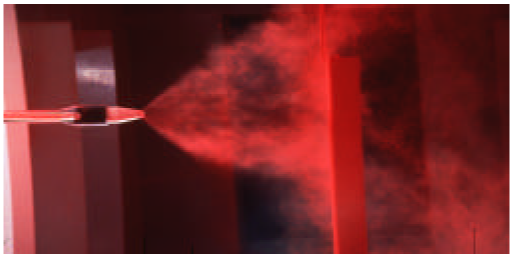

TECHNICALHELP4U

Powder Coating Made Easy

Powder Coating 101

TECHNICALHELP4U

Powder coating made easy: Powder Coating 101

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Introduction

Powder coatings is a great industry. Powder has ran through our veins for over 16 years, it is not new to us and we have literally done every single job associated with this industry with the exception of the raw material side. Our contributors have formulated, manufactured, developed, managed, troubleshoot, applied and consulted. Powder can make you laugh and it can make you cry. This manual is targeted at the person who wants to do it right. The person who is tired of getting rejects and field failures on their parts. Where applicable, shortcuts and money saving tips are incorporated. However, at no time do we cut out safety or quality. These are the traits of a successful manufacturer. If you want to do it cheap and don't care about safety or quality, then we suggest you read no further. We wish you good luck.

Over the years we have seen entrepreneurs with barely enough money for rent and a powder gun become millionaires and seen millionaires with huge facilities go bankrupt. Where you end up is directly proportional to how seriously (and at times - unserious) you take this business.

Regardless of your current skill level in the industry, you will find this manual will serve your needs. From the novice hobby coater to the OEM applying millions of pounds annually, this manual has valuable information for you.

Powder Coating can fall into the following categories:

- *Powder coating for hobby*
- *Powder coating job shop*
- *Powder coating for an OEM*

Eventually we end up crossing into each category. Every single powder coating line at one time or another is used for hobby, or 'government' work. Job shops may end up making certain parts for sale which they sell outright becoming OEM''s. OEM's may have excess line capacity which they end up using to do job shop work.

Research is imperative when deciding which industry you will serve with powder coating. Find your niche, do quality work at a reasonable price and you will be successful. Some areas which are hot right now include refinishing wheels, coating temperature sensitive parts such as wood or plastic and doing OEM work

Chapter
1

What is Powder Coating?

Although powder coating has been used for over 30 years, it has only been over the past decade that powder has hit mainstream use in industry, hobbies and art.

Powder Coating is basically a dry paint. Instead of being dissolved or suspended in a liquid medium: such as, solvent or water, powder is applied in its dry form, finer than ground pepper, courser than flour, directly to the surface to be coated.

Each powder particle contains resin, pigments, modifiers, extenders and if it is a reactive system, a curing agent. Most powder coatings are reactive and contain curing agents.

The term for these reactive powder coatings is: ***Thermoset***
The term for the non-reactive powder coatings is: ***Thermoplastic***

Ingredients used in the manufacture of powder coatings.

Why should we use Powder Coatings?

Powder Coating offers a number of significant advantages:

* Absence of solvents
* Applied in one coat - high standard of finish with good edge coverage
* Few rejects
* Resistant to chipping, scratching, abrasion and bending
* Easy to apply
* Cleaner working conditions
* Virtually no atmospheric pollution, very little or 0% VOC!
* Safety in use and on storage, low fire hazard
* Insurance premiums may be lower
* No viscosity adjustments
* Savings in overall costs possible

Powder coatings are electrostatically applied to parts using either a fluidized bed or electrostatic spray. The part to be powder coated is grounded and the powder is charged, this attracts the powder to the part, much like a magnet attracts steel.

This charge holds the powder to the part and the part is then cured (baked) in an oven. A typical cure cycle would be 15 minutes at 380 F. Cure cycles always refer to the amount of time the part is at the temperature specified, not how long it is in the oven

Due to the significant advances in formulating, manufacturing and application technologies over the past 15 years powder is used in many areas previously not thought possible.

Powder coatings are daily applied in shops ranging from custom job shops to the world's largest manufactures. Metal, plastic, wood, composite and glass substrates can be coated provided the part does not deteriorate or distort at the cure temperature of the powder. Current low temperature technology allows for cure in the 250F range.

Office Furniture, General Metals, Engine Parts, Light Fixtures, Industrial Shelving, Computer Cases, Toolboxes, Medical Equipment, Barbeque and Gas Grills, Appliances, Ceramic bottles, Ceramic flash/instrument bulbs, Ceramic roofing tile, Wooden toilet seats, Kitchen cabinets, Home-office furniture, Outdoor grill tables, Children's furniture and many other items can be successfully powder coated.

How are Powder Coatings Made?

Powder coatings are manufactured using an extruder, or compounder, which melt mixes the raw materials together. This mixed material is then flattened and cooled and then subsequently ground down to the appropriate particle size for application.

This is an example of an extruder used in the manufacture of powder coatings. This particular one is manufactured by APV.

This is an example of a grinder used in the manufacture of powder coatings. This particular one is manufactured by PPS in England.

Powder Coating Types: Thermoset Powder Coating

Thermosetting powders are primarily composed of relatively high molecular weight solid resins and a crosslinker. The primary resins used in the formulation of thermosetting powder are:

**** Epoxy***
**** Polyester***
**** Acrylic***

These primary resins are used with different crosslinkers to produce a variety of powder coatings. There are many crosslinkers used in powder coatings, including amines, anhydrides, melamines, and blocked or non-blocked isocyanates. Some formulations also use more than one resin in hybrid formulations.

When a thermoset powder is applied and subjected to heat it will melt, flow and chemically crosslink to form a finished film. Chemical reactions during the curing cycle create a polymer network which provides excellent resistance to coating breakdown. Once cured and crosslinked, this polymer network will not melt and flow again if heat is applied.

Powder Coating Chemistry: Thermoplastic Powder Coating

Thermoplastic Powders do not chemically crosslink upon application of heat, but melt and flow over the part in the oven. As the part cools, after exiting the oven, the film hardens, but will remelt upon application of sufficient heat. The primary types of thermoplastic powders are:

**** Polyethylene***
**** Polypropylene***
**** Nylon***
**** Polyvinyl Chloride***
**** Polyester***
**** Polyvinyledene flurides/fluorcarbons***

Thermoplastic powder coatings are based on thermoplastic resins of high molecular weight. The properties of these coatings are dependent on the basic properties of the resin. These tough and resistant resins tend to be difficult, as well as expensive, to grind to the very fine particles necessary for the spray application and fusing of thin films. These systems are used more as thicker coatings of many mils thickness and are applied mainly by fluidized bed technique. Most powder coaters do not apply these.

Thermoset Powder Coating Types: Epoxy Powder Coatings

The epoxy family of powder coatings is the most prominent type of thermosetting powder in use today. The listing of available epoxy formulations is quiet extensive because of the wide formulating latitude that exists. These materials, as is all thermoset powder coatings, consist of resins, crosslinker or hardener, reinforcing fillers, pigments, processing aids, flow agents and other modifiers. A change in the type or the amount of any one of these constituents can noticeably change the properties and performance characteristics of the final product.

Epoxy powder coatings are generally custom formulated to the specific decorative and performance requirements of a given end use. Unfortunately, the epoxy resin based powder coatings have two major deficiencies - they discolor if overbaked and chalk on exterior exposure.

Typical Applications include: Fire Extinguishers, Toys, Mixers & Blenders, Oil Filters, Shelving, Dryer Drums, Fertilizer Spreaders, Refrigerator Racks, Microwave Ovens, Primers, Tools, Kitchen Furniture.

Thermoset Powder Coating Types: Epoxy Hybrid Powder Coatings

This group of powder coatings could be considered part of the epoxy family except that the high percentage of polyester (or Acrylic) utilized (often in excess of half of the resin) makes that classification misleading. Property wise, however, these hybrid coatings are more closely akin to epoxies than polyesters, with a few notable exceptions. They show similar flexibility in terms of impact and bend resistance, but are slightly softer in pencil hardness - H to 3H being characteristic. Their corrosion resistance is comparable to epoxies in many cases, but their resistance to solvents and alkali is generally inferior.

A major advantage of these hybrids, due to the influence of the polyester or acrylic component, is a higher resistance to overbake yellowing in the cure oven. This also translates to improved weatherablilty. These systems will begin to chalk almost as fast as an epoxy, but the deterioration is slower and the discoloration less severe. These systems also have excellent electrostatic spray characteristics with high transfer efficiency and penetrate well into corners and recesses.

Typical Applications include: same end use as epoxies, especially if a slight improvement in heat stability or weathering is required.

Thermoset Powder Coating Types: Polyester Powder Coatings

Polyester powder coatings can be broken down in three groups:

Polyester Urethane: Hydroxyl functional resin cured with a blocked Isocyanurate

Polyester TGIC: Carboxyl functional resin cured with Triglycidyl Isocyanureate

Polyester TGIC Free: Carboxyl functional resin cured either with Tetramethoxymethyl Glycoluril or with Beta-hydroxyalkylamide

All three types of Polyester powder coatings have very good exterior weathering properties and are generally used for outdoor applications.

Thermoset Powder Coating Types: Polyester Urethane Powder Coatings

The primary type which has been in use for the past number of years is a urethane cured polyester powder which is comparable chemically to the exterior quality urethane paints which have been used on aircraft, buses, trucks and railroad cars for the past 17+ years.

Coatings of this type combine outstanding thin film appearance and toughness with excellent weathering properties. They are true competitors to high quality liquid paints, exhibiting superior chip, mar and scuff resistance at 1.5 mils thickness. Adhesion to properly prepared ferrous and nonferrous metals is excellent, providing long term resistance to humidity and salt spray.

These formulations must reach a temperature of at least 360 F before crosslinking can occur. This is due to the fact that the curing agent is blocked with e-Caprolactam to prevent cure at ambient temperatures. These powders are sensitive to films thicker than 3 mills due to the fact that the e-Caprolactam evolution can cause outgassing at thicker films.

Thermoset Powder Coating Types: Polyester TGIC Powder Coatings

This type of polyester is based upon technology developed in Europe. These products can best be described as more exterior durable cousins of the epoxy polyester hybrids - the difference being that instead of using a conventional epoxy resin to co-react with the polyester, a very low molecular weigh glycidal or epoxy functional, curing agent is used.

Overbake color stability, as with epoxy polyesters, is also excellent. Their adhesion and corrosion resistant properties are comparable to the urethane cured polyester, but their resistance to chemicals and solvents is lower. A significant advantage is the fact that these can typically be cured at lower temperatures, for shorter periods than urethane or TGIC Free systems. Cure cycles as low as 6 minutes at 300 F are attainable. TGIC formulations also provide good overbake and outgassing characteristics making them friendly to apply.

The higher melt viscosity of the TGIC crosslinker also results in good edge coverage and tough thick films, but also results in a slight orange peel effect.

Thermoset Powder Coating Types: Polyester TGIC Free Powder Coatings

These formulations were developed in response to industry concerns regarding the possible side effects from overexposure to the curative Triglycidyl Isocyanurate. These exhibit similar performance and application properties as TGIC formulations do.

With TGIC Free formulations it is possible to develop the much desired 'wrinkle' texture effect. An increased resistance to film discoloration and yellowing of the coating is realized with these formulations.

Example of a toolbox coated with a wrinkle powder coating. Kennedy Mnfg.

Thermoset Powder Coating Types: Acrylic Powder Coatings

Acrylic formulations give excellent exterior durability. There are two classifications of acrylic formulations. Urethane Acrylic and GMA Acrylic.

Thermoset Powder Coating Types: Urethane Acrylic

These formulations are similar in properties to Polyester Urethane products, offering excellent thin film appearance, good chemical resistance and hard durable films. The flexibility and impact of these is very poor due to the high crosslink density of the cured film.

Thermoset Powder Coating Types: GMA Acrylics

These are also similar in properties to Polyester Urethane products. They make excellent clear coats over brass and chrome, being ideal for bath fixtures and automotive wheels. These however also exhibit poor flexibility and more importantly are highly incompatible with all other powder chemistries. This requires the manufacturers and users to utilize isolated systems to prevent cross contamination.

Comparison of Properties

Chemistry / **Property**	Epoxy	Hybrid	Polyester Urethane	Acrylic	Polyester TGIC & TGIC Free
Pencil Hardness	HB - 7H	HB - 3H	HB - 4H	H - 4H	HB - 4H
Impact Resistance (in - lbs)	40 - 160+	40 - 160	40 - 160+	40 - 100	40 - 160+
Gloss (60 Degree Meter)	3 - 100+	10 - 100+	5 - 95	10 - 90	10 - 95
Condensing Humidity	1,000 hrs.	1,000+ hrs.	1,000 hrs.	1,000+ hrs.	1,000+ hrs.
Salt Spray	1,000 hrs.	1,000+ hrs.	1,000 hrs.	1,000+ hrs.	1,000+ hrs.
Cure Range	3 min @ 450F - 25 min @ 250F	10 min @ 400F - 25 min @ 300F	10 min @ 400F - 20 min @ 360F	10 min @ 400F - 25 min @ 350F	10 min @ 400F - 30 min @ 300F

These products are available in all color shades and a variety of textures.

Comparison of Properties continued

Generic Powder	Typical Properties	Typical Applications	Relative Cost
Hybrid	Very good chemical resistance	Water Heaters, Radiators Transformer covers, Office Furniture, Shelving	1 (least expensive)
Epoxy	Excellent chemical resistance & properties Poor exterior color/gloss retention	Metal Furniture, Auto Parts, Microwave Ovens, Shelving, Appliances	2
Polyesters	Good chemical resistance Very good mechanical properties & exterior color gloss retention	Automotive Wheels, Light fixtures, Above Ground LP Containers	3
Acrylic	Very good chemical resistance Poor flexibility	Oven Parts, Washing Machines, Aluminum Extrusions	4 (most expensive)

Chapter 2

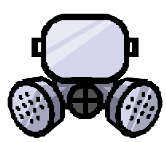
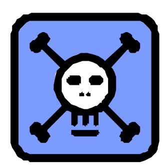
Powder Coating Health & Safety

Powder Coating is inherently significantly safer to use than solvent borne paints. However there are some points to keep in mind.

Powder coatings are a significantly safer and environmentally friendly alternative to traditional solvent borne paints. This is due to the fact these are 100% solids, with little or no VOC's. Powder coatings contain polymers, curing agents, pigments and fillers which, like any industrial chemical, require safe operator handling procedures and conditions.

Some powder formulations may contain heavy metals such as lead, mercury, cadmium and chromium. The handling of materials containing such elements is controlled by OSHA regulations.

Powder Coatings should be handled in a manner such as to minimize both skin contact and respiratory exposure consistent with particular Material Safety Data Sheet (MSDS) recommendations.


The opening of, discharging of powder from, and handling of empty containers such as boxes and bags often presents the greatest worker exposure, even with well-designed systems. Engineering practices, personal protective equipment and good personal hygiene should be used to limit these exposures. In a well-designed spray operation, there should be negligible exposure of operating employees to dust.

Powder coatings, because of their fine particle size and frequently large percentage of TiO2 will absorb moisture (hydroscopic) and oil readily. If powder is left in contact with the skin for an extended period, it will tend to dry out the skin. To prevent this, gloves and clean clothing should be worn by the workers. Operators of manual electrostatic guns must be grounded.

To prevent carrying powder away from work, cloths should be changed prior to leaving the workplace. If powder does get on the skin, it should be washed off at the earliest convenient time and at least by the end of the day. Some workers may show skin reactions to powder. These individuals must be especially careful to wash frequently. The practice of washing the skin with organic solvents is an unsafe practice that should be forbidden.

Cleaning with soap and water is the appropriate hygienic practice.

General Powder Coatings Health and Safety Points:

*Be sure to review the MSDS for your specific products.

<u>Extinguishing Media</u>: Use carbon dioxide, dry chemical or foam.

<u>Conditions to Avoid:</u> Excessive heat and direct sunlight

<u>Materials to Avoid:</u> Strong oxidizing agents.

<u>Hazardous Decomposition or Byproducts:</u> Thermal decomposition may yield carbon dioxide, carbon monoxide, smoke and various toxic fumes.

<u>Inhalation Health Risks:</u> Potential respiratory tract irritant.

<u>Skin and Eye Contact Health Risks:</u> Potential skin irritant, may dry out skin. Sensitive individuals should use a barrier lotion and avoid prolonged skin contact. Eye contact may be abrasive, therefore contact lens use is not recommended or use safety goggles.

<u>Steps to be taken in case material is spilled:</u> Wear appropriate protective clothing and respirator to prevent overexposure. Sweep up material taking care not to generate airborne dust. Collect into closable containers for proper disposal. Prevent runoff to storm sewers and ditches leading to natural waterways.

<u>Waste Disposal:</u> Dispose in accordance to local, state and federal regulations.

<u>Precautions to be taken in Handling and Storage:</u> Protect containers from physical damage.

Store in a cool (~75F), dry area out of direct sunlight. Avoid eye and prolonged skin contact.

Avoid breathing dusts during application. Wash thoroughly after handling.

Respiratory Protection: Use NIOSH approved respirator with a dust/mist cartridge if needed. Selection of respiratory protection depends on the contaminant type, form and concentration. Select in accordance with OSHA 1910.134 and good industrial hygiene practice.

Ventilation: Provide adequate general or local exhaust ventilation in volume and pattern to remove decomposition products during baking, welding or flame cutting of parts powder coated.

Sprinklers and fire detection equipment is required in the powder booth in many states. This is always a wise practice. Even non-flammable powder coatings, when in an atomized state (powder and air mixture) can support a fire if exposed to an ignition source. A stray spark between an ungrounded part and gun could be an ignition source. If a fire is detected and the supply of powder is shut of, the fire from the guns will stop.

Please review OSHA CFR 1910.107(h)(12) as well as NFPA 33, Standard for Spray Application

For specific information on compliance issues related to your powder coating operation, consult your local agencies governing fire, plant safety and environmental requirements.

You may also wish to reference the following:
NFPA 33 Standard for Spray Application using Flammable or Combustible Materials
NFPA 68 Guide for Venting of Deflagrations
NFPA 69 Explosion Prevention Systems
ANSI Z9.3 Spray Finishing Operations - Safety Code for Design, Construction & Ventilation.
U.F.C. Part V Article 45

Chapter

3

Powder Coating Pretreatment

The key to successful powder coating is starting with a clean part. To maximize the benefits of powder coating and reduce field failures, the use of these pointers is highly recommended..

Powder Coating unquestionably offers excellent physical qualities when it comes to adhesion, corrosion resistance and impact resistance. To maximize those characteristics, however, requires effective pretreatment.

In order to get the powder coating to adhere to the substrate, the metal must be prepared so that the full quality of the powder coated finish can be achieved. Proper pretreatment enhances the end result of the powder coating finish.

The pretreatment process is comprised of essentially two units of operation:

Cleaning and **Phosphatizing** (or conversion coating).

This is a part which is too dirty to be properly powder coated.

The Importance of Cleaning

Cleaning is the most important step in the pretreatment process.
The performance of the conversion coating and ultimately the powder coated finished product, will only be as good as the cleaning in this first unit of operation. In order for conversion coatings to adhere to the metal surface, all impurities must be removed from the surface of the substrate. Soils such as cutting fluids, drawing compounds, rust inhibitors, grease and oil, shop soil and common everyday dirt must be cleaned from the metal. In fact, the degree of cleanliness required for powder coating is higher than that required for liquid coatings.

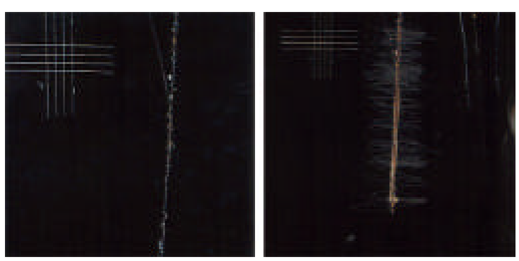
With liquid coating, if a small amount of oil, such as a fingerprint, is present on the substrate, liquid coating can pick that oil up, emulsify it and bring it into the paint coating itself without inhibiting adhesion. Powder coating, without a thorough cleaning, will plate right on top of the soil and subsequently lose adhesion.

Remember:
Without a complete cleaning, conversion coatings will not perform: Without proper conversion coating, the powder coating will lose performance.

The factors of a good cleaning system can be memorized with the acronym:

W.A.T.C.H.

Water **Action** **Time** **Chemical** **Heat**



After only a week on test the right panel (no pretreat) is already showing signs of corrosion (rust). The panel on the right is pretreated with an Iron Phosphate. After 1000 hrs on test the powder on the right came of in sheets. The panel on the left did not change.

The Fundamentals of Cleaning

The labor constraints of mechanical cleaning: sand blasting, shot blasting, air blasting or even wire brush have rendered the approach virtually non-existent in the modern powder coating operation.

Chemical cleaning is without a doubt the most popular approach.

Three Chemicals are used:

Alkalines
Acids
Solvents

Alkalines are the most popular. They are the most versatile and most widely used.

Acids in general are limited to soils that can be cleaned with an acid, mainly corrosion and scale. Acids tend to perform poorly on heavier oils and greases.

Solvents, on the other hand, are very good for oils and greases, but not much more. They are limited in their efficiency in that they will not touch corrosion and scale. The use of solvents also raises a number of environmental and occupational safety concerns. Most importantly for purposes of this discussion, the degree of cleanliness involved with a solvent cleaner is not suited for powder coating.

Effective cleaning involves careful consideration of these issues:

**** Substrate***
**** Soil***
**** Cleaning System***
**** Waste Treatment System***
**** Occupational Safety***
****Environmental Concerns***

Common Chemical Cleaning Systems:

The chemical cleaning system can be performed three ways:

1. immersion or soak tank, 2. spray wash, or 3. pressure wand.

Basically all receptacles to hold and dispense chemicals to the surface of the substrate.

Hand washing obviously represents the most basic approach to cleaning. It is extremely labor intensive and labor sensitive. The cleaning will only be as good as the person doing the job. Hand washing is not recommended prior to powder coatings. Soil is moved around, but never completely off, the surface of the substrate. This technique provides such inadequate cleaning that we do not recommend that it be employed prior to coating of any sort.

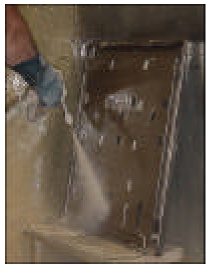
The next most fundamental system would be immersion or soak tank cleaning. This represents a step up from hand washing in which parts are immersed in a heated solution which helps to emulsify and remove the soils. An immersion system allows the handling of parts larger than those which can easily be hung on a conveyor system through a spray washer.

There is no impingement (physical scrubbing action) involved in an immersion system. The cleaning action is much like dipping dishes into soapy sink water and then simply rinsing them off. This type of approach would not provide proper cleaning without some physical scrubbing or spray working to remove dirt particles. Occasionally some systems will feature agitation that provides some impingement, but there is nothing in this approach, except the chemicals, that aids in the cleaning action.

Immersion is ideal, however, for cleaning strangely configured parts where the physical spray cleaner is unable to reach every area of the substrate surface due to limitations posed by the configuration. In an immersion system the part is completely submerged ensuring, absent an air pocket, that the cleaning chemical is covering the entire surface.

Immersion tanks are easily contaminated. Soil is always in suspension or in contact with the part being cleaned. To a certain degree this also happens in a spray washer, but spray washers are generally overflowed such that oil and grease soils are skimmed off at a constant rate and only the particles settle out to the bottom of the tank and are not being recirculated.

Pressure wand or nozzle washing is a hand spray system of pressure washers not unlike those found in the do-it-yourself carwash. Pressure wand washing offers the impingement, heat and chemicals important to good cleaning. It is a less than desirable approach because, like hand washing, it is operator intensive. If the operator performs well and reaches every area of the surface; the part will be clean. To miss just a spot puts the ultimate performance of the coated product in jeopardy.


Operator using a pressure wand to clean a part.

The most popular, all around system is spray washing. A power spray washer system offers all the factors of good cleaning. Spray washers hold the chemical in a tank from which cleaner is sprayed onto the metal. This approach provides the combination of impingement with the cleaning properties of the chemical to expedite the cleaning process. The important contact "Time" component of the W.A.T.C.H System is controlled in this approach ensuring the spray reaches the surface for exactly the same amount of time on each part.
When temperature is involved, the cleaning action is enhanced all the more.

Spray washers can be of any size, and can be configured in a customized manner to suit a variety of pretreatment requirements. One limitation to spray washing can be water quality which, when substandard, can impede the efficiency of the cleaning.


Example of a 5 stage washer system

Conversion Coating

The next step in the pretreatment process is conversion coating. A conversion coating is used on a metal substrate to provide adhesion and corrosion resistance.
There are three basic types of conversion coatings:

* Iron Phosphatizing

* Zinc Phosphatizing
* Chromic Conversion Coating

Iron Phosphatizing:

Iron phosphatizing is the easiest, most commonly used conversion coating for powder coated products. Iron phosphate coating can be used on steel, aluminum, zinc and galvanized. It leaves an amorphous rather than a crystalline coating. Iron phosphate coating converts the surface of steel to an iron phosphate type coating which will increase adhesion and decrease corrosion under the coating. Iron phosphatizing is easy to use and to maintain.
It is also less expensive, safe and easier to dispose of.

Zinc Phosphatizing

After iron phosphatizing, the most versatile and popular system with powder coating would be zinc phosphatizing. It achieves the quality performance expected from powder coating. Zinc phosphatizing not only converts the surface of the substrate, but also overlays a crystalline structure. It actually grows a zinc phosphate crystal on the surface of the metal.

Under the examination of an electron microscope, iron phosphate coating appears smooth while zinc phosphate coating leaves an intricate matrix to which the powder coating can adhere. This gives the metal a heavier coating than iron which in turn also offers superior corrosion resistance. The same substrates pretreated with iron phosphate coating can be pretreated with zinc phosphate coating.

Zinc phosphatizing is harder to maintain and there are more critical controls. Zinc is less tolerant to changes in time, temperature, concentration and pH. It is more expensive. Zinc phosphatizing requires a higher capital expense in that tanks have to be stainless steel or acid resistant. The zinc content also renders it more difficult to dispose.

Where absolute maximum corrosion resistance is required, zinc phosphatizing would be our recommended approach. Even though powder coatings exhibit very high corrosion resistance as opposed to conventional liquid coatings, the zinc phosphate will further improve upon those corrosion resistance characteristics. Products which require long service life or which must endure the torture of harsh environmental or atmospheric conditions are probably best pretreated with a zinc phosphate coating.

How to Phosphatize

Iron phosphate coating can be applied in all three chemical cleaning systems (1. immersion or soak tank, 2. spray wash, or 3. pressure wand.)

The cleaning and conversion coating is typically accomplished in stages. There can be as few as two stages.

1- Clean & Conversion Coat
2- Rinse

Three Stages
1-Clean & Conversion Coat
2-Rinse
3- Seal

Or a five stage system:

1-Clean
2-Rinse
3-Conversion Coat
4- Rinse
5- Seal

Additional stages can be used in custom-designed systems.
Zinc phosphatizing must be done in a five stage operation.

In pretreating powder coated products, we recommend the use of a five stage system in which the cleaning stage is separated from the phosphatizing stage. The overwhelming importance of a thorough cleaning prior to powder coating has lead us to conclude that a five stage system works best.

Rinsing: Sealing

While cleaning and phosphatizing are the principle units of operation in the pretreatment process, the importance of thorough rinsing cannot be overlooked. It is very important that the rinse stages be kept clean to avoid recontamination of the parts. Any chemical remaining on the part becomes a soil which must be removed prior to proceeding to the next stage of the system.

The rinsing stage cannot be overlooked.
There are two types of final rinses: chromated and non-chromated. The chromated final rinse has always been known as the standard of the industry,

but it has come under increasing scrutiny from the environmental and occupational safety regulators. The trend is away from chrome to safer, non-chromated rinses.

Without an absolutely clean part, conversion coating will not perform to the extent that offers the subsequently powder coated parts to realize optimum adhesion and corrosion resistance.

A commitment to thorough cleaning is key to maximize powder coating performance

Chapter

4

Powder Coating Application

How does it stick? The application of the powder coating is a fairly straightforward part of the process, yet it has the greatest effect on the finished appearance of the coating.

Powder Coating is basically applied either by dipping a heated or grounded part into the powder paint, or by fluidizing (mixing powder with air) the powder and then spraying it to a heated or grounded part.

Powder Coatings Application: Application Equipment

Powder coatings are applied using one of three standard methods:

- Fluidized Bed
- Electrostatic spray, Corona charge
- Electrostatic spray, Tribo charge.

Fluidized Bed

In this process, the combination of the fluidized bed and electrostatic electrodes create a cloud of charged powder particles above the powder bed. As in any fluidized bed, the powder material is fluidized by introducing compressed air through a porous membrane into the powder bed. Depth of powder material in the bed is usually 2" to 4" (50 mm to 101 MM)

Electrostatic charged electrodes, are so located in the powder bed as to charge the air used to fluidize when high voltage DC potential is applied to them. Ionizing this air results in electrostatically charged powder particles, having relatively identical high electrical charges

These particles thus repel each other and move upward. Having different electrical potentials, the powder particles and the parts to be coated or grounded, produce an electrical field of attraction. Basically, only the electrostatic field produced in this process is used to apply the powder material to the parts being coated. In contrast to electrostatic spray methods, little air is used to control the volume and velocity of the powder material.

The electrostatic fluidized bed is ideally suited to substrates that have a relatively small vertical dimension, such as flat sheets, expanded metal, wire mesh, screen, cable, tubing and small parts on a conveyorized line. The electrostatic fluidized bed offers the advantage of being able to coat some objects such as flat sheets on one side only as opposed to the conventional fluidized bed that requires dipping of the entire part. The electrostatic fluidized bed includes an integral control panel and utilizes the same powder supply unit as the manual electrostatic spray system.

The preheating of parts is not necessary with this method. The electrical forces -- positive to negative -- will cause the deposition of the powder on the surface whether that surface is hot or cold. Preheated parts used with electrostatics will result in a thicker coating than otherwise.

Typical fluidizing hopper used for applying powder coatings. Fluidizing hoppers can be as small as 1 lb or over 1000 lbs.

Electrostatic Powder Spray Coating

To apply powder coating materials with the electrostatic powder spray process, five basic pieces of equipment are needed:

1. The powder feeder unit. Feed Hopper.
2. The electrostatic spray gun. Corona or Tribo.
3. The electrostatic voltage source. For Corona only.
4. A powder recovery unit. Reclaim and/or Filter module.
5. The spray booth.

In the operation of an electrostatic powder spray system, powder is supplied to the spray gun from a feeder unit, where the powder is stored for use. Powder is siphoned, or pumped from the feeder unit through powder feed hose to the spray guns. Spray guns direct the powder toward the part to be sprayed in the form of a diffused cloud. Propelling force is provided both by air used to transport the powder from the feeder unit to the spray gun, and by the electrostatic charge imparted to the powder at the gun. This electrostatic charge is generated in any of the following methods: Internal Corona, Remote Corona and Tribo.

Electrostatic Powder Spray Coating, Corona Gun.

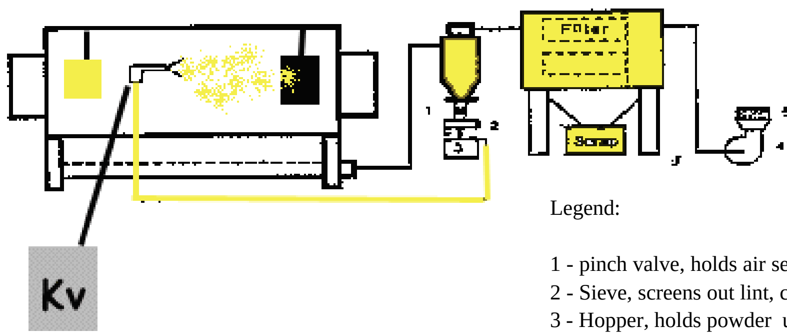
There are two types of corona guns.
Internally charged (Low Voltage) Corona gun
Remotely charged (High Voltage) Corona guns

Each type comes in negative or positive polarity, although corona charging generally uses negative polarity at the electrode. This is because negative polarity produces more ions and is less prone to arcing. Positive charging guns are mostly used in tribo touch up applications and with some thermoset materials.

This very high voltage potential at the electrode requires a power supply rated between 30,000 and 100,000 volts. This creates an field of electrical attraction between the gun and the grounded part. The particles stick to the part much like a magnet to steel, creating a layer of powder on the part. Over spray, or powder not adhering to the part, is collected for re-use. In the collector unit, powder is separated from the conveying airflow.

Typical Corona powder gun.

Collected powder is then recycled, either automatically or manually, back to the feeder unit to be resprayed. Air is passed through a filter media device into a clean air plenum and then through a final or absolute filter back into the plant environment as clean air. The coated part is then carried from the application area and subjected to heat, which results in the flowout and curing of the powder material.



Note: The powder will spray without voltage, but will not adhere without it, unless the part is preheated to over 160F

Legend:

1 - pinch valve, holds air seal and powder in..
2 - Sieve, screens out lint, clumps and contamination
3 - Hopper, holds powder until needed by guns.
4 - Blower, pulls air through system.
5 - Final filter to keep returned air clean.
6 - Kv, power supply and gun control unit.

Electrostatic Powder Spray Coating,

Electrostatic powder spray guns function to shape and direct the flow of powder as supplied from the feed hopper; control the pattern size, shape and density of powder, as it is emitted from the spray gun; impart the electrostatic charge to the powder being sprayed, and control the deposition of powder on parts being sprayed through gun position, pattern shape and electrostatic levels.

The charging electrode we mentioned earlier is located at the front of the spray gun. When the powder passes by the electrode, it picks up a charge - which is variable, and deposits on the part

The thickness of this deposition can be controlled by position of the spray

gun, length of spray time, level of electrostatic charge and velocity of the powder flow from gun to part, part aperture, etc. Thickness of the applied powder to the part also can be controlled by affected characteristics inherent to the powder being sprayed; such as particle size, shape, type of powder material and distribution of the powder particle size range.
These factors are all covered in out troubleshooting guide.

Electrostatic Powder Spray Coating, Corona Gun.

The two types of Corona guns are very similar. The difference is where the high voltage power supply is located. The cable between gun control and gun will therefore be of low voltage (internal) or high voltage (remote).

Corona gun technology has evolved greatly over the past ten years and two advances are becoming prevalent throughout the industry.

Automatic Current Control: Allows for automatic adjustment of gun voltage to maintain the gun current and field strength between the gun and part at an optimum level. This allows for more uniformity in the coating since the gun logic compensates for operator and part configuration variations as well as faraday cage effect problems.

Free-Ion Collectors: Is a device which extracts free ions from the space between a gun and a part, drawing them to a grounded collector electrode behind the gun tip. An inexpensive retrofit to existing equipment, these also permit for greater uniformity and greatly improved faraday cage penetration abilities.

Powder coating booth with corona guns. Note the perfect powder cloud.

Wagner corona gun control panel system

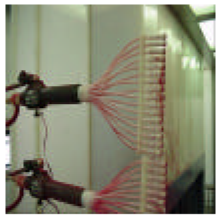

Corona spray gun

Electrostatic Powder Spray Coating, Tribo Gun.

The word tribo is derived from the Greek word tribune, meaning to rub or produce friction. With tribo charging the powder is charged by means of special materials(such as Teflon) which by stealing electrons from the powder particles impart a positive charge on the powder as it flows, and rubs, through the gun.

Tribo guns have no internal or remote power supply. This means no electrostatic field is created, virtually eliminating the faraday cage effect, making this the ideal approach for use in coating intricate parts such as detailed automotive rims and heatsinks.

These formulations are much more dependent upon the formulation and particle size as well as environment than corona powders are. High humidity or extremely dry environments can affect the amount of charge imparted upon the powder.


Tribo spray gun

Electrostatic effectiveness: For all powder applications

The effectiveness of any of these types of powder spray guns is not totally dependent on the gun alone. Characteristics of the powder material also affect the transfer efficiencies realized in the process. The powder particles must, of course, be capable of accepting the electrostatic charge imparted by the spray gun. A compromise between high conductivity and low conductivity is necessary, to ensure both acceptance of the electrostatic charge and adhesion to the part sprayed.

The nature of the particle material likewise has an influence upon the possibility of it obtaining a maximum charge. The particle must first be able to accept the maximum charge as it passes through the ion cloud. The degree of acceptance is directly related to the electrical conductivity of the particle.

The charge upon the particle likewise has great influence upon the manner in which the material collects upon the surface and the rate at which the film of material builds. A charged layer accumulates upon the surface with the material and has the effect of building a force which opposes further deposition.

The rate of film growth must be related to other factors such as the velocity at which the charged powder is projected toward the surface, the distance of the gun from the surface, the particle size, the time of exposure of the surface in the spray, the voltage on the gun and the quantity of powder being delivered from the gun.

Increasing the voltage applied to the spray gun while keeping other factors constant will result in more film being collected on the part in equal exposure times. The rate at which powder collects on the part at the beginning of the exposure increases as the voltage increases. As exposure increases, the accumulation rate tends to become the same for all voltages, when using a corona discharge gun. Generally, as the distance from the gun outlet increases, the film accumulated on the part in a given time decreases. Film accumulation is much more rapid initially when the distance is small.

The effects of the air velocity gradient at the part upon the deposition of powder are similar to those of distance from the gun. As the air velocity increases, the accumulation in a given time decreases.

The ultimate film thickness obtained is independent of the rate of powder delivery in the absence of air velocity gradient interference. The rate of film build which occurs initially is approximately proportional to quantity of powder delivered per unit of time at a constant voltage. As spraying time increases, the effect of powder output on the rate of film growth becomes less pronounced.

The initial rate of growth of the film thickness is approximately proportional to the particle size; the rate of growth depends upon the particle size over a wide range of spraying time, and the limiting value of the film thickness is greater with smaller sized powders.

By proper understanding of the manner in which these variables generally influence the deposition of the material, an applicator can take into consideration characteristics of equipment, methods and materials which will result in a satisfactory application

Operation Conditions

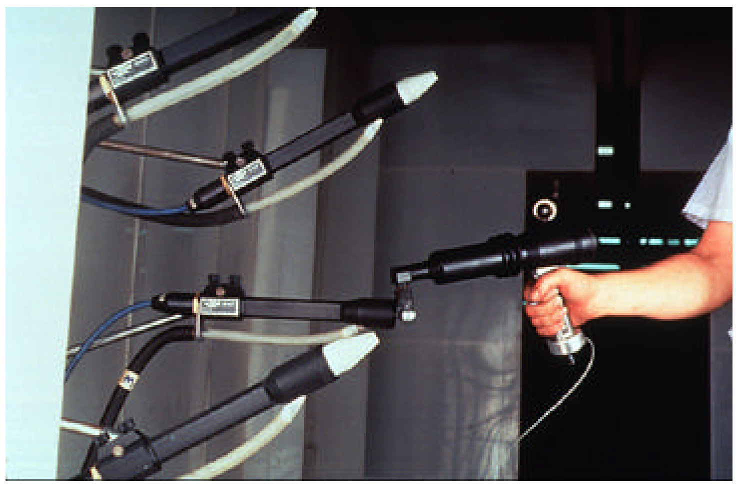
For electrostatic spray guns to function properly and safely, the following conditions should be maintained:

- Fixed powder spray guns must be adequately grounded at their points of support, if metallic, to reduce the possibility of static charge buildup on the gun and the possible discharge of this static charge to a part or component in the spray area.

- Manual powder spray gun operators must be adequately grounded (usually through the gun handle) to prevent buildup of a static charge on the operator's body during spray operations.

-Powder spray gun parts which come into physical contact with moving powder must be inspected and cleaned on a regular basis. Parts which contact powder during the movement of powder are prone to wear (especially if the powder material is abrasive) at high velocity and form impact fusion. Worn parts result in poor control of powder flow, accentuated impact fusion and more frequent cleaning is required. If a part is worn, it should be replaced

- Electrostatic spray guns, manual and automatic, should be checked periodically to determine the level of electrostatic charge being imparted to the powder material being sprayed. The lack of, or decrease in, expected electrostatic charge indicates a problem in the electrostatic system and should be corrected as soon as possible. Troubleshooting guides should be utilized when inspecting or repairing any component within the electrostatic system to reduce the possibility of electric shock.


Operator checking the output voltage of corona guns

- When using fixed or automatic powder spray guns, interlocks should be provided which will rapidly de-energize the high-voltage elements involved with electrostatic spray under any of the following conditions: stoppage of ventilating fans or failure of ventilating equipment from any cause; stoppage of conveyor carrying goods through the electrostatic spray, upon trigger from spark detection modules in booth, and other conditions as prescribed by regulatory agencies.


Spark detection system used in Nordson booths.

Yes, Powder booths can go up in flames despite the lack of solvents used. With no detection modules the fire will burn fast with terrible results. We know of a few of these fires over the past few years, one at a customer who disabled their detection system.

Powder Booth

A powder booth is an enclosed cabin designed to allow parts to pass through each end and contain the electrostatic powder process. These booths are designed to accommodate automatic and manual equipment based on the system parameters. These booths are made of several different materials; steel, (painted or stainless), polypropylene, or thin polyethylene.

Powder booths are sized by two air flow requirements. The first requirement is containment air. In order to collect the over sprayed powder particles, the powder booth is designed to provide 110-120 lineal feet per minute (lfpm) air flow across all the openings A properly designed booth will have laminar air flow throughout the cabin without interrupting the powder coating process. The second design criteria for air flow requirements is based on safety. Each powder is rated with a lower explosion limit (LEL) measured in oz/ft. The powder booth must be designed with enough safety ventilation air flow not to exceed 50% of the LEL limit. This powder concentration level is determined by the number of guns and nominal powder output per gun.

Every type of booth designed for powder applications is designed with a recovery system. The recovery system is used for two main reasons:

1- to provide the necessary containment and safety air.
2- to recover the oversprayed powder.

Most systems sold in the U.S. have two filter sections. The primary filter is used to separate the oversprayed powder from the air from reclaim. The secondary or final filter to keep the working environment free of powder particles.

There are three main types of recovery systems available in the market today:

Conventional
Filter Belt
Cartridge


Conventional Powder Booth


Cartridge type Powder Booth: Iontech

Powder Booth: Conventional Recovery Systems

The original powder booth was designed with a cyclone as the main component with a recovery system. The overspray powder is drawn to the bottom of the booth by airflow and gravitational forces. This air flow is generated by a blower that creates a vacuum on the system through a series of ductwork. The ductwork from the booth is connected to a cyclone. The cyclone in a conventional system is used as the primary means of powder separation.

The powder and air mixture enters the cyclone at a typical velocity of 60 feet per second. The shape of the cyclone causes the mixture to swirl with the powder particles dropping out the bottom. The relatively clean air passes out the top of the cyclone. The powder from the cyclone falls into a sieve through an air isolation device such as a pinch valve. The sieve screens the powder to eliminate dirt particles. The clean powder then falls into the hopper for repaying. Fresh powder is loaded into the hopper to provide a continuous operation. It is a good policy to monitor the particle size distribution of this blend with your supplier to ensure optimal transfer efficiency.

This powder is then transferred to the application guns to complete the reclaim cycle.

The relatively clean air coming from the top of the cyclone is drawn into a collector or bag house for the secondary separation. Due to the cyclone design, between 5 - 15 % of the reclaimed powder passes through the cyclone to the collector. The powder is then drawn to the collector filters. The filters are then back pulsed through a timed sequence, the 'bang' frequently heard periodically is powder spray application areas. This back pulsing consists of short high pressure air blasts that free the powder particles from the filter element. The powder falls into a scrap barrel and is collected for disposal. Due to the extremely high concentration of ultra fine particles below 7 microns, reuse of this material is discouraged.

Powder Booth: Filter Belt

There are two separate air circuits used in the operation of the filter belt booth: recovery and reclaim air.

The 'recovery' air is used to provide the downdraft airflow and draw the oversprayed powder particles to the filter material. A main exhaust blower creates a vacuum through a plenum area underneath the belt that draws the powder to it. This airflow provides the high volume, low vacuum air required to keep the powder particles inside the booth cabin and provide the necessary safety air ventilation.

The filter media separates up to 99% of the powder from the air. A final filter is used before this air is exhausted for any particles that pass through the system. The filtered air is then returned to the plant a clean air.

The 'reclaim' air is used to vacuum the powder off the filter belt for reuse. This low volume, high vacuum air is generated by the reclaim exhauster.

The pick up head is a ling slotted tube that extends across the entire width of the belt. The powder is conveyed through a connecting hose to the reclaim cart.

The cycart contains filters for secondary powder separation in the filter belt booth. The powder that collects on the filters is back pulsed and released into the rotary feeder. The rotary feeder is used to regulate the amount of powder flow into the sieve and maintain the vacuum in the cycart.

Fresh powder is fed into the system in a similar fashion. The fresh feed exhauster draws the material from the powder container into a spate cycart assembly. This powder is also back pulsed into a rotary feeder. The reclaimed and fresh powder is mixed through a Y diverter into a sieve. The sieve filters the powder and provides a consistent mixture of powder particles to the hopper.

The recovery concept in a multicolor filter belt booth is very similar to the single system.

In a multicolor system, the pick-up head vacuums the powder from the filter belt and transfers it through a connecting hose to a high efficiency mini-cyclone. The main purpose of the mini-cyclone is to allow quick color changes in the filter belt system. This mini-cyclone is smaller than a conventional booth cyclone due to the low volume of reclaim air in the system.

The mini-cyclone is used to separate the powder from the air in the multicolor system. The powder falls from the mini-cyclone into a pinch valve assembly and then to a sieve for screening. The clean powder then falls to the hopper for reuse. The relative clean air from the mini-cyclone is transferred to the cycart collector for final separation. The reclaim exhauster has a final filter for returning clean air to the powder room. Fresh powder can either be loaded directly on the filter belt and passed through the reclaim system or emptied directly into the hopper.

Powder Booth: Cartridge Recovery Systems

This compact self-contained cartridge booth was the third type of recovery system developed. This type of system used replaceable cartridge filters for the primary powder separation. These cartridge elements are typically made of corrugated material to increase the available surface area for filtration.

The collector and blower assembly are mounted directly to the booth without any ducting. Any powder not deposited on the work piece is drawn to the filter cartridges by the exhaust fan. The air that is drawn through the cartridge filters is then exhausted through a set of final filters for secondary separation and returned to the working area. The powder collected on the filters is back pulsed through an alternating sequence that drops the particles to the bottom of the collector. A fluidizing section in the base of the collector allows the powder to be transferred back to the reclaim canister. It is then filtered through a sieve before being fed back into the hopper. Fresh powder is either fed into the collector through a chute or loaded directly into the hopper.

Powder Fines

Fines are the tiniest particles of powder in a batch. A given batch of powder may contain about 10% fines. If precautions are not taken, the concentration of fines in a powder booth can increase. Because of their light weight, fines tend to be difficult to handle. Normal charged particles are readily attracted to the grounded part. If a batch of powder contains a high concentration of fines, the powder tends to deposit light amounts of film. In addition, fines tend to go through collection cartridges and final filters causing reclaim problems. As a precautionary, good practice method, the reclaimed powder should be mixed 1:1 to assure consistent product application characteristics.

Maintaining high transfer efficiency is another protective measure used to hold down the buildup of fines. Because of their poor electrostatic attraction, a high percentage of overspray tends to consist of fines. Thus, minimizing overspray holds down the fines buildup. High transfer efficiency is maintained through proper equipment use, high quality powder coatings and trained applicators.

Heating Applications In Powder Coatings

The requirements of the particular application must be thoroughly studied and these matched with the capabilities and design principles of available ovens. Such a thorough investigation of all aspects of the heating components of a powder finishing line is critical to achieving an efficient, effective and satisfactory operation which will produce a high quality product

Preheating

Parts on their way to the coating application area are preheated where required to dry off any moisture remaining from previous cleaning or conditioning steps. Such heating must only be adequate to accomplish this simple function. Temperatures -at most - can be in the range of 190 F (88C) and can be attained with any number of available ovens. Ventilation of the area is of little significance and only time dryness relationship is of importance.

Preheating also is needed to raise the temperature of parts which are to be coated by processes requiring that the powder fuse on the part upon contact. This requires the establishment of a temperature time coating cycle so that coating thickness can be reproduced. The hotter the part, the more the amount of material adhered before the temperature falls below the fusion point. The temperature time curve for such ovens must be known and reproducible. Generally such ovens need not be ventilated beyond that required bye safety considerations. These conditions can easily be met by any number of commercial ovens.

Parts generally preheated for application reasons are items such as: glass bottles, plastic pens, MDF, certain woods and sometimes castings.

Postheating - Product Cure

Post heating operations on a powder finishing line are perhaps the most critical. They are used to melt, flow and cure the powder which has been applied to the part at ambient temperature as with the use of the use of the electrostatic spraying process. This application of heat has to be very carefully controlled because temperature-fluidity characteristics of a particular powder are peculiar to that powder and it is this relationship that determines how the flow of the material will take place as the temperature is raise. Most materials cross link and become more viscous with the time at a given temperature so this, for thermosetting materials further complicates the control.

The final properties of the coating can only be acquired uniformly over the part if parts of the coating are treated in thermally equivalent conditions. The post heat ovens for this reason again must be of high quality and be equipped with adequate controls to insure reproducibility.

Postheating - Process Considerations

Many elements and variables must be considered and studied when selecting ovens for the powder coating line. Of utmost importance are:

* Product. Size, Configuration, Mass, Temperature limitations.
* Conveyor. Method, Product holder, Line speeds.
* Powder. Formulation type, Thickness, Cure profile, Color, Gloss, Cure test.

All parameters should be defined and communicated to equipment and powder suppliers involved to insure that an integrated system and successful installation are achieved

Postheating - Hot Air, Gas or Electric Convection Cure

Convection heating uses a medium such as air to transfer heat from the energy source to the product. Many convection systems use a fired source (gas flame or steam) which provides heated air circulation in the oven chamber. Using a combustion chamber, the oven atmosphere can contain combustion products, solvent vapors, and possibly traces of unburned fuel. Other convection ovens utilize electric low-intensity infrared elements (calrods, resistance emitters) to provide a clean, safe method of convection heating.

The time required to bring the powder deposited on a part to its cure temperature is largely a function of the mass of the part and the rate at which the part accept heat using convection heating. Large metal objects may require from 30 minutes to 60 minutes or more to reach the desired cure temperature, while smaller parts can be brought o temperature much more rapidly. This heat absorption by the part is a waste of heat energy as far as powder curing is concerned.

But considering all of the process requirements, such as part configuration, products with varying size and dimension and processes where products of similar configuration cannot be batched. This may be the most flexible and efficient method of curing.

The temperature response time of a large convection oven is not particularly rapid, often taking up to an hour or more for the oven to reach operating temperature. They require considerable floor space and routine cleaning if good finishes at high production rates are to be obtained. Despite these limitations, convection ovens are currently the most popular for industrial painting curing. Energy and operating costs however are often high and users should be aware of alternative methods for their production lines.

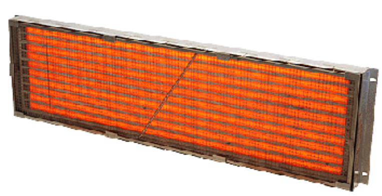
Postheating - Infrared Radiation

Short, Medium and Long wave, high-intensity infrared heating utilizes electrical energy to provide a direct, radiant method of heating. Infrared is transmitted directly from emitter to product via electromagnetic waves traveling at the speed of light (186,000 miles per second).

Different from convection heating, high intensity infrared requires no medium to be heated for heat transfer to take place. Heated energy is transferred quickly, cleanly, and efficiently typically tungsten quartz infrared lamps. These can be electric or gas fired. High intensity infrared can have fast temperature-time response. Curing ovens using this method of radiation heating are compact in size and can be zoned to match exact product configuration and size. Oven start-up times of 10-15 minutes or less are common. Savings in energy, space and time can be realized with high intensity infrared.

Infrared radiation is best used with products of consistent shape produced on dedicated lines in large volume. A direct line of sight, heater to object surface is needed for proper powder cure and cure is affected by object distance. Rotating the coated product during the infrared cure for round to cylindrical shape product produces uniform heating with consistent cure results. Reflow and cure times rang from 10 seconds to 120 seconds using high intensity infrared.

* Infrared also permits for horizontal and vertical zone control for varying part profiles.
* It is possible to shut off, or turn down, zones to save energy.
* Infrared is 3 times more efficient on average than convection.



Typical IR panel. Many of these are typically grouped together

Postheating - Ultraviolet Light & Electron Beam

UV cure relies on the penetration of UV light through the coating while EB uses accelerated electrons that can penetrate even pigmented coatings.

This supplied energy causes a rapid chemical and physical change brought on by the energies agitation, or excitement, of photo initiators formulated into the product.

This technology is very dependant upon line of sight cure and end uses with three-dimensional parts is limited. In fact, worldwide use of this technology is limited to a handful of companies.

A UV powder paint line is suited to powder coating of heat sensitive materials. A typical cure range would be 2-3 minutes at 175F to 230F.

Oven Exhaust Issues

Gas convection cure ovens and some dry off ovens are exhausted to remove raw fuel, byproducts of combustion and any emissions from the coating materials. The coating materials may include compounds which are emitted by design, as well as decomposition byproducts from fallen powder or parts. By necessity, ovens designed to cure conventional solvent borne coatings must have much higher exhaust rates to remove hazardous solvents from the oven and work atmosphere. The removal of combustion byproducts is critically important to prevent yellowing or darkening of light colors.
General guidelines for powder cure ovens are:

* Three air turnovers per hour for non-appearance parts.
* Four to Six air turnovers per hour for dark colors.
* Six to Eight air turnovers per hour for clear coatings.
* Eight to Twelve air turnovers per hour for light colors and appearance parts.

Certain situations may require higher exhaust rates:

* Curing solvent borne or Ecoat in the same oven with powder. The byproducts of these can interfere with powder cure or produce yellowing in light colors.

* Curing multiple powder chemistries in the same oven environment can produce gloss reduction and even wrinkling in a smooth coating.

* Combination cure and dry-off ovens. High exhaust rates required to remove water vapor.

* Contaminated make up air (plant air) used rather than fresh outside air.

The number of air turns in an oven is the rate at which fresh air replaces the initial air volume by the oven blower. The exhaust requirements can vary greatly with oven design.

Indirect burners represent far less of a problem with combustion gases than direct fired burners. The air turns for direct fired ovens should be higher.

If the oven is under exhausted over a period of time contaminants such as nitrous oxides and sulfur dioxide may build up to produce a condition known as a fouled oven. In these cases some coaters place buckets of liquid Ammonium Hydroxide or solid Ammonium Salts at the oven exit and entrance at shutdown to assist in neutralizing these acidic materials. Additionally, cleaning and servicing the burners may be necessary.

The formula for determining Oven turns is:

Oven Turns = Make up air exchange Rate/Oven Volume.

Oven Residue

Many powder coating ovens have an oven fuzz which builds up in and around the cool zones such as the vestibule at the oven opening and around the exhaust fan.

This material is generally made up of:

**** Low molecular weight resins***
**** Flattening agents***
**** Blocking agents***
**** Degassing agents***
**** Decomposition products from the resin***

The cause of the build up is generally caused by poor oven design or poor maintenance. This oven residue should be cleaned out by vacuuming or washing with a power spray washer.

Other factors which may contribute are:

* Frequent line stops with a full load in the oven.
* Excessive oven temperatures
* Uneven heat in the oven resulting in hot and cool zones. This can result from baffling, the placement of a cooling tunnel or poor insulation on exterior facing walls.

Hazards associated with these residues are:

* Flammability
* Inhalation by workers
* Contamination of the finished part.

Note, even though not all residues represent fire hazards they should be treated as such.

Our thoughts on ovens:

Build my own or buy professional?
Let me begin by saying that there is a serious threat of fires, explosions, personal harm and/or death with an unsafe oven installation. It is imperative that installers, operators, maintenance personnel and managers recognize these threats and act accordingly. Over the past 15 years I have seen three installations go up in smoke due to unsafe ovens and one person needlessly died.

You want to build an oven? Can you install and do you understand the following safety devices?

Motor Overloads, Fan Proving Air Cells, Purge Timers, Powered Exhaust, Deviation Control Programming, Guards for Moving Parts, Explosion Relief Doors/Hatches
High Limit Control, Door Switches, Safety Shutoff Valve, High/Low Gas Pressure Switch
Combustion Safeguard System

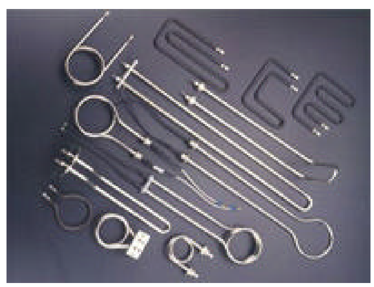
Sure, for a hobby powder coater go ahead and buy an old oven for your parts. You could even build your own oven using low-watt density Incoloy (or similar) sheathed heaters - remember to follow UL guidelines and ensure your heater loads are broken into circuits no higher than 48 amps each, use 16 gauge aluminized steel for the interior shell (aluminized is important for reflectance). Insulate your oven with 3-5 inches of 6 # mineral wool and top off the outer frame with heavy duty structural steel. You can purchase prefab oven panels from Rapid Industrial Finishing 1-800-536-3461, they are online at www.RapidEngineering.com. Make sure you take into account NFPA 86, which requires that all fuel-fired and/or class A process ovens are equipped to provide adequate explosion relief (1ft sq/15 ft cubed oven volume).

Can you design in explosion venting latches on the doors along with an explosion venting panel in the roof of the unit?

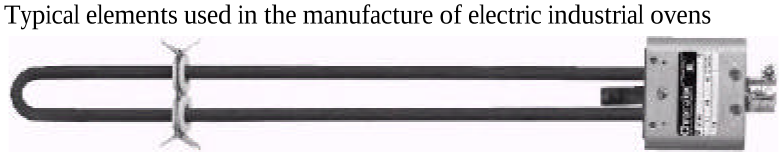
How much heat do you need? It is not as simple as getting some toaster oven elements, wiring them up and plugging it all in. Figure out your requirements with this equation:

Parts Being Finished =
Work load per hour (lb/hr) × specific heat of the parts (Cp) × the temperature difference between the parts and the solution (in this case air) (F) divided by 3,412 (BtuH/KW).

If you still insist on building your own ovens, then you can find all the heater elements (1,500 watt element for about $100) you need at: www.InfraredHeaters.com Contact them at 800-442-2581 or sales@heatersplus.com Their helpful staff will be more than happy to help you put together an element and control package.



Typical elements used in the manufacture of electric industrial ovens



Want to be a real powder coater?
Then you need to take this seriously and realize you need professional equipment. Almost 90% of the oven issues our technicians have seen were with novice built ovens (fabricated with insulated steel panels and electrical heat elements - much like your oven at home). Sure your shop can build the best widgets in the industry, but do your engineers understand how to precisely control airflow and velocity? Do they know how to ensure effective heat transfer that ensures accurate and uniform temperatures along and across the parts?

If not you will have <u>discoloration, orange peel and under/over bake problems</u>.

If you need to save money and still get quality parts you need to build a quality oven or purchase a good used oven. By building an oven using the suggestions on the prior pages and incorporating a professional burner box you will have a much better system than one using electrical elements to heat the oven. However, even these ovens can have air issues unless you have first hand knowledge of the baffle design and air flow requirements of your particular oven configuration.

Contact JohnsonGas at 800-553-5422 or Lanemark www.Lanemark.com for quality prebuilt burner boxes.


Example of oven construction


This is a prefabricated oven burner

Gas or Electric (convection and IR),

Gas is significantly less expensive to operate than electric (for both convection and IR ovens). A significant portion of electric energy costs for ovens derive from the monthly demand charges imposed on energy consumed during periods of high demand. For purposes of comparison, analyze the energy costs of an electric system with a demand capacity of 392 kW and a 300 kW average usage level operating eight hours a day, 22 days per month. With these figures, estimated monthly electrical energy cost is $7,168.24 - of which almost 60% was attributable to demand charges.

Compare these operating costs with those of a 1.6 million BTU/hr. gas system. With the same usage per month, gas charges are estimated at $1,047.55. The significant savings were possible because there are no utility demand charges for gas usage. Thus, energy-related operating costs for the proposed larger system were estimated at about $6 per hour vs. almost $41 per hour for the previous system.

Are you going to run your oven during the day (when demand charges are high) or only on third shift?

Oven Efficiency.

Oven efficiency is the ratio of the heat input into the product vs. the energy consumed by the oven. Electric radiant elements typically have a radiant efficiency (the ratio of radiant energy emitted vs. energy consumed) of 60 to 90%. Gas burners typically have radiant efficiencies of 40% to 60%. In each case, the remainder of the energy input (that which is not converted directly to radiation) becomes heated air within the oven.

Engineers design ovens to use this heated air to provide additional heat to the product and offset losses that typically occur through the exhaust and enclosure. The moving air improves overall oven efficiency, ameliorating the inherent radiant inefficiency of gas (when compared to electric). The additional convection heating system supplements the preheated air, helping to heat the poles more rapidly and uniformly than is possible with radiant heating alone.

What about UV and Electron Beam?

UV powders have been available for about 10 years. In fact I was one of the original formulators of UV coatings as they exist today back in the early 1990's. The first successful UV application of powder coatings was by Baldor USA for their electric motors. UV is still however in it's infancy due to the high costs of the curing equipment and powder coatings. It is however an excellent choice for highly heat sensitive substrates such as preassembled parts such as shocks and electric motors as well as for plastics. You can cure a UV powder in as little as one minute!

The following comparison shows how dramatically curing time can be reduced by moving from convection to infrared and finally to UV curing for a free radical 100% UV solids operation. In one particular analysis, the cost reduction from converting from 100% heating to 100% UV solids resulted in a savings of over $250,000 per year on electric energy. - ($/ft2)

What about Temperature and Energy?

It has been documented (Powder Coating, October 1996, p. 33) that within a commercially applicable cure oven temperature range of between 284F (140C) and 410F (210C) the energy consumption increases by an average of about 6% for every 18F (10C) temperature increase:

Temperature:	Energy Consumption Increase (%)
284F (140C)	0.0%
302F (150C)	6.0%
320F (160C)	12.1%
338F (170C)	19.1%
356F (180C)	26.2%
374F (190C)	33.8%
392F (200C)	41.9%
410F (210C)	50.4%

284F (140C) was chosen in this example as the baseline temperature, however, any given temperature can be used as baseline. Many powder coatings are capable of curing at this temperature, make sure you specify this temperature with your supplier!

Mathematically, energy consumption changes can be expressed as:

Cure Oven Energy Consumption Change in % = 100 x (1.0033(+ Temperature Change in Fahrenheit) - 1)

Notes:
* Temperature changes can be positive (temperature increase), or negative (temperature decrease).

* Resulting values from the equations shown above are estimates. Oven design, insulation, air flow, and other factors may change the 6% figure for an 18F (10C) temperature increase somewhat. However, these equations offer a reasonable assessment for energy consumption changes related to oven temperature changes.

Application Conditions:

We have reviewed earlier that powder coatings are:

- Hydroscopic (tend to absorb moisture easily)
- Sensitive to heat and hot environments.
- Are fine particles and inhalation exposure should be minimized.

Some points to keep in mind:

1. Control temperature. Recommend 80F 27C or less. Remember that powder requires minimal storage space. For example, a semi-tractor-trailer-sized area can accommodate 40,000 lbs of powder which is approximately equal to 15,000 gallons of liquid paint.

2. Efficiently rotate the stored powder to minimize inventory time, so that powder is never stored for a period exceeding the manufacturer's recommendation.

3. Avoid having open packages of powder on shop floor to preclude possible moisture absorption and the high risk of contamination

4. Precondition powder prior to spray application by providing preconditioning fluidization as is available on some automatic systems or by adding virgin (unused) powder through reclaim system. These techniques will break up the powder if minor agglomeration has occurred in the package or during storage.

5. Maximize powder transfer efficiency in the booth to avoid the problems associated with the recycling of large quantities of powder.

6. Minimize the amount of the powder coating material held on the shop floor if temperature and humidity of application areas are not controlled.

Excess Heat

Powders must maintain their particle size to allow proper handling and application. Most thermosetting powders are formulated to withstand certain amount of exposure to heat in storage. This will vary according to types and formulation, but can be estimated at 100 - 120F.

When these critical temperatures are exceeded for any length of time, one or all of the following physical changes may happen. The powder can sinter, pack and /or clump in the container. Pressure of powder weighing on itself, (i.e., large tall containers, can accelerate packing and clumping of the powder toward the bottom of the container).

Unless exposure to the heat has been excessive and over an extended period of time, powder which has experienced such changes can usually be broken up and rejuvenated by passing it through a coarse (~ 60 mesh) screen.

Powders with very fast or low-temperature curing mechanisms may undergo a chemical change as a result of exposure to excess heat. These powders may partially react or "B stage". Even though these powders may be broken up, they will not produce the same flow and appearance characteristics as unexposed powders. These powders will have and will irreversibly retain restricted flow even to the point of a dry textured appearance after curing.
Protect from Humidity, Water and Contamination

Water and powder do not mix when the intent is to spray as a dry powder. Exposure to excessive humidity can cause the powder to absorb either surface or build moisture. This causes poor handling such as poor fluidization, poor gun feeding which can lead to gun spitting and eventually blockage. High moisture content will certainly result in poor electrostatic behavior which can result in changed or reduced transfer efficiency and in extreme conditions will affect the appearance and performance of the baked coating film.

Because powder coating is a dry coating process, contamination by dust or other powders cannot be removed by filtering as in liquid paint. It is imperative, therefore that all containers are closed and protected from plant contaminants such as airborne cardboard carton fibers, packing materials, grinding dusts, aerosol sprays, etc.

Chapter

5

Powder Coating Quality Control

Powder coating can look like it is completely cured, yet still be unable to provide the complete physical properties it is capable of. Use of Quality Control testing is a key part of your process

Quality control is an often misunderstood part of the coating process. In order to ensure that your customer is getting the best properties from the powder job, it is important to conduct test which verify the degree of cure of the paint.

Evaluating finished film properties and specifications

Your customer has specific ideas of what the powder coating process will do for their parts. It is imperative you test some fraction of your powder coated parts to ensure you will meet or exceed these expectations.

Powder coatings obtain their full physical and chemical properties only when completely cured at the proper temperature for enough time. Use of these tests will help ensure you are shipping parts which conform to your customers or your internal specifications.

When determining what powder to use, make sure you supplier understands exactly what your needs are. These tests are similar to what your suppliers do and are based on industry recognized procedures.

In this chapter we cover the main tests most customers require:
Gloss, Color, Impacts, Thickness, Hardness, Flexibility, Cure and Adhesion

SPECULAR GLOSS

SCOPE: To measure the specular gloss of nonmetallic powder coatings.

EQUIPMENT:

1) Gardner Micro (or equivalent) Glossmeter
2) Properly coated surface

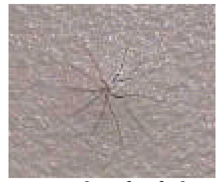
PROCEDURE:

1) Prepare panel or substrate according to supplier recommendations
2) Place room temperature panel on a flat surface.
3) Remove the gloss meter from its protective holder and place in a vertical and level position on top of the surface.
4) Press the "Mode" button until the proper sample mode is displayed. Use the 60 angle as the default mode, unless otherwise specified by the customer (20 and 85 angles are available). Press the "Operate" button and wait for the result to display.

RESULTS: Report the specular gloss indicated on the gloss meter digital readout.

DIRECT/REVERSE IMPACT


Example of a Pass


Example of a failure

SCOPE:To determine the impact resistance of a powder coating applied to a substrate.

EQUIPMENT:
1) Variable Height Impact Tester
2) Properly coated surface

PROCEDURE:
1) Prepare panel or substrate according to supplier recommendations
2) Allow panel or substrate to cool to room temperature.
3) Place the panel on the table provided at the bottom of the variable height tester beneath the rounded impact surface.
4) If direct impact is to be checked, the panel should be placed on the table with the coated surface up. Place the coated surface down for reverse impact.
5) Raise cylinder weights to top and allow to drop freely.
6) Continue to drop cylinder weights at lesser heights until an impact is made that does not crack the coating.

RESULTS: Report the results in inch-pounds. To determine the inch-pounds the following equation applies: height in inches multiplied by cylinder weight in pounds equals inch-pounds. The weight of the cylinder is 4 pounds and inches are indicated on the impact tester.

VISUAL COLOR

SCOPE: To determine the visual color as defined by the quality specifications.

EQUIPMENT:
1) MacBeth Light Booth
2) Properly coated panel or substrate
3) Known standard

PROCEDURE:
1) Prepare panel or substrate according to supplier recommendations
2) Allow panel or substrate to cool to room temperature.
3) Select the proper light condition to review the color by activating the buttons on the light booth that corresponds with the desired light condition.
4) Review the known standard next to the trial panel at arms length away in the light booth at various angles to ensure color consistency per reviewers color knowledge.

RESULTS: Report the results as pass or fail.
NOTES: The proper light sources depend on the customers requirements. Daylight is for exterior, Incandescent and Fluorescent is for interior.

DRY FILM THICKNESS

SCOPE: To measure the dry film thickness of a nonmagnetic coating applied over a metallic (ferrous or aluminum) substrate.

EQUIPMENT:

1) Properly coated surface
2) Dry Film Thickness Gauge

PROCEDURE:

1) Prepare panel or substrate according to supplier recommendations.
2) Place room temperature panel on a flat surface.
3) Place film thickness gauge probe in a vertical and level position on top of the surface. (see notes)

RESULTS: Report the thickness reading indicated on the film thickness gauge in mils.

NOTES: For the handheld PosiTector 6000, the probe is located at the bottom of the unit and the entire device should be held upright and flat on the test panel. The Fisherscope MMS unit includes a wire remote probe, which should be pressed downward onto the test panel.

FILM HARDNESS BY PENCIL TEST

SCOPE: To determine the film hardness of the coating on a substrate in terms pencil leads of known hardness.

EQUIPMENT:
1) Properly coated surface
2) Calibrated wood pencils or drawing leads meeting the following scale of hardness:

4B-3B-2B-B-HB-F-H-2H-3H-4H
Softer Harder

3) Abrasive paper
4) Mechanical Lead Holder, for drawing leads if used.

PROCEDURE:
1) Prepare panel or substrate according to supplier recommendations.
2) Place room temperature panel on a flat surface.
3) Rub the lead against the abrasive paper at an angle of 90o to the paper until a flat, smooth surface is obtained.
4) Starting with the hardest lead, hold the pencil or lead holder firmly with the lead against the film at a 45o angle and push away from the operator.
5) Repeat the process down the hardness scale until a pencil is found that will not scratch (surface mar) or gouge (expose substrate) the coating.

RESULTS: Report the hardest pencil that will not scratch or gouge the coating. Unless specified as a "gouge" test by the customer, it is assumed that the "scratch" hardness will be reported.

MANDREL BENT TEST (FLEXIBILITY)

SCOPE: This method determines the resistance to cracking (flexibility) of organic coatings on the substrate

EQUIPMENT:

1) 1/8 Inch Bend Conical Mandrel Tester
2) Properly coated panel

PROCEDURE:

1) Prepare panel or substrate according to supplier recommendations.
2) Allow panel to cool to room temperature.
3) Slip the panel between the mandrel and the drawbar with the finish side towards the drawbar.
4) Rigidly clamp the specimen in a vertical position adjacent to the mandrel by placing the long edge behind the clamping bar in such a manner that the panel is always set up to the narrow end of the mandrel.
5) Move the lever through about 180o bend at uniform velocity to bend the specimen approximately 135o.
6) Bring the drawbar to the starting position and remove the panel from the mandrel.
7) Examine the bent surface of the specimen immediately with the unaided eye for cracking along the bend of the panel. Cracking of the coating is considered a failure.

RESULTS: Results are reported as pass or fail to a 1/8 in. Mandrel Bend.

ADHESION

SCOPE: To assess the adhesion of coating films to metallic substrates by applying and removing pressure sensitive tape over cuts made in the film.

EQUIPMENT:
1) Cutting Tool
2) Properly coated surface
3) Adhesive, one-inch wide semi-transparent pressure sensitive tape

PROCEDURE:
1) Prepare panel or substrate according to supplier recommendations.
2) Place room temperature panel on a flat surface.
3) Using the crosshatch cutting tool, cut through the film to the substrate in one steady motion using just sufficient pressure on the cutting tool to have the cutting edge reach the substrate. Make all cuts about ¾ in. long. Two cuts should be made perpendicular over the same area to form a "grid" pattern.
7) After making the required cuts brush the film lightly with a soft brush or tissue to remove any detached flakes or ribbons of coating.
8) Remove a length of tape approximately 3 in. long.
9) Place the center of the tape over the grid and smooth into place by a finger.
10) Remove the tape by seizing the free end and rapidly (not jerked) pull back upon itself.
11) Inspect the grid area for removal of coating from the substrate.

RESULTS: Rate the adhesion based on the following:
5B - The edges of the cuts are completely smooth; none of the squares of the lattice is detached.
4B - Small flakes of the coating are detached at intersections; less than 5% of the area is affected.
3B - Small flakes of the coating are detached along edges and at intersections of cuts. The area affected is 5 to 15% of the lattice.
2B - The coating has flaked along the edges and on parts of the squares. The area affected is 15 to 35% of the lattice.
1B - The coating has flaked along the edges of cuts in large ribbons and whole squares have detached. The area affected is 35 to 65% of the lattice.
0B - Flaking and detachment greater 65%.

NOTES:
Special considerations must be made when testing coatings over products that may be are rounded or otherwise unsuitable for use with the crosshatch tool. In such cases, a knife or other cutting edge may be used.

SOLVENT CURE TEST

SCOPE: To determine cure of powder coatings. Reagent A, MEK, is recommended for epoxy powder coatings or other powder coatings which exhibit a high degree of solvent resistance. Reagent B, blend of MEK and xylene, is recommended for other powder coatings including hybrids, polyester urethanes, and TGIC cured polyesters.

EQUIPMENT:
1) Reagents: MEK (Methyl ethyl ketone) and xylene
2) Containers to hold mixed or single reagents.
3) Cotton-tipped stick
4) Properly coated panel

PROCEDURE:
1) Mix MEK and xylene in ratios of:
Reagent A:100% MEK
Reagent B:10% MEK/90% xylene by volume
2) Fill squeeze bottles with reagent blends and label accordingly.
3) Saturate cotton tip with appropriate solvent or blend. It is recommended to resaturate tip after 50 double rubs. A double rub is one stroke forward and one stroke back in approximately one second.
4) Use reagent A and B as described in scope.
5) Stoke/slide tip on the test panel (in the same area, at a stroke length of 3-5 inches) while looking for obvious signs of powder coating failure.

RESULTS:
1) Results from this test should always be compared with known cured panels of the same chemistry.
2) The following represents the degrees of apparent cure:

Observation Rating
Dissolving to bare metal No Cure (usually less than 25 double rubs)
Some film removal and softening Partial Cure (25-50 double rubs)
No effect on film appearance or gloss Cured Coating (50+ double rubs)

3) Report number of double rubs to bare metal or failure if applicable. The test is normally stopped when the coatings show no effect after 50 double rubs with the solvent.

NOTE:It is a general practice to use 100% MEK for all testing in the lab. Reagent B is recommended for field use.

Chapter

6

10 Steps to successful Powder Coating

The key steps to successful powdercoating can be distilled to these key points.

10 Steps to Successful Powder Coating

1. Start with a clean part. At a bare minimum ensure you clean parts with MEK or Acetone

2. Use clean air in your shop. At least have a water/oil filter before your gun.

3. Have equipment which is in good working order. Ensure your gun is charging.

4. Do not apply to thin or too thick a film build. Most products need around 2.0 mils of powder for the best appearance and properties. This equates to around 4 passes with a gun depending on the gun and settings.

5. Ensure you properly cure (bake) your part. For most powders you need the part to get to 380 degrees F for around 15 minutes. Overbaking can change the color, underbaking will result in poor physical properties.

6. Use powder coatings from a reputable supplier. See our Supplier section, cheap or auction retailers may supply you with poor quality material with a large amount of fillers or poor properties. With powder coatings you generally get what you pay for. Always request a panel of the powder you have purchased. This will provide you with a lab sprayed reference check of the material.

7. Ensure you have a good ground for your part. Poor grounding can result in an inconsistent film build and application difficulties.

8. Your oven must be well ventilated. Poor air circulation and turnover can cause inconsistent cure, hazing on the parts, discoloration and build up of by

products in your oven.

9. Clean, clean, clean. Be sure to clean up well after you powder coat parts, residual powder coatings can contaminate other coatings leaving color specs or even craters.

10. Implement a quality control program. At a bare minimum check the cure of your products using the test methods in our QC section. If you don't have any of that lab equipment at least check the solvent resistance and try to scratch the surface of a test piece with a nickel. Nothing is worse than sending out under cured products, this is like buying a loaf of bread with a doughy middle.

Chapter

7

Top Powder Coating Questions.

Here is a synopsis of the top questions we have been asked over the past 15 years about the industry.

We know that powder coating can seem intimidating and overwhelming for the new powder coater. For you we have compiled this section with the top questions asked by new powder coaters as well as information for setting up your new powder coating system.

Why should I use powder coating?

- The use of powder coatings vs. liquid solvent based coatings results in significantly less emissions of volatile organic compounds (VOC's) and hazardous air pollutants (HAP's). They can also reduce energy consumption, can be more cost effective and provide better properties.

How long have powder coatings been around?

- Powder coatings have been applied in the US since the mid-1950's when they were being used to coat pipe for corrosion protection and electric motor parts for insulation. These powders were applied using a fluidized bed into which a heated part was dipped. These coatings were functional coatings and did have the greatest appearance.

What is the difference between Thermoplastic and Thermoset powder coatings?

- Thermoplastic powder coatings will melt and flow when heated, but do not change chemically. They will remelt when reheated. Thermoset powder coatings will melt and flow when heated and then chemically 'crosslink' or react. These will not remelt when reheated and tend to have better physical properties than Thermoplastics. Most powder coatings are Thermoset.

What Powder Coating Chemistry should I buy?

- It all depends on your application. Most chemistries can be custom formulated to meet your specific needs. For most applications, the best bet is a TGIC Polyester, these can be used on parts which are outside and have good physical properties. For interior applications a Hybrid powder coating is cost effective and has good properties. An Epoxy powder coating has great properties and excellent corrosion and chemical resistance but is also only for interior applications. A Urethane Polyester has good flow and physical properties, is for exterior applications but can be expensive and has a higher oven temp requirement than TGIC coatings. When in doubt, go with a TGIC. Remember, never use and Epoxy or Hybrid for outdoor applications. They will fade.

What about Porcelain enamel Powder coating?

- Although Porcelain is applied with similar equipment as standard powder coatings, it is very different. Porcelain powder is called Frit and is much more expensive a process which requires an oven temperature of 1,200 F to fuse the Frit (powdered glass) to the metal surface. Sinks, bathtubs and some appliance parts are coated with Frit.

How should I prepare my parts for powdercoating?

- Most coatings need some degree of pretreatment in order to achieve acceptable coating properties and appearance. With powder coatings the pretreatment is critical. Pretreatment refers to cleaning parts and leaving a 'conversion coating' for the paint to adhere to. At a minimum, parts need to be clean and dry with no residual oils or chemicals on the parts. Depending on the final use of the part additional processing may be required before powdercoating.

Interior applications, non corrosive environments (chairs, furniture, decorative finishing):
For these applications, you may be able to get by with simply degreasing the parts. The finish may remain for a number of years, or come off in sheets after a few months.

Interior applications, corrosive or heavy use environments (washers, auto under hood, equipment)
You must at a minimum, degrease and apply an iron phosphate pretreatment. A one step cleaner/phosphatizer may work for basic applications.

Exterior applications or highly corrosive environments.
Do not even consider simply degreasing the part. The coating will fail, sooner

than later. A minimum of a three stage pretreatment is required. Your customers will eventually be very disappointed if you do not do this.

How do I spray Powder? What makes it stick?

- Powder coatings are generally applied via an electrostatic spray gun. Compressed air moves the powder coating through the feed tube from the box, drum or hopper to the gun. It is possible to move the powder with air because the air 'fluidizes' the powder making it act like a liquid. The gun then applies a charge to the powder particle by the use of a high-voltage, low-amperage electrostatic field which it generates between the gun electrode and the grounded part. This charge is usually negative. There are guns available which do not use an electrode to generate the charge, they use a special insulator/conductor inside the gun which generates a charge through the use of friction. This is a Tribo gun and it generates a positive charge. Most guns used are Corona guns.

The powder sticks to the part the same way a magnet sticks to metal or a lint to a static charged shirt. This charge will diminish or decay over a few hours. Most parts enter an oven as soon as they are powder coated. In the oven the powder melts, flows and crosslinks.

Why do I need a spray booth? How is the powder reused?

- The main function of the spray booth is to safely contain the powder coating so that the overspray generated does not go into other areas of the plant. You must ensure that the airflow through the booth is sufficient to contain all the overspray into the recovery chamber without disrupting the powder depositing on the part. A general rule of thumb is to maintain a face velocity of 100 ft/min across all openings. Since there is no solvent in the coating, the exhaust air can be safely circulated back into the plant.

The powder can be reused by simply blending the overspray with virgin, or new, powder. The reclaimed powder is of value only if it is free of contamination from other coatings. Color changes in a reclaim type booth can be simplified by the use of separate recovery chambers.

What about curing ovens?

- The main types of ovens used for baking, or curing, powder coated parts are: Convection, infrared or a combination of the two. Convection ovens are gas or electric, which heat air and circulate the heated air in the oven. Infrared ovens are also gas or electric and emit radiation energy in the IR wavelength band. This energy is absorbed and causes the powder to cure.

What is Transfer Efficiency?

- Transfer efficiency is defined as the ratio of powder applied to the parts to the total amount of powder sprayed. Reclaimed, or recovered powder is not considered in this calculation. Factors which affect transfer efficiency include the operator skill, shape of part, booth design, powder quality, spray techniques, grounding of the parts and condition of equipment. The high transfer efficiency rates and ability to reclaim overspray contribute to the large economical advantage powder holds over liquid.

Can I recoat parts? How?

- Powder coated parts are routinely recoated for a variety of reasons. To recoat a part with the same product it was coated with you usually can simply rehang the part, turn the gun voltage down, respray it and cure as needed. Certain chemistry powders cannot be recoated, such as highly chemical resistant epoxy powders. These products need to be lightly sanded to obtain the proper level of adhesion.

Can I strip Powder coatings? How?

- Powder coatings can be stripped with Mechanical methods, Thermal/Bake methods, Chemical methods. The method used will depend on the speed, degree of stripping, effect on the parts and environmental concerns.

Mechanical methods included sanding or blast stripping the powder coating with abrasives or fluidized aluminum oxide (sand).

Thermal methods may adversely effect the hardness of the parts stripped due to the operating temperatures required. This is however often used for noncritical parts. Most of these systems are batch type systems in which the oven is ramped up to 750 F and the organics in the coatings are volatilized. These 'VOC's' are usually destroyed by an afterburner in the exhaust.

Chemical methods included hot or cold chemical solutions of aqueous caustic or non caustic alkalis. Most solvent systems such as Methylene Chloride are no longer viable due to environmental and health concerns.

Care of Powder Coated Parts.

Properly cured powder coatings are resistant to most chemicals, however, DO NOT allow MEK or Trichloroethane to come in contact with the powder as it will attack the surface.

You can wax powder coated pieces if you want to but it's not necessary.

Whenever possible, use washers beneath both nuts and bolt heads.

Excess powder can be removed with either an oiled tap/die for threads or with a die grinder affixed with an abrasive wheel or cone.

Unless using a high heat powder, do not expose cured powder coatings to temperatures over 400 degrees for an extended period of time.

Use care in packaging powder coated parts, they are durable but do not like cardboard packing.

How do I change over from one powder to another without contamination?

The first issue is to consider the compatibility of the two powder coatings. A compatibility test of the two powders can determine if problems will result when the two powders are mixed. Generally your powder coating supplier can run this test for you. The test consists of blending the two powders in ratios of 90:10, 50:50 and 10:90, then spraying a test panel with each blend.

If the two powders are compatible (compatible is when minimal gloss change and no craters occur) the change over can be rather simple:

- Run the existing powder as low as possible.
- Blow out hoses, guns, transfer and powder pumps and your sieve.
- Squeegee down the booth and dispose of the powder.

You should also consider:

* For cyclone systems, air purge for 15 minutes. Blow off and wipe down the bottom 2 feet of the cyclone interior. Remove and vacuum clean the collection canister.

* For cartridge filters, which hold up to 35 pounds of powder in each filter, it could take several hours or even days until the majority of the powder is back pulsed through the filters. Back pulsing will not completely remove the prior powder from the cartridge filter. This could leave some doubt if any contamination quality issues arise. Consider replacing, and asking your new powder supplier to assist with the cost of, these filters.

If the products are not compatible, all electrostatic equipment (including the booth) will need to be cleaned and some items replaced. The proper steps to follow are:

1. Run the existing powder as low as possible in the coating booth.

2. All powder should be removed from all electrostatic spray equipment such as transfer pumps, hoses, powder pumps, sieves, feed hoppers and spray guns.

3. Cyclone ductwork should be cleaned with compressed air and where possible wiped down. If necessary, plastic shot blast media can be run through the ductwork to ensure all traces of powder are removed.

4. Powder in the booth should be squeegeed into the collector module and then wiped down with a diluted alcohol (IPA) solution. Interior walls of the feed hoppers and the sieve should be wiped down with this solution. Do not get any of this or other solvent solutions on the fluid bed membrane.
5. Replace equipment on the coating line such as all hoses, venturi tubes and the sieve screen.

6. The bulk feeding apparatus should be completely cleaned.

7. Cleaning the collector module (reclaim) involves the removal of cartridge filters, vacuuming out all powder, wiping down the walls with a diluted alcohol solution. Once the system is completely cleaned and the new cartridge filters are installed, they will need to be seasoned. A properly seasoned cartridge filter will prolong its life expectancy and help maximize the coating booth's operating efficiency. Seasoning of the cartridge filters takes anywhere from 2-8 hours.

Seasoning instructions are provided by your booth manufacturer. They generally consist of operating your system without electrostatics turned on and is complete when predetermined booth face air velocities are reached at specific air settings.

8. Your system is now ready to go!

What is a Datapaq and how do I use one?

The question of whether a thermosetting powder coating is "cured" is one that is often answered with a degree of uncertainty. There can be many ways to answer this question using smoke charts, IR heat guns, Temperature tape or sticks, solvent rubs and oven recorders from various suppliers. The best method of assuring cure is process control of the oven and part temperature, because part temperature is ultimately the determining factor of whether your powder coating has cured or not.

A datapaq is an oven temperature data logger and is available from www.Datapaq.com for around $3,000. An alternative is the Cure Trak from www.ECD.com

A data logger system such as these is a means of recording and viewing air temperature as well as part temperature through the dry-off and cure ovens. The recording is accomplished by hanging the oven recording system, along with the part in the oven. You can attach up to 6 probes to the data logger to various areas of the part to record both air and part temperature as the part goes through the cure cycle. This data is then downloaded from the logger unit to a pc running the software supplied by the logger manufacturer.

Cure curve on ECD software.
Photo courtesy of ECD

Operator setting up probes on a steel part.
Photo courtesy of DataPaq

Once the operator has downloaded the data from the data logger you can either view or print many different reports. By entering all the data about the run such as probe location, oven configuration and temperatures you can learn a great deal about the process.

The operator can determine how long it took each probe to reach a specified temperature and how long it was above that temperature. This information is good to know since powder coatings are supplied for cure in terms of time and temperature. Also, many pretreatment suppliers make recommendations to time and temperature for their conversion coatings because if parts exceed given temperatures in the dry-off oven, degradation of the conversion coating could result.

Many powder coating suppliers are willing to run a data logger through your cure oven free of charge, just give them a call and ask. Their technicians can then interpret the results and review them with you, making oven balancing and formulation suggestions based upon your specific parameters.

Scratch and Dent Fillers Under Powder Coatings:

Scratches and dents in sheet metal substrates are often encountered by fabricators and coaters. To salvage these parts you will want to repair the substrate prior to powder coating. Many coaters try Bondo or automotive body repair compounds which are applied to a clean dent or scratch, allowed to harden, then sanded and coated. Some work fairly well, most do not.

In order for a filler to successfully work with powder coating the following is required:

- Good adhesion to both the substrate and to the powder topcoat.
- Sufficient temperature stability to allow for powder cure.
- Sandable and machinable.
- Non-gassing and free of surface causing defects.

There are two fillers we have experience with: the first is Lab metal from Alvin Products (978) 975-4580, the other is Devcon Titanium Putty from ITW Devcon (508)777-1100. The Lab Metal is applied directly from the can, the Putty is a two component which you must blend.

To test these fillers we impacted CRS panels with 160 inch pounds and Aluminum panels with 80 inch pounds to create a deep dent. These dents were filled and smoothed with a trowel, or scraper, then cured as recommended by the manufacturer. The area was then sanded, cleaned and then powder coated with three different powders: an epoxy, a hybrid and a TGIC via a corona spray gun. The panels were then cured per the standard cure cycle for the powder, a range of 360F to 400F.

All of the products showed the patched areas to be free of out gassing and had excellent adhesion for all powder chemistries and on both the aluminum and CRS panels.

What maintenance does a powder system need?

- We have put together a complete maintenance checklist for your use. This is available at the end of our manual.

Tell me about grounding and powder coating:

- Inadequate ground is the most frequent problem encountered in powder coating systems. A sufficient ground path must be provided for all equipment associated with powder applications for safety and efficiency reasons.

Safety Reasons:

Grounding is necessary to carry charge away from the application equipment to prevent static discharge or sparks which provide an ignition source and may lead to a dust explosion. This is one of the most serious safety hazards associated with powder coating. All automatic powder systems must be equipped with spark detection equipment to shut down the spray guns in the event of a discharge. The grounding of the operators helps to prevent shocks as well as sparks. Conductive shoe soles and grounding straps can help prevent shocks from static build up in operators.

Efficiency reasons for grounding.

Good ground is required to carry away charge which is delivered to the parts by the powder or through ionized air. This allows more powder to be deposited and better penetration into Faraday areas. The main reason is that good ground improves transfer efficiency.

As powder builds up on the surface of the part, charge separation begins to occur in the part. That is, in the case of a negatively charged powder, positive ions in the part flow toward the powder coated surface and electrons carrying a negative charge flow to ground. In order to continue powder attraction to the part the ground circuit must stay intact. Thus ground maximizes the powder charge holding capacity of the part.

What causes poor ground?

Most ground problems are the result of poor design or inadequate maintenance. For some powder booths there may not be enough air movement to capture the over sprayed powder. This powder may drift out of the booth and settle on the conveyor or load parts. Powder is a very effective electrical insulator and it will interfere with ground if deposited at contact points. This is especially true if coated hooks or hangers go through the oven and the powder is cured in place.

An important design feature involves hook/hanger configuration.
S shaped hooks may provide only a single contact point and allow the part to change position. V shaped hooks, for example, can offer at least two contact points and hold the part more firmly in place to prevent undercoating with powder. When possible, the hooks/hangers should be designed to shield the contact point from the coating. Hooks made from square stock should be turned on an angle to have a sharp contact point.

It is also important to maintain metal to metal contact at all points. This is usually done by cleaning the hooks/hangers, via burn off, chemical stripping or blasting. Following burn off it is also important to insure that any residue or ash is removed. This ash may also be an electric insulator and as such it will interfere with ground. To prevent powder build up on hooks/hangers ensure they are fully loaded to prevent empty contact points from being coated.

Maintenance of proper gun placement and aiming as well as booth capture air flows will also prevent a build up of powder on hooks/hangers. Cleaning excess powder off of the conveyer is also a good practice. Ensure that your gun control panels and booths are properly grounded using ground cables instead of depending on connections to the control cabinet.

How can I test for sufficient ground?
Testing for sufficient ground is preferably done with a Megohm meter or megger. It is important to follow the entire ground path. For parts, it is best to start with the conveyer and check every link in the chain to the part (from the conveyor to loadbar, loadbar to rack, rack to hook, hook to part). This will tell you if and where any problems may exist. The NFPA Bulletin 33 states that less than one megohm is needed to minimize the chance of sparks, for efficient coating resistance of 0.5 megohm or less is best

While testing, if a wire lead is attached to ground and directly to a clean part, the effect of good ground can actually be seen by coating the part with this connection in place. If the noted improvement in the deposition/thickness or penetration is dramatic then the benefits of good ground become more clear. If the improvement is slight, but resistance readings are one megohm or higher, chances are still good that better ground will improve harder to measure characteristics such as transfer efficiency and consistency.

Obtaining good ground:
A good ground starts with the earth connection. Using water pipes may provide you with reasonable success. The optimum ground however, is achieved by driving a copper rod into the soil to a depth of 8 to 10 feet. This

should then be connected to the conveyer at multiple points for insured good contact.

Minimizing connections between the conveyer and the part can be very helpful in optimizing ground. A solid rod has fewer contact points to worry about than a chain of multiple connections.

The addition of a well grounded rub bar or brush above the booth helps to insure contact with fixtures in the event that the conveyer is not providing adequate ground due to a build up of lubricants and contaminants.

Modify hook designs to encourage contacts and frequently clean hooks.

Can I use powder as a primer for liquid coatings? How?

Powder coatings are frequently used as basecoats or primers for liquids. The reasons for this can be:

* To provide improved corrosion protection from the powder coating
* To provide improved edge coverage from the powder coating
* To provide appearance or special effects available only in liquid topcoats.

Most powders work well as a primer coat, however, some additives, such as gloss control agents, will interfere with topcoat adhesion. Some may float to the surface of the coating or co react to give a film which is very solvent resistant. Epoxies may be the best for corrosion protection and are the most popular base coat. They are not good for clear coating though, since UV light can be transmitted through the topcoat and cause the epoxy to chalk.

The composition of the liquid topcoat is also critical. Most solvent based liquids offer the best results because they "bite" into the powder. Lacquers and enamels work well due to their high solvent content. High solids and two part systems can also be used, but compatibility becomes even more important since the solvent content is decreased.

It is important to always test the appearance and adhesion of a liquid over a powder coating. Test intercoat adhesion using the crosshatch method (see our quality section).

Some issues you may encounter include

* Lack of intercoat adhesion: Change to a liquid with a more aggressive solvent composition or solvent wipe the base before coating. You can also scuff sand the base coat.

* Color bleed through: Incomplete cure of basecoat, try to cure the basecoat for a longer time.

* Lack of adhesion to part: Poor cleaning or the base coat is undercured.

Can I touch up powder coatings?

It is sometimes needed to touch up areas left by hangers or hooks or to repair damage resulting from abuse of the coating during handling or assembly.

Most room temperature cured epoxy coatings can be successfully used to touch up powder with excellent results.   These epoxy coatings generally consist of two parts: A base and a hardener which you mix together before using. You can spray of paint this on.

Other options include using a solvent based liquid to touch up the areas.

Check with these suppliers of touch up paints:

Custom Pak Products: 414/251-6180
ORB Industries: 800/771-7140
Raabe Corporation: 800/966-7580
Randolph Products: 201/438-3700
Seymour of Sycamore, Inc: 800/435-4482

How do I take care of color standards?

A color standard is generally a panel supplied by your powder supplier or most often by your customer which shows you what the color is expected to look like. This standard also gives you an idea of the appearance and gloss of the product you are to spray. You should always have a color standard for all products you spray and check your runs against this standard to ensure you have consistent quality.

To prevent these standards from changing the following steps should be followed:

* Store the panels in an envelope and out of the light.

* Do not subject to extremes in temperature.

* Handle with care and hold by edges only.

Where do I begin? What do I need to powder coat?

To powder coat parts you will need the following:

- A powder coating gun. The inexpensive $80 to $150 dollar guns are worthless for anyone who wants to go into this for business. For hobby work they may suffice - for a while. A good powder coating gun will cost you around $3,000. Use a reputable company such as Nordson or Iontech in Ohio, or Gema in Illinois.

- A powder coating booth. Basically this is an enclosure with a vacuum to collect the oversprayed powder. I have seen old liquid waterfall booths used for this as well as plywood enclosures. I have also seen plants burn down using plywood enclosures with ordinary vacuum cleaners collect the overspray because sparks from the vacuum motor ignited the powder cloud.

- A cure oven. For a hobby powder coater an ordinary oven will probably work for you as long as the parts fit. Do not plan on cooking food in the oven once you cure powder inside of it. Powder cure does cause some nasties to come off and these will collect in that oven.

For anything other than hobby powder coating you will need a real industrial oven capable of holding around 380 degrees F. They can be a basic 'batch' oven which is basically a very large oven which you can wheel a rack of parts into, a large panel constructed oven with a conveyor passing through it or an elaborate Infra Red Oven. Your parts and production goals will dictate what you need.

With these three items, powder gun, powder booth and cure oven you can powder coat parts successfully provided they are completely clean. For the hobby coater it will suffice to clean parts such as valve covers, fishing lures or knick knacks in a pail with a solvent such as MEK or Acetone. For a professional powder coater you will need, at a minimum a system to clean and pretreat your parts. If you want to powder coat for business, it is imperative you understand pretreatment and sell this feature to your customers.

Without good pretreatment, powder coating is worthless!
I cannot stress this enough, and trust me, valuable customers know this.

Powder Application Rooms.

The purpose of an application rooms, or environmental rooms, are multi purpose rooms designed to isolate the application process from the harsh, dirty plant environment as well as to provide a consistent temperature and humidity control to provide the optimum application efficiency of the process. In addition to Federal and local fire codes (which typically include a 1-2 hour fire rating) incorporate the following ideas into your design:

* The walls, ceilings and surfaces of the application room should be made of smooth, easy to clean materials which should be sealed to ensure they do not introduce airborne contaminants into the room. Do not use materials such as unpainted sheetrock, unsealed wood paneling, or plasterboard which will shed fibers. Typical construction methods include using common lumber yard materials, masonry materials such as concrete blocks or purchasing a pre-fabricated room from a supplier who specializes in such designs. These prefab rooms are generally insulated, powder coated steel panels with tongue and groove construction.

- The room should be large enough to allow workers to clean, maintain and operate the system with ease. Keep in mind how much room is needed to roll booths off line for cleaning and maintenance if setting up a multi booth system. It is also important to have powder coatings condition at the temperature it will be sprayed at so size the room for a 1 to 2 day supply of powder. If using fork trucks or hand trucks, ensure you have enough room for these. Do not however use the room for general powder storage, set up another area for long term storage.

- Ensure that the operators can enter and exit easily, while minimizing cross through traffic. Use tacky walk off mats to prevent dirt and contaminants from entering the room. Some operations even use air chambers which blow the operators off with ionized air. Incorporate at least one overhead door to make booth maintenance and delivery by fork truck possible.

- Powder suppliers recommend that the application areas be maintained in the range of 65 to 75 degrees F with 40 to 60 percent humidity. These ranges ensure consistent film builds without the need for constant adjustment and reduces equipment wear by keeping moisture away from the reclaimed powder.

- Ensure the room is positively pressurized to prevent outside contaminants from entering through the openings in the room for the parts and doors when open. Ensure that the air vents doe not interfere with the air flow in the booth. The recirculated air should also be filtered to remove airborne contaminants as small as 2 microns and have a velocity of less than 200 FPM. These systems should have a two-stage filtration system on the return air side, with a washable pre-filter and disposable after filter.

- Good lighting is a necessity in the application area. The lighting fixtures should be flush mounted to eliminate any dust traps for powder which may (and it will) escape the powder booth. Remember that according to the NFPA 33 standard, any light fixture within 5 feet of a booth opening must be rated for Class II, Division 2 locations.

Typical Medium Cost Job Shop Spray Booth
Here is a typical spray booth used by job shops. Note the conveyor passes through the top allowing a consistent production flow. You also have room here to wheel in a rack of parts (batch system) and coat them in the booth. The booth has inexpensive filters and very good lighting.

Typical Box Feeder Powder Gun
Here is a basic box feeder. This one is from Binks/Sames.

Just stick the wand into your powder box or drum. Plug the unit into 110 AC and a compressed air source. Connect the ground strap to your booth or part. And you are ready to spray powder!

This unit runs around $4,500

Here is a job shop layout for a company which coats chairs and automotive parts. The building is just a basic butler type steel building.

The overhead conveyor comes toward you on the right hand side. Parts come in on the dock down at the far end of the building where they are hung on the conveyor and go through a 5 stage pretreat system (blue tunnel on the right) then they enter a dry off oven (set around 200F). They then enter the manual spray booth on the left and get cured by the gas oven right after it. From there they are removed, packaged and shipped out.

Presuming your system has been properly set up, which for a hobby coater is as simple as:

1. getting a box for a booth
2. plugging in your gun and oven
3. connecting the ground strap from the gun to the part
4. trigger the gun and spray the powder on the part
5. put the part in the oven for the cure time

These same basic steps would be followed for the job shop and OEM coaters who spray millions of pounds year.

What can I powder coat?

The basic rule of thumb is that you can powder coat anything which you can bake in an oven.

Current powder technology allows a minimum cure cycle of 15 minutes at 250F.

This means you can powder coat:

- Virtually anything made of Aluminum, Brass, or Steel
- Magnesium parts - including die cast and Thixomolded
- MDF (medium density fiberboard) (certain toilet seats are powder coated)
- Glass (for many years Polo cologne bottles were powder coated)
- Many grades of plastics. (certain Bic pens are powder coated)

You may ask, how do I powder coat wood, glass and plastic if the powder is applied electrostatically?

The answer is easy, simply preheat the part to get it up to around 200 degrees F and spray the powder on - it will stick right to it. Then you bake it out as usual.

Chapter 8

Powder Coating Special Effects

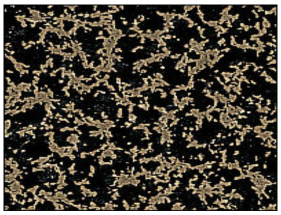
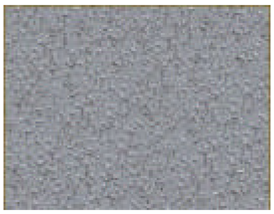
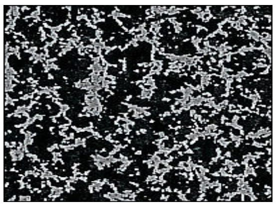
By learning how to do your own special effect coatings, you can create products which stand out from your competition and save a significant amount of money on your powder coating.

Special effect powder coatings bring glitter and a unique look to your products. Besides the basic colors and textures available in powder coatings you will find that suppliers offer many specialty products. These can include hammertones, spices and metallics. The price per pound of these material is significantly higher than basic powder coatings. You can get these appearances on your own with little work.

Hammertones:

These are coatings which look as though they have been 'hammered' they have a base coat with a metallic veining throughout. Easy to by blending in around 5% of the metallic look you want along with 0.5% to 2.0% of Troy 508 (Troy Chemical 1-973-443-4200) or CAB. The best base for these products are hybrids.

Here you see three different hammertones based on color and additive package. The one in the middle is available from powder manufacturers only, you cannot blend to get this.

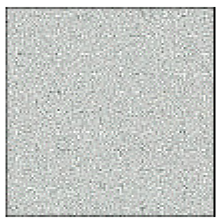




Spices:

Spice coatings simply are a mixture of a variety of colors. A popular spice which looks like granite is simply a blend of white and black powders. Other spices, such as those used for outdoor furniture may have up to 4 other colors blended together. Don't be afraid to blend different colors/glosses of powders which are of the same chemistry (same chemistry is very important) together to experiment.

Metallics:

Metallics are regular powder coatings to which up to 7% of aluminum, bronze or mica flake has been blended in. You can get these from companies such as Englehard (800-758-9542) or EMD (1-888-367-3275) or Silberline (800-348-4824)




Applying metallics

When applying metallic powder coatings take the following into account:

- Most metallic powder coatings need to be clear coated to prevent marring and tarnishing of the aluminum pigments.

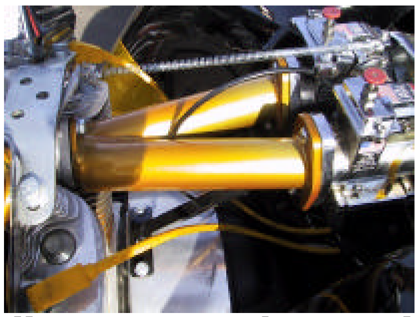
- Metallic powders must be fluidized, not fed directly from a box, to be consistently applied.

- Turn the gun voltage down when applying metallics, a voltage of around 35 KV is recommended as a starting point.

- Blow your guns and lines out often to prevent globs of aluminum from spitting out on your parts, resulting in what looks like little clumps on your parts.

Orange basecoat TGIC with 3% gold flake added.

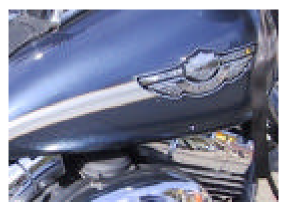
Clear Acrylic topcoat with 1% Gold flake added.



Yellow TGIC with 4% gold flake added in.

Blue TGIC with 3% silver flake and 1% blue mica added

Stripes added on with an Enamel



Bonded / non Bonded powders

Metallic powders can be bonded or non bonded. Bonded products increase the cost of the product rather significantly. The main benefit of bonded metallic powder coatings is that these coatings can generally be reclaimed and may work in Tribo systems.

Bonded powders are made by a special process which combines the aluminum particles with powder particles in a special chamber.

Non bonded metallic coatings are not easily reclaimed because the metallic tends to separate from the powder during application. The metallic particles are charged differently than the coating into which they are blended resulting separation of coating and metal pigments.

If you are blending your own metallics then your coatings are non bonded. Most powder suppliers can supply you with bonded materials but the extra cost is generally not worth the ability to reclaim the powder coating.

The key to applying and making your own specialty effect powder coatings is in ensuring your formula gets completely blended and remains blended. It is strongly recommended to use a fluidizing hopper when applying these products to keep the material blended, a vibratory feeder is not recommended.

Color fades:

These can easily be done by simply masking off the part you want to be a different color, powder coating the rest and then partially curing out the part (for about 30% of the cure cycle) Then simply allow the part to cool, mask the coated part off. Powder the rest of the part and remove all the masking, now cure out the part for the entire cure cycle. You can get very creative by finding ways to blend in the colors at the interface by using compressed air to 'fade'

You can alternatively not use any masking and do not cure out the first color, by selectively using the powder tips (use fan tips) and varying the air settings, you can airbrush the interface very neatly and cure the part out at once.

This is an orange Polyester Urethane which was sprayed and cured out. Then it was masked off and a Black Polyester Urethane was applied and cured. The silver is a pinstripe added by their shop.

Fades can be much more elaborate than this and you can produce some incredible blends between the colors. Try various approaches to this on some spare steel until you become a pro. Quality special effect application takes years of practice.

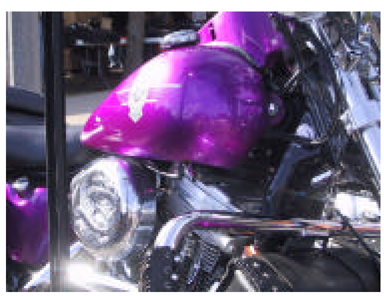
Deep Candy Apple Colors:

Want a deep Candy Apple Red? Coat your part with a silver metallic or a bright white and cure it for about 80% of the cure cycle, allow to cool. Apply a 'tinted clear' red, which is basically a powder coating with a reduced amount of pigment - your powder supplier should understand what you need if you use that term 'tinted clear'. Cure this layer out for another 80% of the cure cycle.

You can coat with a clear coat if needed but this should suffice. Another option is to use a base coat of red, cure that out for 80%, cool and then coat with a clear coat which has some mica or silver flake added.

This method works very well for all your 'candy' color approaches.

More products from our work with the custom bike shop, you can easily duplicate much of this work on your own parts in a small shop. This company only has a bead blaster, spray wand pretreat, custom built booth, one Nordson handgun and a batch gas oven which can hold 2 bike frames at once!



A white TGIC base coat with a 'tinted' purple Polyester Urethane topcoat. We added 1% blue mica to the purple.

Candy apple red
TGIC powder applied
over a white TGIC base!

Candy Apple Pointers

Keep in mind that with transparent and tinted powder coatings the particular appearance you get is based upon the color of the transparent coating combined with the substrate or base coat over which they are coated. To produce a consistent appearance, the transparent coating must be applied uniformly with a very tight film thickness range. The thickness can be controlled by proper adjustment of the application equipment and maintaining the same distance from the part at all times.

Chapter

9

Powder Coating Troubleshooting

Nothing can be more frustrating than being unable to get quality parts of your line. These pointers will help you with troubleshooting most of your application issues.

When you run into problems on your application line it can be very difficult to get your powder supplier to help you unless you are a fairly large size account. Even when they do respond, they send you a salesperson with no technical experience. Some of the key information you need to have on hand to expedite troubleshooting is listed below. By going through the trouble shooting steps listed, you can however, get to the root cause of the problem more quickly.

Information your supplier needs:

- What exactly is the problem?

They need to know what you are seeing in detail. Digital photos can help greatly. Saying, “It looks terrible”, does not tell them as much as “I have pinholes on all my cast parts, the sheet metal looks fine”.

- What product, lot # and box/drum # are you using.

- Did you try another lot or container?

- Does this happen with all powders, or just this one?

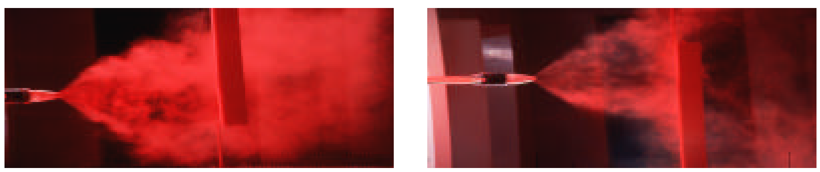
- What are your curing conditions?

- How are the parts pretreated?

Sintered Powder

Clumping like this is called sintering. It can be caused by storing the powder in a warm area or when the manufacturer process the powder too hot. If the clumps can be easily broken up the powder should still be usable.

Proper powder application



Spraying way too much powder vs. the right flow rate

Dead Bed - No air percolating through powder surface

Powder coatings are fluidized by means of air feed to a porous membrane (plenum) at the bottom of the feed hopper. This air rises, fluidizing the powder. Properly fluidized powder resembles a gently boiling liquid.

1. Check incoming air supply. Is it on? Do you have appropriate pressure? Try to increase the air to the feed hopper. Most powders fluidize properly between 10 - 20 PSI.

2. Is the powder compacted in the hopper? If it does not move around easily upon agitation with a stirring stick or your hand, remove from hopper, place in clean bag and break up by hand.

3. Is the plenum in the hopper clogged from dirty air, foreign objects or from solvent cleaning? Never use solvent to clean hoppers or air plenums, the powder will dissolve into the pores.

Dusting - Powder blowing out of hopper

Properly fluidized powder will remain in the hopper. Fugitive dusting causes housekeeping issues, wastes powder and is unhealthy for the environment since it is not contained.

1. Check incoming air supply. Is it too high? Try decreasing air pressure by 5PSI at a time. Most powders fluidize properly between 10 - 20 PSI.

2. Are you reclaiming powder? If so, perhaps the virgin to reclaim ratio is too high. Try adding virgin powder. Have your powder sales representative check particle size of the blend.

Stratification - Powder separating into layers of fine and coarse particles

Powder stratification can occur with standard powders, but is more prevalent with post blends such as metallics and micas. Some textured coatings can exhibit this also.

Vibratory feeders are not recommended for use with textured or metallic coatings because they tend to exaggerate this effect.

1. Is the powder level in the hopper to full? The hopper should not be more than 2/3 full while the powder is being fluidized. Powder coatings expand ~ 100% while fluidizing.

2. Is the particle size distribution skewed to the fine side? Try adding more virgin powder if using a reclaim system. Have the particle size of the material checked.

Poor powder feed

Powder feed relies on proper fluidization in order to transfer the material from the hopper to the guns. A balance between the gun feed, transport and atomization air supplies is also crucial.

1. Ensure powder is properly fluidized. i.e. resembles a gently boiling liquid.

2. Is the equipment in good working order? Check transfer pumps, feed pickup tubes and gun. Some transfer pumps utilize a Teflon insert, which can wear through and cause feed problems.

3. Are the air settings correct? Is there enough air volume to the equipment for proper use? Review equipment manual for adjustment guidelines.

4. Check for kinks and obstructions in the feed system.

Impact fusion - Hard buildup in feed tubes and orifices

Powder coatings can impact in certain areas of application equipment. This occurs mainly in areas where the flow direction changes, such as where the feed hose is bent more than 25 degrees or in areas where a part is directly in the powder path, such as in gun nozzles.

1. Is the system properly maintained and cleaned frequently? Lines and guns should be blown out with clean dry air at least once a shift.

2. Is there moisture or oil in the system from dirty air supplies?

3. Is the feed air or transport air setting too high? Try reducing air pressures.

4. Are the parts in good working order? Worn parts or parts improperly cleaned (scratches or gouges in the part) will tend to create the surface to which impact fusion adheres.

5. Is the powder too fine? Check virgin to reclaim ratio.

Contamination in reclaim powder

1. Is the application area in an isolated area? If not, what is the condition of the plant environment.

2. Is contamination entering booth from parts? Check cleaning and pretreatment equipment and ensure proper part drainage before entering booth.

3. What is the condition of the conveyor or hangers? Clean conveyor regularly (or continuously) before entering powder spray booth. Strip hangers as needed.

4. What is the condition of the reclaim sieve? Is it torn, missing or not operating? Is the reclaim sieve waste bucket full?

Geysering - Air blowing large holes through surface of powder.

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2. Is the powder compacted in the hopper? If it does not move around easily upon agitation with a stirring stick or your hand, remove from hopper, place in clean bag and break up by hand.

3. Is the plenum in the hopper clogged from dirty air, foreign objects or from solvent cleaning? Never use solvent to clean hoppers or air plenums, the powder will dissolve into the pores.

Powder drifting from spray booth

Powder coating booths are generally designed to provide 110 to 120 linear feet per minute (lfpm) air flow across all openings. This airflow is highly dependant upon many factors.

1. What is the condition of the bag or cartridge filters? Are they blinding? Clean or replace these. Check spray booth air for humidity which can cause blinding. Check reverse air (backpulse) cleaning.

2. Are the final filters clogged? Check filter bags or cartridges for powder leakage. Repair or replace.

3. Too large of open area in spray booth. Reduce open area which will increase booth air velocity.

4. Powder delivery (feed) too high. Try to reduce the number of guns spraying or the amount of powder to each gun.

5. Applied powder contains too many 'fines' which tend to remain airborne and drift.

Inadequate powder buildup and/or wraparound on parts

1. High Voltage source not providing enough KV at charging electrode or grid. Check high voltage source is on, systematically check electrical continuity from voltage to electrode.

2. Replace missing or broken electrode, clean electrode insulated by powder build or impact fusion

3. Poor Ground. Check ground from conveyor rail through hanger to part. All contact areas must be free of powder build, grease and other insulating materials. Check ground with a MegOhm meter (<1 MegOhm)

Powder delivery (feed or air) is too high.

1. Turn down powder feed until all material passing through charging corona is adequately charged.

2. Turn down air setting or move gun position farther away from part if powder is blowing by part.

3. Excessive moisture in powder booth air. Moisture in humid air will tend to dissipate charge in the powder spray area.

4. Powder too fine: Check virgin to reclaim ratio and particle size.

Poor penetration into corners and recessed (Faraday Cage) areas

Faraday cage areas are formed in areas of a part where there is a recess or a channel. Due to this effect, the powder particles are not drawn into these areas, resulting in minimal or no coverage.

1. Is powder delivery too low? Turn up powder delivery air setting. Use gun barrel extension (pea shooter)

2. Poor Ground. Check ground.

3. Spray Pattern too wide. Select smaller deflector or use suitable slotted barrel and cover.

4. Voltage too high. Turn down voltage setting so powder builds on part edges and leading edges do not repel powder from corner.

5. Powder delivery velocity too high. Turn air setting down so powder/air stream does not blow powder out of corners.

Back ionization - powder is repelled from part in spots

Back ionization can occur when the part being coated becomes saturated with free ions, resulting in nowhere for the 'charge' to go put back the way it came.

1. Voltage to high: Turn down the voltage setting.

2. Gun positioned too close: Change gun placement further from part. 8 to 12 inches is generally ideal.

3. Poor Ground.

4. Powder too fine: Too much reclaim in virgin powder. Virgin powder too fine.

Static charging - powder picks up a random charge through powder hoses

1. Powder booth environment too dry, Relative Humidity should be in the range of 50%

2. Poor delivery and/or reclaim equipment ground. Ensure all equipment is properly grounded.

3. Powder feed hoses run too long or of improper construction. Check with your equipment supplier since advances in technology have lead to electrically conductive powder hose designed to eliminate the static charge build-up. These products generally incorporate an electrically conductive inner core and a static dissipative outer core.

Spurting, surging, or puffing - interrupted powder feed

1. Insufficient air pressure or volume. Check air supply. Air supply piping to equipment should be of adequate diameter and length as specified by application equipment supplier. Is there enough air volume when other equipment is operated?

2. Hoses kinked, flattened or too long. Check powder feed hoses. Ensure they are of appropriate length.

3. Hoses, pump venturies or guns clogged with powder. Clean hoses, venturies and guns. Check air supply for moisture which causes powder compaction. Check powder free flowing properties , Check spray booth environment humidity. Check powder supply for contamination. Check reclaim sieve.

4. Improper spray pattern type for tip or deflector being used
The spray pattern for a specific type of tip or deflector should be well defined and consistent. Variations from gun to gun should not be noticeable, unless air settings are different.

5. Worn electrostatic gun parts. Replace worn feed tubes, orifices, deflectors and covers.

6. Impact Fusion build up. Clean gun parts as needed.

7. Delivery (feed) air too low. Check air supply. Increase air for powder feed.

8. Hoses, venturies or gun blocked with powder. Clean hoses, venturies and guns.

Gloss too high for a low gloss type powder

Gloss in powder coatings can be controlled through many different formulation techniques. Gloss is generally read by a glossmeter at an angle of 20, 45, 60 or 80 degrees. A typical tolerance is +/- 5 units.

Low gloss formulations tend to be more sensitive to consistent cure conditions.

1. Under cured. Increase temperature of oven or increase dwell time in oven. Is part reaching specified cure temperature for the proper time? Check cure profile with a data logger

2. Powder formulation. Check with powder supplier.

Gloss too low for high gloss type powder

Gloss in powder coatings can be controlled through many different formulation techniques. Gloss is generally read by a glossmeter at an angle of 20, 45, 60 or 80 degrees. A typical tolerance is +/- 5 units.

1. Incompatible powder contamination. Clean application equipment before changing powders. Check compatibility offline in a controlled test prior to introducing any new powder formulations.

2. Micro-pinholing from outgassing. Various by-products are released upon powder cure from the chemical reactions. Gasses also evolve from porous castings. If the film gelled over before these all evolve, pinholes can occur. Check the substrate for porosity and moisture. Check powder for moisture from reclaim or compressed air. Try a slower reactivity powder formulation.

3. Powder resin type or formula. Check with powder manufacturer.

4. Under cured. Increase oven temperature or dwell time. Check cure profile with a data logger.

Contamination in powder

Contamination can consist of many things, fibers, particles, color specs. Good housekeeping and a proper spray environment is the best prevention of contamination.

1. Reclaim in-line sieve torn, missing or inoperable. Replace sieve or repair as needed.

2. Powder or dirt falling in spray booth from conveyor or hangers. Clean conveyor regularly, or continuously, before entering powder spray booth. Strip and clean hangers as needed.

3. Contamination from parts entering spray booth. Check cleaning and pretreatment equipment and ensure proper part drainage before spray booth.

4. Contamination from plant air circulated through spray booth. Isolate spray booth area. Preferably enclose in a room with filtered, humidity controlled air supply.

Inconsistent film thickness

1. Guns positioned improperly. Check and reposition guns so spray patterns overlap slightly.

2. Reciprocators not matched to line speed. Adjust line speed or reciprocator stroke.

3. Air flow in booth disturbing spray pattern. Consult your equipment supplier.

4. Defective spray equipment.

Excessive Orange Peel

Orange peel in powder coating refers to a wavy textured look in the coating, similar in appearance to an orange peel. This may or may not be a desired appearance and is inherent in some powder formulas.

1. Warming-up of the coated material is too slow or too fast. Check cure cycle and cure oven. Contact powder supplier. If powder is cured too fast, the material gels before it has time to flow out properly.

2. Powder particle size too coarse or poor electrostatics. Check particle size distributions, Reduce powder charge by turning down the kv setting.

3. Moisture contamination. Try fluidizing powder for 1 hour prior to use. Replace powder.

4. Heat damage of the powder. If the material has sintered, or B-staged powder must be replaced.

Off color

1. Improper oven exhaust. Check exhaust vent. Ensure adequate air turn over cycles.

2. Bake time too long. Adjust line speed

3. Oven temperature too high. Lower oven temperature

4. Variations in film thickness. Adjust process to ensure consistent film builds.

5. Powder off spec. Check with powder supplier.

Pinholing, outgassing and craters through coating surface

Pinholes are generally tiny holes in the surface of the film and look like pinpricks.
Outgassing is generally a little larger in diameter and resembles a volcano under magnification
Craters are even larger and go to the substrate, they resemble moon craters.

Pinholing or Outgassing:

Humidity of the powder is too high. Check storage and application area humidity.
1. Air entrapment in casting. Try preheating part to 320F. Contact powder supplier.
2. Gas entrapment and escaping due to chemical reaction. Lower film thickness, contact powder supplier

Craters:

1. Contamination with other powder. Clean up the area. Contact powder supplier.
2. Poor pretreatment with grease remaining. Check pretreatment. Contact pretreatment supplier.
3. Contamination with incompatible materials in the spraying area or plant. Silicones, oils greases, perfumes, hair spray, food products have all been known to cause craters.

Pull-away or tearing - coating film shrinks, leaving bare substrate

1. Poor cleaning, metal preparation or dry off. Check pretreatment equipment, dry off oven and part drainage.

2. Certain weld areas may still contain flux which will cause pull away.

3. Extreme variations in part heat up rate may cause this to occur in areas where thin gauge is attached to or contacts very heavy gauge steel.

Poor impact resistance and/or flexibility

1. Under cured: Increase oven temperature or dwell time.

2. Powder formulations: Certain formulations inherently have low impact resistance and very high hardness. Contact your powder supplier to review the expected properties of your product.

Poor corrosion resistance

1. Poor cleaning or pretreatment.

2. Under cured: Increase oven temperature or dwell time.

3. Powder resin type or formula: Check with powder manufacturer.

Poor chemical resistance

1. Under cured: Increase oven temperature or dwell time.

2. Powder resin type or formula: Check with powder manufacturer.

Poor adhesion

1. Poor cleaning or pretreatment.

2. Under cured: Increase oven temperature or dwell time.

3. Change in substrate: Check substrate with supplier.

4. Powder resin type or formula: Check with powder manufacturer.

Poor pencil hardness / poor abrasion resistance

1. Under cured: Increase oven temperature or dwell time.

2. Powder resin type or formula: Check with powder manufacturer.

Charging Theory

In a corona charge system a non-uniform electric field is created between a gun and grounded part by applying a high voltage potential to a pointed electrode. This creates an electric field whose strength is greatest at the tip of this electrode.

As the free electrons or ions present in the air pass through this electric field, it will be drawn into and be accelerated along the field lines which have been formed. As it travels and accelerates, this ion will eventually run into an air molecule. When it impacts the air molecule, if it has picked up enough energy, it will split the molecule to form two secondary electrons and one positive ion. These in turn get pulled into and accelerated along the field lines.

As with magnets, opposites attract, so the positive ions accelerate towards the charged electrode. As the positive ions travel along the field line to the electrode, some will impact and split molecules, the remaining impact the electrode and split new ions from its surface. This corona discharge process also creates a 'cloud' of millions of ions and free electrons. This cloud is referred to as 'space charge'.

As powder particles pass through this field they attract free ions present and subsequently increase their own charge. This continues until the particle can create it's own electrical field at which point the external field lines are repelled and ions from the external field can no longer reach the particle. At this point the particle has reached maximum charge and travels along the field to the part.

This process is ruled by Pauthenier's formula
r = radius of particle
F = field strength
e = charge of an electron
k = electron mobility
n = electron concentration
t = time
ea = absolute permittivity er = relative permittivity of material

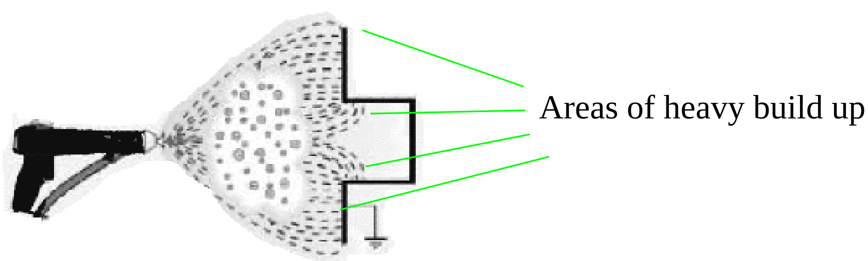
$$q(t) = 4\pi\varepsilon_0 \left(1+2\frac{\varepsilon_r-1}{\varepsilon_r+2}\right) r^2 E \frac{enkt}{4\varepsilon_0+enkt}$$

Faraday Cage Effect

If a bucket or any other hollow conductor is given a charge on its inside, then the charge will spread all over the outside surface of the conductor in such a way as to produce no electric field inside. This is called a Faraday Cage, first identified by Michael Faraday 1791 - 1867.

An example of the Faraday cage effect is that of an aircraft being struck by lightning. This happens frequently, but does not harm the plane or passengers. The metal body of the aircraft protects the interior.

In the application of powder coatings with Corona Charging systems the electrical field will follow the path of the lowest resistivity to ground. This means that most of the electrical field generated by the corona will concentrate on the edges of a recess or channel of a part, resulting in rapid build up of powder in these locations.



Due to this process two problems arise.

One is that fewer particles are able to penetrate into the recessed areas because they are being pulled to the field lines which are along the edges of the faraday cage. The field lines are unable to penetrate these recess because of the faraday cage effect.

The second is that the free ions which are continually generated when the gun is triggered, are also following these field lines and quickly saturate the areas and powder build up with extra charge, resulting in back ionization.

Since the corona charge generated field lines do not penetrate these areas the only means of getting the powder into the recess area and subsequently to stick to the substrate requires a fine balance between the corona charge strength and air flow settings.

The reason a tribo gun works so well in these areas is because they do not generate the field lines which cause the faraday cage.

Live demonstration of a Faraday Cage. The electricity travels on the outside.

Back Ionization

As charged powder coatings are applied to the metal surface the strength of the electric field inside the layer of the powder coating increases.

As each new particle is deposited the following happens:

- Cumulative charge of the powder layer increases.
- Cumulative mirror charge inside the metal increases. (this is the opposite charge, which 'holds' the
  particle to the surface.
- Strength of the electric field inside the layer of powder coating increases.

If we continue applying charged powder to the surface, the strength of the electric field inside the powder layer becomes high enough to ionize the air trapped between the particles. This is similar to what happens around the gun electrode when voltage is applied.

This results in the same electron acceleration and ion splitting effect which happens during the charging.

Due to this onrush of electrons and ions, sparks or 'streamers' develop through the layer of powder. These streamers consist of numerous electrons and positive ions flying in opposite directions.

As these positive ions move out of the coating layer they neutralize the charge of negative powder particles around the streamer. This motion also creates a phenomenon called 'electric wind' which pulls these neutralized powder particles from the coating layer. This results in micro-craters which resemble stars.

These positive ions also neutralize the charge of powder particles enroute to the grounded part, resulting is substantially reduced transfer efficiency.

Gun Nozzles, Tips and Deflectors

There are a number of different gun configurations available to powder coaters. Proper spray pattern is key obtaining high first pass transfer rates, consistent film builds and faraday cage penetration. Your equipment supplier is always the best source to ask regarding the appropriate setup for your line.

The most commonly used nozzles are the deflector-pattern nozzles and flat spray nozzles. Both are available in various pattern shapes. The flat spray nozzle is more directional and has a well-defined pattern. The deflector-pattern nozzle has a soft, well-dispersed pattern. There are gun extensions that will help you reach deep recessed parts safely and without too much effort

Chapter

10

Supplier Listing

Top Suppliers:

Powder
Dupont Powder Coatings: www.dupontpowder.com
1-800-247-3886

Hentzen Powder Coatings: www.Hentzen.com
Fred Wells (414)353-4200

Equipment
Iontech: www.Ion-Tech.com
J.B. Graves (513)641-3100

Powder Line Consultants:
Bruno Fawer (817)307-2011
BrunoFawer@email.msn.com

Powder Coatings

Akzo Nobel Coatings Inc./Interpon Powder Coatings
6001 Antoine Drive Houston, TX 77091
713/684-1504 713/684-1392 FAX
Dave Heflin - Vice President, Sales & Marketing

Americoats
3429 N. Runge Street Franklin Park, IL 60131
847/455-1400 847/455-2797 FAX
Raj Patel- President

BASF Corporation - Industrial Coatings
26701 Telegraph Road Southfield, MI 48034
630/761-4319 630/761-0560 FAX
Greg Stanek

Becker Powder Coatings, Inc.
3875 Brookham Drive
Grove City, OH 43123
614/539-8456
614/539-8457 FAX
Paul Johnson – President

Cardinal Industrial Finishes
901 Stimson Avenue City of Industry, CA 91745
626/937-6767   626/336-0410 FAX
Keith Hocking - General Manager

DuPont Powder Coatings, USA, Inc.
9800 Genard Houston, TX 77041
713/939-4000 713/939-4027 FAX
Steve Houston - Vice President of Sales

Enviro-Powder Company
6450 Hanna Lake Avenue Caledonia, MI 49316
616/698-8102   616/698-7911 FAX
Michael James McAllister - President

Govesan-America Corp.
2041 Wooddale Drive Woodbury, MN 55125
651/731-6330 651/731-6332 FAX
Miguel Rodriguez-Maceda - General Manager

H.B. Fuller Company
2900 Granada Lane Oakdale, MN 55128
651/236-3733 651/236-3535 FAX
Jeff Wroblewski - Global Sales and Marketing Manager

Innotek Powder Coatings, LLC
3400 W. Seventh Big Spring, TX 79720
915/263-5263 915/267-1318 FAX
Wes Wagner - Technical Manager

Jamestown Powder Coatings
108 Main Street Jamestown, PA 16134
(724) 932-3101 ext.125 (866) - POWDERJ
Fax: 724-932-5147
Rich Walton - Executive Vice President

Morton International, Inc.

407 Long Pointe Drive
Avon Lake, OH 44012
(440) 930-5667 Fax: 440-930-5668
Phil Bechtold - Sales Director-East

Peridium Powder Coatings
1020 Albany Place SE PO Box 80
Orange City, IA 51041
712/737-4993 800/728-6435
712/737-4997 FAX
Mark Vogel - Industrial Marketing Manager

Pioneer Powder Products
1521 North 31st Avenue Melrose Park, IL 60160
(708) 345-4848 (800) 708-4844
Fax: 708-345-4855
John Hernandez - General Manager

PPG Industries, Inc.
19699 Progress Drive Strongsville, OH 44149
440/572-2800 800/450-2652
440/572-0848 FAX
Barry Keating - Global Market Manager, Powder Coatings

Seibert Powder Coatings
11110 Berea Road Cleveland, OH 44102
(216) 631-2002 (800) 231-2002
Fax: 216-631-6211
Sam Rhue - President

Williams Hayward Protective Coatings
7425 W. 59th Street Summit, IL 60501
(708) 563-5182 Fax: 708-563-6269
Edward Kurcz - Vice President

The Sherwin-Williams Company
6329 Cloverleaf Circle East Amherst, NY 14051
(716) 741-0179 Fax: 716-741-0168
Bob Cregg - National Sales Director Powder Coatings

Spraylat Texas, LP
PO Box 1337, 3333 N. I-35 Gainesville, TX 76241
940/665-9590 940/665-8867 FAX
Bob Schmuck - General Manager, Powder Coatings Division

Tiger Drylac USA, Inc.
1251 E. Belmont Street Ontario, CA 91761
909/930-9100 909/930-9111 FAX
Dr. Chris Haslacher - Vice President

Trimite Powders, Inc.
PO Box 2785 Spartanburg, SC 29304
864/574-7000 864/587-6152 FAX
W. Luther Stancil - Vice President/General Manager

Valspar Corporation
1136 Fayett St. No. Kansas City, MO 64116
(816) 421-7700 (800) 800-1900
FAX: (816) 421-4563

Powder manufacturers routinely provide samples ranging from 2 lbs up to over 50 pounds to customers. Sometimes they will even custom match a powder for you and provide a free sample of the match to you, these samples are usually around 3-5 lbs.

All you need to do is contact the manufacturers listed on the prior pages and request a 'color card' of their products and inquire about their lab turn around times for a custom match. It helps if the potential of the match is a large amount, say an order of 1000 lbs or more monthly. Suppliers get especially excited if you are a custom job shop who, 'is bidding a job for large OEM' whose name of course is confidential, but will result in about '2-3 skids of powder' (about 2,600 to 3,900 lbs) monthly or even biweekly.

Color card samples are even easier to get, especially from larger companies, this includes bright cherry reds, textures and metallic powders.

Good luck on your sample attainment.

Electrostatic Spray Equipment

Ion Tech   4815 Para Drive   Cincinatti OH 45237   513-641-3100

ITW Gema   Box 88220,   Indianapolis IN 46208 800-628-0601

Nordson   300 Nordson Drive,   Amherst OH 44001   800-626-8303

Binks Sames   9201 Belmont Avenue,   Franklin Park IL 60131 800-99-BINKS

Wagner Systems Inc   700 High Grove Blvd,   Glendale Heights   IL 60139
800-473-2524

SPARE PARTS SUPPLIERS FOR GUNS:

PCF Group Inc. 652 Glenbrook Rd. Stamford CT 06906
203-961-0100

Powder Parts Inc 16 Prosper Ct #1 Lake in the Hills IL 60102
800-598-2160

Pretreatment Suppliers

BetzDearborn 200A Precision Drive Holland PA 18966
800-775-7175

Bulk Chemical Inc P.O. Box 186 Mohrsville PA
19541 800-338-2855

Coral Chemical Company 135 LeBaron St. Waukegon IL 60085
800-228-4646

DuBois USA 255 E. 5th st. Ste. 1200 Cincinnati OH
45202 513-762-6810

Fremont Industries Inc 4400 Valley Ind. Blvd. Shakopee MN
55379 612-445-4121

Henkel Surface Tech. 32100 Stephenson Hwy Madison Hts. MI
78071 800-521-6895

Oakite Products, Inc 50 Valley Rd Berkely Hts. NJ
07922 800-526-4473

Cure Oven Suppliers

BBC Industries, Inc (IR) 1526 Fenpark Dr. Fenton MO 63026
800-654-4205

BGK Finishing Systems (IR) 4131 Pheasant Ridge Dr. Minneapolis MN 55449
612-784-0466

Blu Surf, Inc 8550 E. Michingan Ave Parma MI 49269
517-531-3346

Cincinnati Ind. Mach. 3280 Hageman St. Cincinnati OH 45241

513-769-0700

Despatch Industries P.O. Box 1320 Minneapolis MN 55440 800-473-7373

Eclipse Combustion 1665 Elmwood Rd. Rockford IL 61103 815-877-3031

Fostoria Industries, Inc 1200 N. Main St. Fostoria OH 44830 419-435-9201

Gehnrich Oven Sales Co. 50 Haynen Ct. Ronkonma NY 11779 800-955-6836

Glenro Inc 39 McBride Ave Patterson NJ 07501 800-922-0106

The Grieve corp. 500 Hart Rd. Round Lake IL 60073 847-546-8225

Lube Equipment for Conveyors

Digilube Systems Inc. 545 S. Main Street Springboro OH 45066 800-837-5667

Schaefer Brush Manufacturing 1101 S. Prarie Ave Waukesha WI 53186 800-347-3501

Lube Con 201 N. Webster St. White Cloud MI 49347 612-445-4121

Paint Striper Manufacturers

Coral Chemical Company 135 Lebaron St. Waukegan IL 60085 800-228-4646

DuBois USA 255 E. 5th St. Cincinnati OH 45202 513-762-6810

Fremont Industries Inc. 4400 Valley Ind. Blvd. Shakopee MN 55379 612-445-4121

Heathbath Corp. P.O. Box 2978 Springfield MA 01102 413-543-3381

Henkel Surface Tech. 32100 Stephenson Hwy Madison Heights MI 48071 800-521-6895

Mitchell Bradford 563 S. Leonard St. Waterbury CT 06725
800-648-3412

Oakite Products Inc. 50 Valley Rr. Berkeley Hts. NJ 07922
800-526-4473

KV Meters

ITW Gema Box 88220, Indianapolis IN 46208
800-628-0601

Nordson Corp. 300 Nordson Drive, Amherst OH 44001
800-626-8303

PCF Group Inc. 652 Glenbrook Rd. Stamford CT 06906
203-961-0100

Vacuum Cleaners

American Vacuum Co. 7301 N. Monticello Ave. Skokie IL 60076
800-321-2849

Nilfisk of America 300 Technology Drive Malvern PA 19355
800-645-3475

Nortech Corporation 265 Greenwood Ave Midland Park NJ 07432
201-445-6900

Vac-U-Max 37 Rutgers St. Belleville NJ 07109
800-822-8629

Masking Supplies

Echo Supply 1026 Hanson Court Milpitas CA 95035
800-878-6924

Harman Corp 360 South St. Rochester MI 48307
810-651-4477

Stock Cap 13515 Barrett Parkway Dr. St. Louis MO 63021
800-827-2277

Touch Up Paint

Custom Pak Products, Inc. N 115 W 19150 Edison Dr. Germantown WI 53022 414-251-6180

Cutler Bay Inc. P.O. Box 126 Newburyport MA 01950 978-465-1357

Dielectric Polymers Inc. 218 Race St. Holyoke MA 01040 800-628-9007

Innotec 1760 State St. Racine WI 53404 800-776-7194

ORB Industries. 2 Race St. Upland PA 19015 800-771-7140

Raabe Corporation Box 1090 Menomonee Falls WI 53052 800-966-7580

Production Racks

Magic Rack 2490 McGaw Rd. East Columbus OH 43207 614-492-8811

Mighty Hook Inc 2522 W. Chicago Ave. Chicago IL 60622 773-278-0801

Regal Springs Box Box 197 West Jefferson OH 43162 614-879-6772

Toledo Wire Products 1230 Expressway Dr. Toledo OH 43608 419-729-5446

Gloss Meters

BYK Gardner Inc 9104 Guilford Rd. Columbia MD 21046 800-343-7721

Film Thickness

DeFelsko Corp. 802 Procter Ave Ogdensbury NY 13669 800-448-3835

Test Panels

ACT Laboratories 273 Industrial Drive Hillsdale MI 49242 248-827-3333

Solvents for cure tests and chemical resistance:
Reading Scientific Co. 2200 N. 11th St. Reading PA 19605 610-921-0221

Be sure to visit the Powder Coating Forum on the web at:
http://www.TechnicalHelp4U.com/forum

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