Spray Painting and Coating Waste Reduction Alternatives

Many products require some type of coating, such as paint, lacquer or varnish. By incorporating waste reduction techniques into coating application processes, companies can realize great savings.

By reducing waste, large-volume painting operations may be able to avoid reaching the threshold level for chemical use which requires reporting emissions to the Minnesota Emergency Response Commission and compliance under the Minnesota Toxic Pollution Prevention Act. The U.S. Environmental Protection Agency (EPA) is proposing new air emission rules which will apply to many painting processes. Painting operations that adopt waste reduction practices now will have an advantage if stricter air emission standards must be met in the future.

Opportunities for reducing waste exist throughout the coating process, from product design through manufacturing, coating and cleaning. Look for opportunities to reduce waste when selecting coating equipment and coatings. Operator technique and cleanup when jobs are finished are also areas waste can be reduced. This fact sheet discusses how businesses can incorporate waste reduction strategies into their coating processes to reduce or eliminate paint-related wastes and emissions.

The following sections list select options available for spray painting and coating. MnTAP can provide additional information on these topics and vendors can provide detailed product information and hands-on training.

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 rework.

Pretreatment/Cleaning

Cleanliness of parts. The first step for reducing waste in pretreatment is assessing the cleanliness of parts. Determine the sources of contaminates to reduce or eliminate them. Consider to what degree surfaces become contaminated with substances such as oil from machining, dirt from the manufacturing environment and oil from people's skin.

Cleanliness of the process. Next, determine the cleanliness standard needed to satisfy the pretreatment process. Once contaminant sources are identified and cleanliness standards are set, determine which contaminants can be eliminated. If contaminants cannot be reduced sufficiently through process changes, assess the cleaning methods used.

MnTAP developed "Get It Plated Right," a series of fact sheets which covers a variety of difficult part cleaning issues. This series is available online at <mntap.umn.edu>.

Phosphatizing. Phosphatizing prepares the surface of metal parts for coating. The volume of water used to maintain the phosphatizing bath solution can be reduced by analyzing and controlling each bath's temperature, chemical concentration and pH level; and by recirculating the solution or rinse water to other baths where possible. An added benefit is the potential for reduced chemical use. Additional information on cleaning and phosphatizing can be found in the fact sheet, "Metal Phosphatizing Operations [#64]," available online at <mntap.umn.edu>.

Paint Stripping

Evaluate the problem. Usually, old paint must be removed before a new coat of paint is applied. Assess what caused the need for repainting. Inadequate initial part preparation, defects in the coating, application equipment problems and coating damage due to improper handling can all result in the need for repainting. While no process is perfect, reducing the need for repainting directly affects the volume of waste from paint removal.

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Consider other approaches. Once the need for paint stripping is minimized, consider alternative paint-stripping approaches. Outsourcing paint-stripping work may be cost effective. Consider the advantages of reduced environmental liability, avoiding employee exposure to paint-stripping hazards, and eliminating expenses for purchasing, operating and maintaining stripping equipment. Because outside stripping operations specialize in paint stripping, they are more efficient and can reduce the problems associated with stripping.

If you choose to maintain an on-site paint removal operation, key factors to consider are the characteristics of the substrate being stripped, the type of paint being removed, and the volume and type of waste produced. Chemical stripping has commonly been used in a number of applications, but less toxic and less costly alternatives are available. For example, chemical stripping can often be replaced with mechanical stripping using metal and nylon brushes. Alternatives to chemical paint-stripping include:

- abrasive blasting with a variety of materials
- mechanical removal using scrapers, wire brushes or sand paper
- pyrolysis: vaporizing the paint coating in a furnace or molten salt bath
- cryogenics: freezing the paint off
- extreme high-pressure water or air

Often, removed paint and chemical stripper combinations require disposal as hazardous wastes. Waste type and volume can have a major impact on cost.

Transfer Efficiency

The type of coating material and application method used impact transfer efficiency. When discussing spray application equipment, transfer efficiency measures how much paint makes it from the container onto the surface being painted. More importantly, the overall transfer efficiency of a specific coating refers to the amount of coating needed to get the proper dry film thickness. Overall transfer efficiency accounts for the amount of coating lost to evaporation and emissions relative to the amount of solids that coat the part.

Improved transfer efficiency uses less paint per finished product. Because less paint is used, air emissions from solvents in the paint are reduced. It also reduces the rate of paint entering booth filters and landing on the floor and walls of the spray booth. High transfer efficiency rates reduce the amount of paint wasted while minimizing solid and liquid wastes, and air emissions.

Spray Application Equipment

Equipment Available

To achieve the best transfer efficiency assess the application equipment available and evaluate equipment performance using each coating material considered appropriate for your application. Each combination of application equipment and coating creates its own characteristics. Weigh these results against the specifications set for your finished product. For example, if increasing transfer efficiency results in a coating film thickness that is greater than specified, materials will be wasted.

Conventional Spray

In use for over 50 years, conventional, or atomized spray, uses air at high pressure (40 to 70 pounds per square inch [psi]) to atomize a liquefied stream of paint. The high-energy air stream finely atomizes paint making it easy to apply and yielding very good finishes with high-quality visible characteristics.

A disadvantage to conventional spray is that a high degree of atomization is accompanied by a very fine spray that is highly susceptible to overspray. The result is more paint waste and low transfer efficiency.

High-volume/Low-pressure (HVLP)

As the name suggests, a high volume of air at low pressure is used to atomize paint. The air-pressure limit for HVLP is 10 psi at the spray gun air cap. The lower energy level reduces overspray and improves transfer efficiency. Generally, fluid-delivery rates up to 10 ounces per minute with low viscosities work best with the HVLP gun. At higher fluid delivery rates or with heavier materials, HVLP may not atomize well enough to achieve an acceptable finish.

Airless

This method of atomizing paint does not use compressed air. Paint is pumped at high pressure through a small opening at the spray tip to achieve atomization. Changes in airless spraying are made by adjusting the coating's viscosity or the system's pressure. This method has higher transfer efficiency than conventional spray. Many high-viscosity coatings can be applied without costly solvent thinning. Also, this method allows for rapidly applying a heavy paint coat—useful for keeping up with a fast-moving paint line.

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Air-assisted

This spraying system "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 spray and improved transfer efficiency and finishing appearance when compared to airless technology. The ability to lower the fluid pressure from airless systems is the primary factor in increased finish quality. Also, operator technique is enhanced as the application rate is slowed, making product coating easier.

Electrostatics

The electrostatics method gives the paint and the part opposite electrical charges. As paint is sprayed the electrical charge draws it to the part, which results in higher transfer efficiency. In this process, paint spray is less susceptible to drafts and air currents. Another advantage is that electrostatic coating helps wrap coatings around part edges. For safety when using electrostatics, the part should be grounded or prepped with a solution that will provide a ground path. With special equipment, waterbased paints can also be electrostatically applied.

Rotary Atomization

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

Other Equipment

Spray Booths

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

Dry filter booths generally meet the requirements of small-volume painting operations because of their low purchase cost. One disadvantage to using a dry filter booth is waste disposal. Often the majority of waste is the filter media itself, 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 the need for disposal of filter media and reduces waste in weight and volume. This is achieved by chemically separating the paint from the water then settling, drying, or using a centrifuge or cyclone to remove the solids for disposal.

Paint Heaters

Paint viscosity may need adjusting before spraying. Most often this is accomplished by thinning the paint with organic solvents. But, using solvents for thinning requires the purchase of additional materials and increases air emissions. An alternative method for reducing viscosity is to use heat. Paint heaters use less solvent, have lower solvent emissions, create more consistent viscosities and produce faster curing rates. Consult your paint supplier to determine if paint heaters can be used with your coating.

Coatings

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 solids content and high percentage of solvent carrier can cause low overall transfer efficiency. To get the required dry film thickness more material must be sprayed compared to coatings with higher solids content and lower volatile organic compound (VOC) emissions.

High-solids

This paint type has a higher percentage of paint solids and a lower percentage of solvent carrier. Overall transfer efficiency is usually better than traditional solvent-based paint. The increased solids content means that the application rate can increase or fewer applications are needed to get the required film thickness. Air emissions from the solvent are generally less due to reduced organic solvent

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content. A paint heater may be required to reduce viscosity. Also, the film thickness is more difficult to control with high solid paints.

Waterbased

These paint types typically have a high solids content, use water as a 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. Some companies have so drastically reduced air emissions from painting with waterbased coatings that they no longer need an air emissions permit or need to report releases on the EPA's Form R reports. Using a waterbased coating may require a cleaner surface, longer drying times, increased oven temperatures and a temperature-controlled paint storage area. The switch to waterbased materials must be done carefully. Waterbased 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 resins to polymerize. These coatings eliminate or reduce solvents and cure at low temperatures.

The 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 more material may be wasted if pot life is neglected.

Powder Coating

Producing no VOC emissions, hazardous overspray wastes or wastewater sludges, powder coatings are 100 percent resin in dry, powdered form which when cured in an oven produce a high-quality, durable, corrosion-resistant coating. Collecting and reusing dry coating material that does not stick to the part is possible. Reuse allows powder coaters to achieve very high overall transfer efficiencies.

Powder coating requires specialized application equipment using electrostatic charges to apply the material. The substrate must be able to tolerate the oven's curing temperature (typically 300 to 450° F). Advancements in powder coating formulas are occurring at a rapid pace. New powder coatings are 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 a lower VOC content than conventional coatings, require smaller ovens and allow for increased production rates due to a shorter curing period. The shape of the part will affect curing—flat surfaces are easiest to cure. Capital investments are higher than for conventional ovens and the cost of the coating material may be higher depending on the application method used and transfer efficiency.

Equipment Cleaning

Equipment cleaning may be required when painting is completed, a color change is needed or maintenance is required during operation. Equipment cleaning offers opportunities for reducing waste and air emissions.

When assessing the cleaning process, all cleaning tasks should be reviewed to determine if cleaning is necessary. While many assume 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.

All solvents should be stored in covered containers when not in use. Leaving solvents in the open air creates unnecessary solvent waste and VOC emissions. 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 are ideal. For example, a gun washer is a piece of equipment similar to a dishwasher designed to hold a number of spray guns and related equipment. It 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. For more information about automatic cleaning systems see MnTAP's reference list, "Spray Gun and Equipment Cleaning System Suppliers [#79]," available online at <mntap.umn.edu>.

One method for line cleaning introduces turbulence to the solvent going through the line during cleaning

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by alternating pulses of solvent and compressed air. Payback on this equipment can come from increased production output due to faster color changes and 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. Savings come from reducing the amount of solvent purchased, and decreasing 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 the used solvent in a container and letting the particulate matter settle out. The container should be designed to allow for the removal of the solvent without shaking up the sludge which has settled. Filtering equipment which removes the particulate matter from solvents is also available.

Distilling is an attractive option for many organic solvent users. Equipment is available in a variety of sizes, one-gallon capacity and larger. For more information, request reference materials on solvent recycling and selecting a still from MnTAP.

Alternative Solvents

Due to the increased need to reduce VOC and hazardous air pollutant emissions, alternative cleaning solvents are being used. Alternatives include formulas containing acetone, dibasic esters (DBE) and terpenes. Although acetone is not considered a VOC, it is extremely flammable. For more information see MnTAP's reference list, "Safer Stripping and Cleaning Chemicals for Coatings and Polymers [#55]," available online at <mntap.umn.edu>.

Operator Technique

An operator's technique affects transfer efficiency and if improved upon or corrected will reduce waste. When using spray equipment, maintaining the distance between the gun tip and painting surface according to equipment specifications will help assure the proper film thickness. For electrostatic applications, the distance between the spray tip and the part also affects the charge the paint maintains.

Gun angle relative to the painting surface also affects transfer efficiency. Keeping the spray gun perpendicular to the painting surface helps avoid uneven coverage that might otherwise require more paint than necessary to produce an acceptable finish.

One tool to assist spray painters is Laser Touch®. Mounted on a spray gun, the Laser Touch® unit emits two laser beams that converge into one dot when the gun is properly positioned. The visual signal of both lasers coming together on a part lets operators instantly know if they have proper aim, gun-to-part distance and gun angle. Call MnTAP for more information about the Laser Touch®.

A new tool to improve operator technique is virtual reality spray painting. Virtual reality software and equipment can be customized to match the parts painted at your company along with the coating viscosities, fluid pressures, air pressures and spray equipment you have. Painters can be trained virtually with no mess, waste or reject parts. Virtual reality spray painting was developed by the Johnson Center for Virtual Reality and Pine Technical Collage. Call MnTAP for more information.

Triggering the spray gun on and off at the appropriate time will minimize overspray and improve finish quality. Also important are proper spray overlap and the speed of the stroke.

Training and experience will provide operators with a knowledge of the various painting techniques needed to paint parts of different configurations. Different techniques are helpful when painting inside and outside corners, or slender, round, flat, large and small parts. Training options are available through trade associations, material suppliers and equipment vendors.

Additional Resources

Additional printed resources about coating and related industries are available from MnTAP. Call to request the checklist, "Resources for Minnesota's Coating Industry [#35]." Resources also can be found on the Painting & Wood Finishing page on MnTAP's Web site <mntap.umn.edu>, or search the site for topics of concern to your business.

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 and reduce costs.
Our information resources are available online at <mntap.umn.edu>. Or, call MnTAP at 612/624-1300 or 800/247-0015 from greater Minnesota for personal assistance.