POWDER COATING TECHNOLOGY

Revision: 4/94
Process / Product: Powder Painting
Process Code: ID-05-03, ID-05-04
Substitute For: Conventional Solvent-based, Waterborne, or High Solids Painting
Waste Stream: Solvents, Paint Sludges, VOC Emissions
Applicable EPA Hazardous Waste Codes: D008, D035
Applicable EPCRA Targeted Constituents: Acetone, n-Butanol, Lead, Methyl Ethyl Ketone, Toluene, and Xylene

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Introduction: In conventional paint spray systems, paint atomization occurs via high-velocity air jets, forcing paint through small air holes in the paint gun face caps. Air pressures used range from 40 to 80 psi, with air volumes of 8 to 30 sqfm. The atomized paint particles travel at high velocities and tend to bounce off the object being painted, rather than adhering to the surface. In addition, the expanding high-pressure air (as high as 70 psi) passes through the small face cap openings, causing turbulent flow of the paint stream following air currents within the paint booth. The amount of paint that bypasses the workpiece (overspray) is relatively high for air pressure atomized spray painting. Transfer efficiencies of 15 to 30 percent are associated with conventional painting systems.

Description: Thin film powder coating, also referred to as a 'dry painting" process, eliminates volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and solvents, and produces superior surface finish. There are four basic powder coating application processes: electrostatic spraying, fluidized bed, electrostatic fluidized bed, and flame spray. Electrostatic spraying is the most commonly used powder application method. For all application methods, surface preparation (i.e., cleaning and perhaps application of a conversion coating) is required to develop good coating adhesion to the workpiece surface. Characteristics of the four different powder coating application techniques are summarized in Table 1 and described below.

In electrostatic spraying, an electrical charge is applied to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded workpiece create an electrostatic field that pulls the paint particles to the workpiece. The coating deposited on the workpiece retains its charge, which holds the powder to the workpiece. The coated workpiece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated.

Table 1. Characteristics of Powder Coating Techniques

Characteristic of Workpiece	Electrostatic Spray	Fluidized Bed and Electrostatic Fluidized Bed	Flame Spray
Size	Larger	Smaller	Not limited
Material	Metallic, must be conductive	Any, not necessarily conductive	Any, not necessarily conductive
Temperature Resistance	Relatively high	High	Not relevant
Aesthetic Value	High	Low, not suitable for decorative purposes	Low, not suitable for decorative purposes
Coating Thickness	Thinner films	Thick high-build films with excellent uniformity	Thick high-build films; uniformity dependent on the operator
Type of Coatings	Thermoplasts and thermosets	Thermoplastic and thermosets	Thermoplasts only
Color Change	Difficult	Relatively difficult	Easy
Capital Investments	Moderate to high	LOW	Very low
Labor	Low since highly automated	Moderate depending on the automatization	Relatively high
Energy Consumption	Only post-heating	Preheating and often postheating	Low, no preheating and postheating
Coating Waste	Very little	Very little	Dependent on the workpiece geometry

From Miser, Tosko A. 1991. Powder Coatings: Chemistry and Technology, Table 6.4, p. 350.

In a fluidized bed, powder particles are kept in suspension by an air stream. A preheated workpiece is placed in the fluidized bed where the powder particles coming in contact with the workpiece melt and adhere to its surface. Coating thickness is dependent on the temperature and heat capacity of the workpiece and its residence time in the bed. Post heating is generally not required when applying thermoplastic powder coatings. However, post heating is required to completely cure thermoset powder coatings.

Electrostatic fluidized beds are similar in design to conventional fluidized beds, but the air stream is electrically charged as it enters the bed. The ionized air charges the powder particles as they move upward in the bed, forming a cloud of charged particles. The grounded workpiece is covered by the charged particles as it enters the chamber. No preheating of the workpiece is required. Curing of the coating is, however, necessary. This technology is most suitable for coating small objects with simple geometry.

The flame-spray technique was recently developed for application of thermoplatic powder coatings. The thermoplastic powder is fluidized by compressed air and fed into a flame gun where it is injected through a flame of propane, and the powder melts. The molten coating particles are deposited on the workpiece, forming a film on solidification. Since no direct heating of the workpiece is required, this technique is suitable for applying coatings to most substrates. Metal, wood, rubber, and masonry can be successfully coated by this technique. This technology is also suitable for coating large or permanently-fixed objects.

The choice of powders is dependent on the end-use application and desired properties. Powders are typically individually formulated to meet specific finishing needs. Nevertheless, powder coatings fall into two basic categories: thermoplastic and thermosetting. The choice is application dependent. However, in general, thermoplastic powders are more suitable for thicker coatings, providing increased durability, while thermosetting powders are often used when comparatively thin coatings are desired, such as decorative coatings. The principal resins used in thermoplastic powders are vinyl, nylon, and fluoropolymer. Thermosetting powders use primarily epoxy, polyester, and acrylic resins.

The concentration of powder in air must be controlled to maintain a safe working environment. Despite the absence of flammable solvents, any finely divided organic material, such as dust or powder, can form an explosive mixture in air. This is normally controlled by maintaining proper air velocity across face openings in the spray booth. In the dust collector, where the powder concentration cannot be maintained below the lower explosive limit, either a suppression system or a pressure relief device must be considered.

Materials Compatibility: Only workpieces that can be oven heated can be coated by the electorostatic, the fluidized bed, and the electrostatic fluidized bed application methods. These technologies are, therefore, most suitable for relatively small, metal objects. The flame-spray method allows powder coatings to be applied to other substrates such as wood, rubber, and plastic, and to large or stationary structures.

Safety and Health: Powder and air mixtures, in the correct concentrations, can be a fire hazard when an ignition source is introduced. Inhalation of the powders should be avoided, as this can cause irritation to the lungs and mucous membranes. proper personal protective equipment should be used.

Consult your local Industrial Health specialist, your local health and safety personnel, and the appropriate MSDS prior to implementing any of these technologies.

Benefits: Powder coating eliminates the need for expensive and often toxic solvents, as well as the control equipment, employee exposure, and the disposal requirements and liabilities associated with liquid coating (wet solvent) use. Because the powder is dry when sprayed, any overspray can be readily retrieved and recycled, regardless of the complexity of the system, resulting in shorter cleanup times. In all cases, the dry powder is separated from the air stream by various vacuum and filtering methods and returned to a feed hopper for reuse. Powder efficiency (powder particles reaching the intended surface) approaches 100 percent. Other advantages over conventional spray painting include greater durability; improved corrosion resistance; and elimination of drips, runs, and bubbles.

Economic Analysis: Analysis of capital costs for a typical coating installation (two wash booths, one dry filter booth, four automatic guns, one manual gun, and two reciprocators) associated with a powder system totals approximately $120,000. This compares favorably to the conventional solvent-based system, which costs approximately $150,000. However, the powdered system is more expensive than waterborne or high solids coating systems, which cost approximately $110,000. Material costs are also substantially lower for powder coating systems ($27,300 per 1,000,000 square feet) than conventional solvent-based systems ($34,900 per l,000,000 square feet) or waterborne systems ($35,600 per l,000,000 square feet), while high solids systems are the least expensive ($24,400 per l,000,000 square feet). Overall, powder coating is the most cost effective when annual operating costs are included (cleanup, disposal, and power). On an applied basis, conventional systems are most expensive, followed by waterborne, high solids, and finally powdered, with approximate costs of $5.66/100 square feet, $5.64/100 square feet, $4.41/100 square feet, and $3.80/100 square feet, respectively.

Major Assumptions: Economic data and basis provided by the Powder Coating Institute, Powder Coating Today, 1987, p 10.

Points of Contact: Powder Coating Institute
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(703) 684-1770

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Code 422
Naval Facilities Engineering Service Center
560 Center Drive
Port Hueneme, CA 93042-4328
(805) 982-3425 or DSN 551-3425

Vendors: The following is a list of powder coating system manufacturers. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

Coating Manufacturers:

Cardinal Industrial Finishes
Powder Coating Division
901 Stimson Avenue
City of Industry, CA 91745
Phone: (818) 336-3345, Fax: (818) 336-0410

EVTECH
9103 Forsyth Park Drive
Charlotte, NC 28273
Phone: (704) 588-2112, Fax: (704) 588-2280

Farboil Company
8200 Fischer Road
Baltimore, MD 21222
Phone: (410) 477-8200, Fax: (410) 477-8995

Plastic Flamecoat Systems, Inc.
3400 West Seventh Street
Big Spring, TX 79720
Phone: (800) 753-5263, Fax: (915) 267-1318

Pratt & Lambert Inc.
Powder Coatings Division
40 Sonwil Drive
Cheektowaga, NY 14225
Phone: (716) 683-6831, or Customer Service (800) 777-6831
Fax: (716) 683-6204

Equipment Manufacturers:

Nordson Corp.
555 Jackson Street
Amherst, OH 44001
Phone: (216) 988-9411, Fax: (216) 985-1417

Sames Electrostatic, Inc.
555 Lordship Blvd.
Stratford, CT 06497
(203) 375-1644

Gema
3939 W. 56th Street
Indianapolis, IN 46208
Phone: (317) 298-5001, Fax: (317) 298-5059

Contact NAVAIR Code 530 (Ref. R 1820022) for further approval authority for use on aircraft and aircraft components. Phone is (703) 692-6025; DSN 222-6025.

This recommendation should be implemented only after engineering approval has been granted by cognizant authority.

Source: Powder Coating Institute, 1987, Powder Coating Today p.l0
Miser, Toako A. 199l. Powder Coatings Chemistry and Technology, Chapter 6, Powder Application Techniques.
'Reducing Waste in Railcar Coating Operation Graco Equipment and Emissions Update, June 1994 pp. 8-9.