The What, Why & How of Powder Coating

A practical approach to powder coating justification.

Introduction to Powder Coating

What is powder coating, why should I consider using it, and how will it work in my operation, are questions that every finisher needs to be asking today.

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The Global Leader in
Powder Coating Technology

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A Practical Approach to Powder Coating Justification

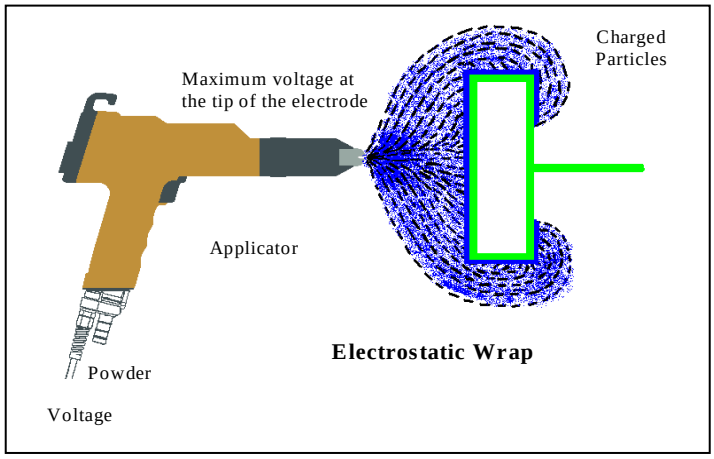
What is powder coating, why should I consider using it, and how will it work in my operation are questions that every finisher needs to be asking today. Briefly, these questions can be answered as follows: 1) powder is a dry, clean finish that gives a highly durable coating, 2) in the long run, powder will save you money, and 3) a powder coating system can be designed to meet just about any requirement your operation may have. The purpose of this booklet is to explain quickly and simply how powder coating delivers these highly desirable solutions to many finishing problems, and to provide you with a practical, worksheet approach, to help you decide if moving to powder is the right move for you.

Over the past decade powder coating has been increasingly accepted as the preferred finishing process for the future. The reasons for this conversion from wet to dry can be attributed to three major forces: economy — the high cost of energy and materials require a more cost effective and less wasteful process; excellence — consumers, and other end users, are demanding higher quality and more durable finishes; and ecology — progressively more stringent regulations are being aggressively enforced in an effort to control air pollution and hazardous waste disposal. Which in turn goes back to economy. The cost of complying with the Regulations and the disposal of toxic and flammable waste are constantly rising.

Many companies have found that it is less expensive to convert to powder than to bring their wet systems into compliance!

With strong financial arguments providing the necessary stimulus, therefore, powder coating technology has evolved quickly. The quality and variety of powders available have grown as an increasing number of companies get involved with its production; and the technology for spraying the powder, collecting it and reusing it, is constantly improving transfer efficiencies and material utilization, and reducing color change times. Early perceptions that powder was too difficult to control, too costly to install, too time consuming for color change, or did not provide enough choice of color are largely obsolete today.

But the move to a totally new technology can still be confusing. This brochure is designed to make your decision easier, providing both explanations and justifications to help determine the right solution for you. So let's start at the beginning and work through the questions.



What is Powder Coating?

Powder is a dry coating. Instead of being dissolved or suspended in a liquid medium, such as solvent or water, powder is applied in a granular form. This material is finer than ground pepper but coarser than flour, and is applied directly to the surface to be coated.

The powder is created by blending the various components (binders, resins, pigments, fillers and additives) and processing them through an extruder into a continuous mass. This homogenous mass is cooled and broken into small chips, which are then ground into the powder. Each powder particle contains within it the necessary components for reforming into the finished coating. After the powder is applied to the part, typically using an electrostatic spray process, the part passes through an oven and cures, melting into a smooth film on the surface of the part.

Powder Formulation

There are two distinct types of powder, Thermoset and Thermoplastic. The Thermoset powders are reactive, which means that under cure conditions there is a chemical "crosslinking", so that, once cured, the coating will not remelt. Epoxies, acrylics and most hybrids are examples of Thermoset powders, making up over 90% of the current powder market.

Thermoplastic powders do not "crosslink" when cured, but simply melt and flow over the surface of the part. The film hardens on cooling, but if it is reheated it will remelt. Vinyls, nylons and fluorocarbons are examples of thermoplastic powders.

Enamel powder is a specialized formulation used in applications that previously used liquid porcelain enamel. It utilizes glass in its formulation and is cured, or fired, at a very high heat. The result is a finish that is particularly resistant to heat, scratching and harsh chemicals, and is typically used in appliances, such as washers, dryers, ovens and ranges.

How is the Powder Applied?

The application process involves applying a charge to the dry powder particles and spraying them onto a grounded substrate. The substrate, or part, is typically grounded through the conveyor or hanger holding the part. The powder, once attracted to the part, is then held on the surface until it is melted and cured into a smooth coating film in the bake oven. The spray process takes place inside a booth designed to contain the oversprayed powder and makes it possible to collect the overspray and ultimately reclaim it for reuse.

The powder is fed pneumatically out of the powder container, or hopper, into the powder applicator, or gun. As the powder exits the gun, a low amperage, high voltage charge is applied to the powder particles, causing them to be attracted to the grounded workpiece. This attraction may even cause the powder to "wrap" around the piece, coating the back side.

The oversprayed powder, suspended in the air contained inside the powder booth, is then passed through a separation process that permits the powder particles to be retrieved from the air. The clean air is fed back to the work environment, eliminating the need for air make-up. The reclaimed powder is mixed with a proportionate amount of fresh, virgin powder for reuse achieving consistent results and up to 98% material utilization.

How Will Powder Coating Benefit My Operation?

Reviewing the potential benefits of powder coating will give you an incentive to proceed with the quest for the best finish for your operation. So let's look at the three "E's" of powder coating in more detail.

Economy

1. Material utilization is much higher with powder, making your material costs much lower. 92% to 98% of the powder you buy will be applied to the parts you are finishing versus an average of 60% with an electrostatic liquid system (the other 40% is waste and must be disposed of!)

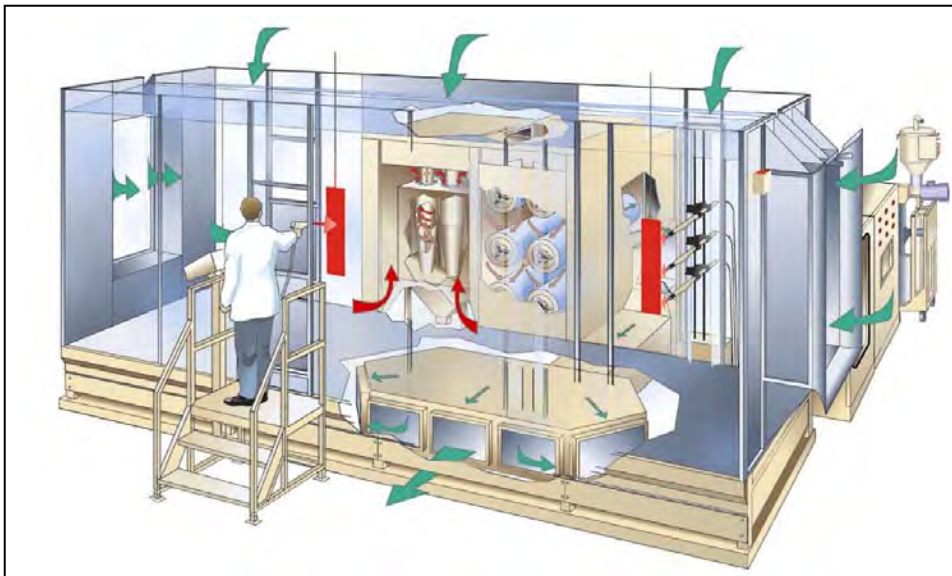
2. Since most of the material is used on the part, there is very little waste to be disposed of. And powder is not considered hazardous waste, so the cost of disposal is minimal compared to the high cost of toxic waste disposal.

3. Air used to exhaust the powder spray booth is returned directly to the plant, eliminating heating and cooling costs for the make-up air required when air is vented outside the plant.

4. Air loss from the curing oven is minimized as there is only a very small amount of volatile substance that must be exhausted. The cost of maintaining oven temperatures is therefore minimized also.

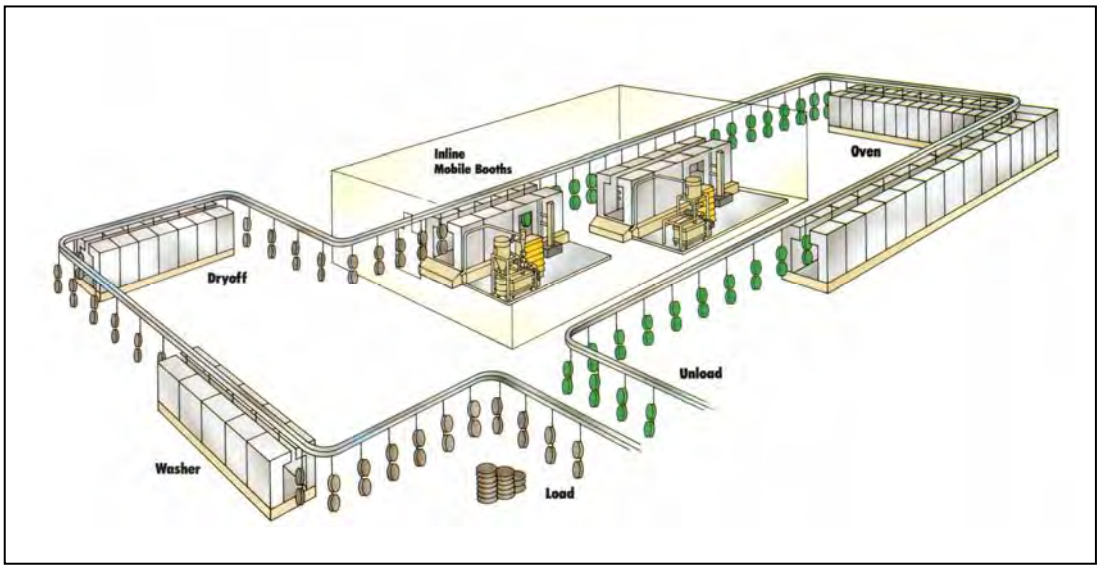
5. Powder is simpler to spray, so less skilled labor is needed, training is easily done and fewer errors are made in coating. All of which saves scrap, labor and, ultimately, operating costs.

6. Most powders require no primer, providing more savings in time and materials.



Excellence

1. The cured powder finish is less susceptible to damage than a liquid finish. There is less need for repair work on the finished item, and packaging is less elaborate, saving time and cost on rework and packaging.



2. Epoxy, acrylic and hybrid powders provide excellent adhesion and hard-ness for improved resistance to chipping, abrasion, corrosion, and chemicals; and it's flexible enough to be formable without cracking.

3. Polyester powders provide additional advantages in ultraviolet and weathering resistance.

Ecology

Powder is the overwhelming preference of the EPA, eliminating:

1. Solvent fumes and VOCs from spray booth and oven exhausts that pollute the air.

2. Potentially toxic sludge and water that can contaminate the earth and must be disposed of as hazardous waste.

How Will a Powder System Work in My Operation?

Powder systems are available in all degrees of technical sophistication, and can be designed to meet a wide range of requirements for performance, cost and space constraints.

From a basic manual, one gun operation with a batch booth, to a highly complex multi gun, totally automated configuration, there are guns, booths and other peripherals for all occasions.

Application Equipment

The guns are all essentially similar in their function of spraying the powder. Each gun has a control unit that regulates the voltage being generated and the rate at which the powder is delivered from the hopper. Areas to review when selecting the application equipment are the efficiency of the charge, the consistency of the powder flow, and the accuracy with which both can be adjusted to provide the right level of performance. Once the optimal settings have been established it is important that they can be repeated systematically each time they are used.

Booths and Recovery

Powder booths are also basically similar, but use two distinct types of recovery equipment, cartridge filters or a cyclone separator. Each style is particularly suitable for a different type of application. To select the appropriate system you should consider the production batch size, and the number of different types or colors of powder being used and the frequency with which they are changed. The finished quality of the desired coating should also be considered when making the selection.

Therefore, prior to starting your search for the perfect powder system, you should have a clear picture of what you need and what factors are important to your operation. If you expect to change powders frequently, then a fast color change time will be high on the list of necessary features; if, however, you do long runs using the same powder throughout, then a highly efficient reclaim system will be more critical. If the parts are all the same then automatic guns may be cost effective, but if they are intricate structures that are difficult to coat, manual operators may make more sense.

Now that we have covered the basics you should have a better idea of what powder is all about. On the following pages are some work sheets that will show you just how powder can deliver savings to your operating costs. After working through them, you may be surprised at how quickly a powder system may pay for itself — and it will keep you in compliance, no matter how much more stringent the regulations become!

A Glossary of Common Powder Coating Terms

Back Ionization: An excessive build up of charged powder particles which may limit further powder being deposited on the substrate. The electrical charge on the surface layer may be reversed, repelling additional powder.

Bulk Density: Mass per unit of volume in powder form including the air trapped between particles.

Cartridge Filter: A cylindrical filter unit used to separate oversprayed powder from air for recovery and reuse.

Corona Charge: The process of inducing a static electric charge on powder particles by passing the powder through an electrostatic field generated by a high voltage device.

Cure Schedule: The time/temperature relationship required to properly fuse a powder coating.

Cyclone: A type of recovery unit using a centrifugal process to separate oversprayed powder particles from an air flow.

Delivery: The process of moving the powder through the application equipment to the end product.

Edge Coverage: A powder's ability to flow over, build and adhere to sharp corners, angles and edges.

Electrostatic Spray Technique: A deposition method of spraying and charging powder so that it is deposited on a grounded substrate. (See Corona charging and Tribo charging.)

Faraday Cage Effect: A condition that may exist on a substrate due to its geometric configuration that may inhibit the electrostatic deposition of powder particles at a specific localized area.

Film Formation: The forming of a continuous film by melting powder particles and fusing them together by the application of energy.

Fluidizing: The process of suspending the powder in a continuous stream of air giving it "fluid" characteristics. Used to facilitate transfer of the powder to the application device.

Fusion: The melting and flow of individual powder particles when heated to form a continuous film.

Grounding: The electrical grounding of the item to be coated.

Impact Fusion: The combining of powder particles to form a solid mass during the delivery and application process.

Lower Explosive Limit (LEL): The lower point for a range of concentrations of organic particles suspended in air which can be ignited by a sufficient energy source.

Micron/Mils: Common unit of measurement of coating thickness. 25.4µ (microns or micrometers) = 1 mil (one thousandth of an inch)

Particle Size: Average diameter of an individual, irregular powder particle.

Recovery: The process of removing non-deposited powder from the air prior to reclaiming it for reuse.

Spray Booth: A specially designed enclosure in which powders are introduced, contained and recovered during the coating process.

Surface Appearance: Generally refers to the smoothness and gloss of powder coating films and the presence and degree of surface defects.

System Utilization or System Efficiency: The combined efficiencies of each component in the powder coating system resulting in total material usage compared to the amount of material entered into the system.

Transfer Efficiency: The ratio of the powder deposited on the workpiece compared to the amount of powder sprayed during a fixed time period.

Tribo Charging: Process of creating a static electrical charge on powder particles by creating friction between them and a nonconductive material.

Virgin Powder: Powder that has not been previously sprayed as opposed to reclaimed powder.

Wrap: A characteristic of electrostatic application for the powder to seek out and adhere to parts of the substrate not in direct line of sight of the delivery point.

Finishing Line Components

Components	Liquid Paint	Powder
Power Spray Washer	3-5 Stage	3-5 Stage
Substrate Coating	Iron/Zinc Phosphate	Iron/Zinc Phosphate
Passivating	Chromic or Phosphoric Compound	Chromic or Phosphoric Compound
Dry-off Oven	Yes	Yes-may be combined with Bake Oven
Cool-off	Yes	Yes
Spray Booths	2 Automatic 1 Manual	1 Automatic 1 Manual (or Combination)
Flash-off Tunnel	Yes	No
Average Bake Oven Time/Temperature	20 mins/300°F	15 mins/360°F
Solvent Exhaust	Yes	No
Conveyor	560 ft.	375 ft.
Air Make-Up Required	Yes	No
Paint Mix Room	Yes	No
Paint Circulating or Routine Maintenance	Minimum Once/Day	Minimum Once/Day
Average Maintenance Time/Gun	10 min.	2 min.
Major Cleaning (Except Color Change)	Minimum Once/Week	Minimum Once/Week
Average Cleaning Time (Except Color Change)	2 Hours	1 Hour

Film Thickness

1 mil = 0.001 inches
1 mil = 0.0025 cm
1 mil = 0.025 mm
1 mil = 25.4 microns

1 micron = 0.0000394 inches
1 micron = 0.0394 mils
1 micron = 0.0001 cm
1 micron = 0.001 mm

Typical Material Cost Comparison

Low Solids Paint	High Solids Paint	Powder
Cost: $12.00 per gal (mixed) Solids Content: 35% (mixed) Efficiency: 50% (E.S. Air Spray) Coverage per mil thickness: .50x.35x1,600* = 280 sq.ft./gal	Cost: $17.00 per gal. (mixed) Solids Content: 55% (mixed) Efficiency: 80% (Hi Speed Bell) Coverage per mil thickness: .80x.55x1,600* = 704 sq.ft./gal	Cost $3.00 per lb. Specific Gravity: 1.4 Volume Solids: .99% Utilization: 98% Coverage per mil thickness: .98x193**x.99 = 134 sq.ft. per lb. SG 1.4
Applied cost per mil thickness: $12.00 = **$0.0428 per sq.ft.** 280	Applied cost per mil thickness $17.00 = **$0.024 per sq.ft.** 704	Applied cost per mil thickness: $3.00 = **$0.0223 per sq.ft.** 134

* 1,600 sq.ft. per gallon of paint @ 1 mil thickness with 100% efficiency and 100% solids is industry standard.
** 193 sq. ft. per pound of powder @ 1 mil thickness with 100% efficiency and 100% solids is industry standard.

Clean-Up and Waste Disposal Comparative Worksheet

Variables	Paint	Powder
A. Clean-up frequency	52 per year (typical)	12 per year (typical)
B. Number of operators	2 (minimum)	2 (typical)
C. Hourly rate plus fringe	$ _____	$ _____
D. Hours required	8 hours (typical)	2 hours (typical)
E. Clean-up cost per year: **AxBxCxE = $/yr.**	52 x 2 x _____ x 8 = $_____/yr.	12 x 2 x _____ x 2 = $_____/yr.
F. Disposal cost	$ _____ /bbl	Not applicable
G. Waste Volume per year	_____ bbl per year	Not applicable
H. Disposal cost per year: **FxG = _____ $/yr.**	_____ x _____ = $ _____/ yr.	Not applicable
Total Clean-Up and Waste Disposal Costs per Year: **E + H = $ _____**	_____ + _____ = $ _____	_____ + _____ = $ _____

Alternate Material Cost Worksheet

Material cost is usually the largest single operating cost of any production finishing operation. This worksheet is designed to compare applied material costs. Applied cost is a function of the cost and solids content of the coating material as it is actually applied, material utilization efficiency (recognizing that liquid paint overspray is lost forever), and the thickness of the applied coating.

	Waterborne Paint	**Solvent Paint**	**Powder**
A. Coating cost	_____$/gal.	_____$/gal.	_____$/lb.
B. Percent volume solids (as received)	_____ %	_____ %	98 %
C. Specific gravity	Not Applicable	Not Applicable	
D. Additive (solvent or water) cost	_____$/gal.	_____$/gal.	Not Applicable
E. Percent of additive (solvent or water) per gallon of mixed paint*	_____ %	_____ %	Not Applicable
F. Cost of usable coating (as sprayed) (D x E) + [A x (1-E)]	_____$/gal.	_____$/gal.	Not Applicable
G. Volume solids, usable coating B(1-E)	_____ %	_____ %	_____ %
H. Dry film thickness	_____mils	_____mils	_____mils
I. System utilization efficiency	_____ %	_____ %	_____ %
J. Coverage, sq.ft./gal.	(1600xGxI)/H or 1600 x G x I H mils 1600 x ___ x ___mils =_____sq.ft./gal	(1600xGxI)/H or 1600 x G x I H mils 1600 x ___ x ___mils =_____sq.ft./gal	(193xBxI)/(CxH) or 193 x B x I (CxH) mils 193 x ___ x ___mils =_____sq.ft./gal
K. Applied cost, $/sq.ft.	(F/J) or _____ / _____ = $_____/sq.ft.	(F/J) or _____ / _____ = $_____/sq.ft.	(A/J) or _____ / _____ = $_____/sq.ft.

* Suppliers recommended reduction ratio = P:S
where P = Gallons of full body paint
and S = Gallons of solvent

Applications

Appliance

Air conditioners & water heaters
BBQ grills
Clothes washer tops & lids
Dishwasher doors & racks
Dryer Drums
Floor cleaners
Freezer liners, racks & cabinets
Microwave ovens
Mixers & blenders
Range hoods & panels
Refrigerator liners, shelves & cases
Sewing machines

Automotive

Air conditioner components
Battery trays & brackets
Brake disk pads
Coil springs & seat frames
Door handles & cranks
Glove compartment latches
Interior panels
Light truck bodies
Mirror brackets & roof racks
Oil & air filter housings
Shock absorbers & hatchback lifters
Starter & wiper motors
Steering wheels & gears
Sport car louvers
Valve covers & fans
Voltage regulator housings
Wheel opening & fender molding
Wheels & bumpers

Building & Architectural

Aluminum extrusions
Concrete reinforcement bars
Exterior building panels
Highway guard rails, poles & signs
Interior partitions & shelving
Ornamental facades & railings
Prefab storage building panels
Posts, rails & fencing
Window & door screening

Electrical

Electrical control housings & panels
Electrical stators & coils
Electronic cabinets
Fluorescent light fixtures
Ignition boxes & timers
Outdoor lighting fixtures
Pad & pole transformers
Recorders & control instruments
Satellite dishes
Switch gears & bus bars
Telephone coin boxes & apparatus
TV antennas

Furniture

Filing cabinets
Hospital beds
Lockers & benches
Metal office partitions
Office chair bases
Patio & wrought iron furniture
Store, library & warehouse shelving
Tubular furniture

Fabricated Metal & Miscellaneous Products

Bicycle frames & parts
Door & safe hardware
Flexible gas connectors
Gym & playground equipment
Hand tools
Luggage frames
Metal Cans
Metal stamping & die cast parts
Oil & gas transmission pipes
Plumbing & marine hardware
Mail boxes & letter sorters
Ski poles & equipment
Swimming pool accessories
Tennis racquet frames
Toys & recreational equipment

Farm, Garden & Industrial Machinery

Commercial Ice Makers
Conveyor part
Farm implements
Feed storage silo components
Garden sprayers
Garden tractors & mowers
Irrigation sprinklers & pipe systems
Lawn spreaders & seeders
Livestock gates & waterers
Office machines & computer cabinets
Power saws & tools
Pumps, blowers & exhaust fans
Solar heating panels & equipment
Textile & printing machinery
Waste treatment equipment

Gema

Your global partner for high quality powder coating

Benefit from our knowledge based on more than 40 years of electrostatic powder coating experience.

From simple manual coating units to fully automated powder coating systems, we offer the best possible solution to satisfy all of our customers in different countries and in different market segments, customers who all have their own individual needs and requirements. Our worldwide network guarantees professional service anywhere, anytime!

We make our customer's products more durable and atrractive. Our finishing experts create the technologies, processes and materials that regularly set the standard for the industry.

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