to apply the material. Its use also means that the substrate must be able to tolerate varying curing temperatures. However, powder coating formulations are available to meet a broad spectrum of manufacturing needs.

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 paint batch life.

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 affect 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.

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.

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

Operator Technique and Training

The techniques spray painters use during application have a direct effect on transfer efficiency and 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.

The distance of the gun from the part must also be consistent. Generally, this will be six to eight inches for non-electrostatic systems. Spray losses increase with distance as does solvent loss. This solvent loss is often adjusted by the addition of more solvent, further decreasing the coating efficiency. This does not correct the overall spray loss, and overspray increases 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 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 is a necessary component of any coating operation. The program may be presented as a means for obtaining a high quality finish while remaining economically competitive as a facility. The various fundamentals should not only be taught, but explained so operators understand the quality and economic advantages of good technique.

Equipment Cleaning

When a painting process is completed or color change is needed, equipment cleaning is required. Equipment cleaning offers opportunities for reductions of waste and air emissions.

The ways in which cleaning solvents are utilized should be continually reviewed. Alternatives should be pursued toward traditional organic solvents such as water for waterborne or water-based paints or low VOC cleaners for traditional paints. All organic solvents should be stored in covered containers when not in use. Leaving organic 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 always recycled, preferably on-site.

For equipment that requires cleaning, methods that eliminate or 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 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 cleaner life while reducing waste and the emissions from evaporation. Line cleaning is another area where use of special equipment can decrease cleaning time, improve efficiency of cleaner use and decrease waste. One method used to improve line cleaning efficiency is to introduce turbulence into the cleaner going through the line during cleaning. Equipment that forces alternating pulses of cleaner 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 cleaner use.

Cleaner Reuse Alternatives

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

Settling is putting used cleaner in a container and 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. Filtration equipment, which removes the particulate matter from cleaners is also available.

Distillation is another option for organic solvent users. Equipment is available in a variety of sizes. For more information, please refer to OCAPP's fact sheet "On-site Solvent Recycling Equipment."

Alternative Solvents

Due to the increased need to reduce VOC emissions, alternative cleaning solvents are being used. They include aqueous formulations, renewables such as methyl soyate (from soy bean oil), dibasic esters and other lower VOC compounds. A variety of options to substitute high VOC organic solvents exists today.

For more information, contact OCAPP at p2mail@epa.state.oh.us, (800) 329-7518 or at www.epa.state.oh.us/ocapp.

References & Resources

NEWMOA. *Metal Painting and Coating Operations-Alternatives to Solvent-Borne Coatings.* www.p2pays.org/ref/01/00777/alternat.htm

PPRC. 1998. *Evaluating Less Toxic Paints and Coatings? Get the Most for Your Money By Calculating True Costs.* www.pprc.org/pubs/factsheets/laund4.html

SBEAP. 2002. *Industrial Painting & Coating.* www.sbeap.org/ppi/publications/Paintbook.pdf

Chrysler Reduces Air Emissions Using a Powder Antichip Primer Process. www.epa.state.oh.us/opp/chrysler.pdf

Painting Progress Benefits Environment-Tennessee Pollution Prevention Partnership Success Story. www.epa.state.oh.us/opp/saturn.pdf