PAINTING

COMMONLY OBSERVED PRACTICES

Most metal manufacturing operations involve some type of part or product finishing for rust protection and, in many cases, to offer a product that is aesthetically pleasing. Most commonly, this finish is obtained by coating the product with a petroleum solvent-based, liquid paint. While conventional painting is generally effective in meeting the facility's requirements, it generates significant amounts of hazardous waste and regulated air emissions. Furthermore, conventional spray painting is relatively inefficient in terms of the amount of paint that is actually transferred to the part being finished.

Painting may be the area where pollution prevention efforts are most dramatic and difficult to optimize. Optimal painting involves careful selection of 1) paint/coating products and 2) method of application. Finish quality, drying characteristics, durability and economics must be considered when selecting a coating product. The method of application can be dependent or independent on the type of coating selected and also involves numerous parameters. For example, a liquid coating can be applied with a variety of equipment whereas a powder coat product requires specific application equipment. The selection of a specific coating application method may also affect the type of precleaning required, paint booth design, air permitting requirements for the facility, curing methods and, obviously, costs.

POLLUTION PREVENTION OPTIONS

PAINT TECHNICIAN TRAINING

Regardless of the coating process used, the pollution prevention option that should be implemented first is paint technician training. For coating operations that involve manual spray application, the least expensive way to reduce paint-related emissions, material consumption, and hazardous waste generation is to practice proper spray techniques. Spray technique training can substantially improve transfer efficiency without the purchase of new or special equipment. This pollution prevention option involves adjustment of present equipment to maintain proper settings, painter training to assure proper spray techniques are performed, and a maintenance system to assure maximum equipment efficiency. Optimization of the existing system also creates a baseline from which evaluation of other paint and application processes can be compared.

An operator using proper spray techniques saves the employer money by using less material, covering the piece in fewer strokes, obtaining a higher quality finish with less waste and reducing air emissions. Reduced air emissions saves the employer money by extending the life of paint booth filters. It may also prevent the need to install expensive emission control equipment and reduce compliance requirements under Title V of the Clean Air Act amendments.

Since proper spray technique is such an important tool in pollution prevention, it is recommended that all spray painters undergo formal training. Training should include an explanation of the fundamentals of good technique, what good techniques can accomplish and how the operator can benefit by practicing them.

The basic fundamentals of good spray technique are:

- **Proper Gun Setup**

  Initial gun setup involves using the paint gun manufacturer's suggested air cap/fluid tip combination for the viscosity of the product being sprayed. 'Thicker' product will need a larger orifice. It is also important to adjust the fan pattern so it is compatible with the size and shape of the part being sprayed. This is particularly important for long, thin parts. The longest axis of the spray pattern should be in line with the longest axis of the part being sprayed. Partial trigger application can also reduce waste when painting small parts or edges.

  Air pressure and fluid settings should also be considered. In general, air pressure should be set at the lowest possible setting that allows for adequate atomization. Excessive air pressure can actually cause paint to bounce off the part increasing the amount of overspray. Fluid settings should be as low as possible while maintaining a comfortable gun speed.

- **Spray Distance and Angle**

  The distance between the gun and the part being sprayed should be kept as close as possible to the manufacturer's recommendations at all times. This distance is affected by both the actual distance between the gun tip and the part, and angle of the gun. Gun angle is affected by yaw (wrist moving left or right), pitch (wrist moving up and down) and rotation (wrist moving clockwise or counter clockwise). It is important to keep a locked wrist while painting. A painter's technique can be video taped or observed by a co-worker. If the proper spray distance and/or gun angle are not being maintained, this should be brought to the attention of the painter with instructions for improvement.

- **Lead and Lag Distances and Overlap**

  Lead is the distance between the point where the gun is triggered and the point where the gun pattern hits the part. Lag is the distance between the point where the pattern leaves the part and the point where the gun is untriggered. Both should be kept to a minimum. Each successive paint pass should overlap the previous one by 50%. This will help assure consistent application thickness and minimize paint usage.

Paint/Coating Selection

The first step in choosing alternatives to existing painting practices or setting up new operations involves evaluation and selection of the best paint or coating. Following is a brief description of the advantages and disadvantages of three common paint/coating options that offer significant opportunities for pollution prevention.

- **High Solids Paint**

  High solids paints are solvent-based products with 50% or more solids content. Because of the higher solids content, the desired film thickness can be accomplished with fewer spray applications. Improved abrasion and mar resistance is also expected on the finished part. High solids paints are sensitive to temperature and humidity and may require heating to obtain an acceptable cure time. Part cleanliness also greatly affects the usage of high solids paints.

  Pollution prevention benefits afforded by high solids paints relate mainly to reduced solvent emissions (volatile organic compounds [VOC]); in both the workplace and released to atmosphere through the paint booth exhaust system and during curing. Lower solvent concentration also reduce required air flow rates for curing, thus decreasing makeup air heating costs. Equipment cleaning requirements will be similar to those for conventional, low solids pain

Waterborne Paint

As the name implies, waterborne paint contains water as a solvent, but may also contain 2 to 30% organic solvent. Waterborne paints are sensitive to the cleanliness of the part and can be applied and cured with reduced air flow. Although waterborne paints are compatible with conventional and high volume/low pressure (HVLP) spray gun application equipment, gun modification (i.e. installation of stainless steel or plastic lines, valves, etc.) may be necessary to prevent corrosion.

While VOC's are not totally eliminated, a significant reduction in emissions can be expected. Waterborne paints also reduce or eliminate the need for petroleum-based equipment cleaning solvents. In addition, painting-related wastes such as paint booth exhaust filters and overspray are less likely to be hazardous because of the lower organic solvent content in the paint.

Powder Coatings

Powder coatings are 100% solids in a powder form. Transfer efficiencies can reach 95% to 99% while achieving a durable, corrosion resistance finish. Powder coating is extremely sensitive to part cleanliness making multistage washers a necessary prerequisite to installing this type of system. In addition, powder coating requires specialized application equipment and a heated curing booth.

Powder coatings totally eliminate the generation of VOC's and hazardous equipment cleaning solvents. In addition, overspray and product collected in the paint booth exhaust system can be recovered and reused.

Method of Application Selection

After paint/coating products are evaluated, the best paint or coating application method should be selected. Following is a brief description of the advantages and disadvantages of five common paint/coating application options that afford significant opportunities for pollution prevention.

High-Volume Low-Pressure (HVLP)

HVLP spray guns operate with a high volume of air delivered at 10 psi or less to atomize the paint. This atomization method reduces overspray and, thus, the generation of paint-related wastes. Transfer efficiencies up to 60% are possible with proper training. In addition, less volatile organic compounds (VOC) are released to the work space/atmosphere.

Air-Assisted Airless

Air-assisted airless guns combine conventional atomization with increased (150 to 800 psi) paint fluid pressure. These guns reportedly achieve a paint transfer efficiency of up to 70%. The fluid delivery rate can also be varied based on part size/shape to optimize paint application. Conversion to air-assisted airless guns will likely require painter training and increased maintenance.

Electrostatic

Electrostatic systems introduce a positive charge to atomized paint at the tip of the spray gun. The part being painted is electrically neutral, causing the charged paint to be attracted to the part. Because of the electrical attraction, electrostatic painting offers a potential transfer efficiency of 68% to 87% with a corresponding reduction in overspray and VOC air emissions. Good edge cover, wraparound, and uniform film thickness are other benefits. Electrostatic painting is more sensitive to the cleanliness of the part than HVLP and convention painting practices. Electrostatic spray guns also tend to be bulky and delicate which may increase maintenance costs.

Two Component

Two component systems allow mixing of the paint and catalyst at the gun tip. This feature eliminates the need for premixing excess quantities of paint to assure an adequate supply of paint is available and reduces the frequency of equipment cleaning. Both of these factors are directly related to the amount of paint and solvent that is generated as waste. Two component painting systems are compatible with most liquid/catalyst paints and either electrostatic or nonelectrostatic applications. Transfer efficiencies are assumed to be similar to HVLP or electrostatic systems.

Powder Coating

Due to the nature of powder coating products, special application equipment and curing ovens are necessary. This system offers nearly a 100% transfer efficiency and no solvent usage for clean up.

COSTS/BENEFITS

Selection of a particular paint system (paint and application method) for a specific application depends primarily upon the products to be coated, the coating materials and production requirements. Before selecting a system, a comprehensive economic analysis considering the following items should be performed:

- Cost per volume of the nonvolatile fraction of the paint
- Transfer efficiency versus paint cost
- Relative costs of various coating process equipment
- Energy consumption

Conventional liquid paints are comprised of both volatile and nonvolatile components. When paint is applied to the part, the volatile components evaporate, leaving the nonvolatile components to form the actual finish. In order to evaluate the cost of an applied finish, one must consider: 1) the nonvolatile fraction of the paint versus the product cost and 2) the efficiency of the paint application method (i.e. transfer efficiency).

Cost per Volume of the Nonvolatile Fraction of the Paint

The cost of a paint based on its nonvolatile (solid) fraction can be calculated from product information (generally the product Material Safety Data Sheets [MSDS]). For example, a paint that costs $15.00 per gallon and contains 33% solids actually costs: $15.00 divided by 0.33 or $45.45 per gallon of solids.

If a desired film thickness is known, this cost can be further broken down into a cost per applied surface area using the following equation:

Cost of paint solids per gallon x film thickness in mils x 0.0006233 = paint cost per square foot of applied finish (where 0.0006233 is a unit conversion factor)

Using the paint cost of $45.45 per gallon of solids and a 2 mil (1 mil = 0.001 inch) finished film thickness, the paint cost per square foot of applied finish (assuming a 100% transfer efficiency) would be:

$45.54 x 2 x 0.0006233 = $0.057 per square foot (ideal)

Transfer Efficiency Versus Paint Cost

The above calculation gives the minimum or ideal cost of paint per square foot of applied finish because it assumes that 100% of the paint product adheres to the part being painted. In order to get an actual cost, one must also include transfer efficiency. In most spray painting operations, only a portion of the product reaches the part to be painted. The remainder (overspray) is collected in the paint booth exhaust filters or settles to the floor of the paint area. The amount of paint reaching the product versus the total amount of paint sprayed is referred to as transfer efficiency . A 50% transfer efficiency means half the paint adheres to the product and the other half is wasted. To calculate the actual cost of paint per square foot of applied finish, one must include the estimated transfer efficiency of the paint operation into the above formula as follows:

Ideal paint cost per square foot x 100/TE = Actual paint cost per square foot

where: TE equals transfer efficiency

Using the previous example and a transfer efficiency of 50%, the actual paint cost would be:

$0.057 x 100/50 = $0.114 per square foot (actual)

Relative Costs of Various Coating Process Equipment

Due to the variation of painting requirements present in the broad category of metal manufacturers, providing a realistic cost comparison between one paint application method and another, in a generic form, is nearly impossible. In order to provide some degree of comparative information the following table is offered:

Table 2-1
Painting Alternatives - Cost/Benefit Summary Guide

Method of Application	Capital Cost	Process Complexity	Waste and Emissions	Additional Considerations
Conventional	Low	Low	High	
HVLP	Low	Low	Medium/High	
Air-Assisted Airless	Low	Low	Medium/High	
Electrostatic	Medium	Medium	Medium	Only metal parts may be painted
Two Component	Medium	Medium	Medium	
Powder Coat	High	High	Low	Extensive parts washing and a curing oven are required

Energy Consumption

Energy consumption should also be a consideration when selecting a paint and application method. Energy consuming operations include pretreatment (i.e. part washing), ventilation and make-up air/heat for curing. All three of these factors are directly related to the type of paint and application method selected. For initial comparative purposes, powder coating and water-borne paints may have higher energy requirements due to increased curing demands.