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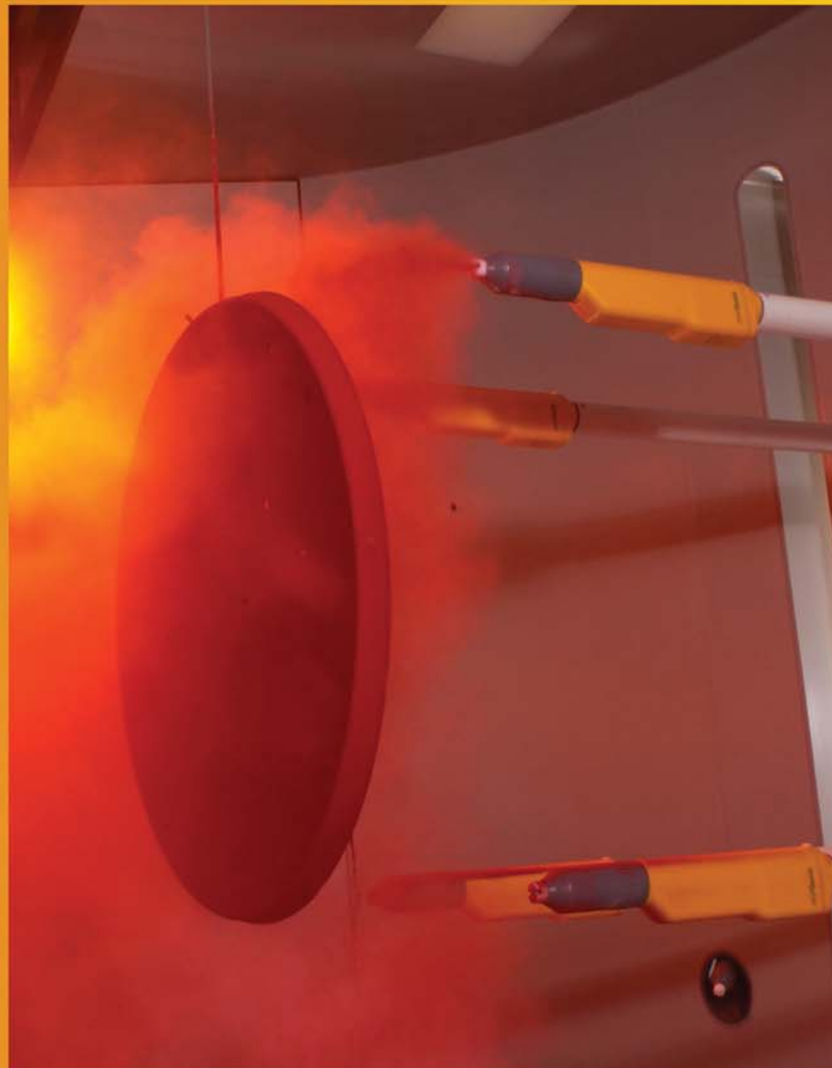
FOR THE POWDER COATING PROFESSIONAL

The World Leader in Powder Coating Systems



The What, Why & How of Powder Coating

A Introduction to the Powder Coating Process for the Medium Density Fiberboard Industry

ITW Gema

Powder Coating of Medium Density Fiberboard

The use of powder coatings as a finish for wood substrates has been a topic of discussion for several years, but only recently have powder materials been available to the marketplace. New breakthroughs in powder chemistries have led to the emergence of a new finishing option for manufacturers of Medium Density Fiberboard (MDF) products.

Specifically, manufacturers of products using MDF can apply a "laminate-like" finish to complex wood shapes. Products that are traditionally coated with vinyl, melamine, paper laminates, or other organic finishing process may find powder coatings as an attractive alternative. When used with MDF, powder coatings provide a seamless finish to curvilinear shapes, rounded or ogee edges, concave and convex surfaces, cabinet doors, drawers, and multiple sides simultaneously.

Powder Coating of MDF Cabinet Door

Powder coating advantages translate into several benefits regarding coating performance, operational costs, and environmental friendliness.

Designs Without Limits: Until now users have had two choices: design around the limitations of laminates or pay the price for liquid paint coatings.

One Step Finishing Process: Gone are the days of sanding, priming and sealing for paint– and the gluing and edge banding of laminates. Additionally, volatile solvents traditionally required by both are eliminated.

Simple to Handle, Vertical Orientation: Just hang the work from an overhead conveyor, then coat all sides of the piece at once. No drying time or awkward handling is required.

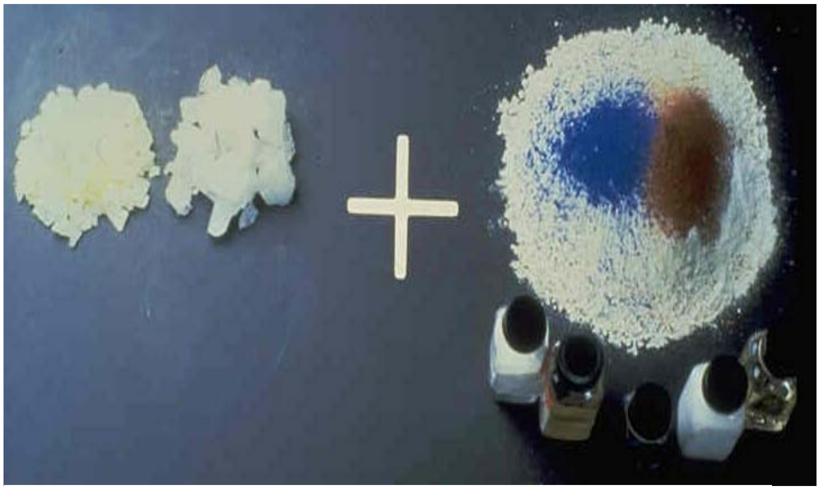
Over the past decade, powder coating has been increasingly accepted as the preferred finishing process for the metal finishing industry. Based on the technology available today, powder coatings appear to be the coating material of the future for the wood industry. The reasons for this conversion can be attributed to three major forces:

Economy - the high cost of energy, labor and materials require a more cost-effective and less wasteful process.

Excellence – consumers, and other end-users, are demanding newer designs and appearances, higher quality and durable finishes.

Ecology – progressively more stringent regulations are being aggressively enforced in an effort to control air pollution and hazardous waste disposal. This in turn goes back to economy.

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



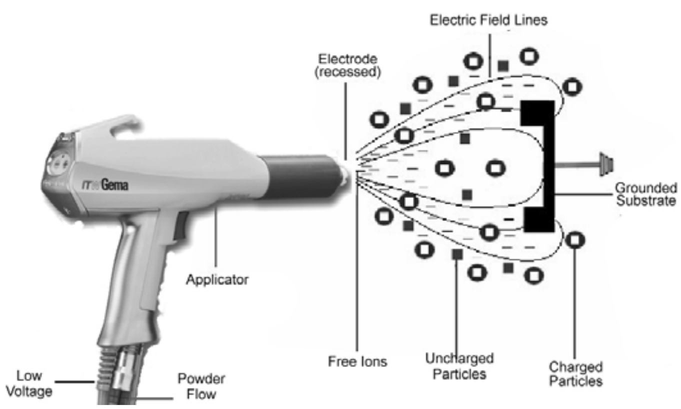
Resins Plus Pigments and Additives

Powder Coating

"Powder coating" is a one-step finishing process. The powder is a dry coating and, instead of being dissolved or suspended in a liquid medium, such as solvent or water, is applied in a granular form. The material is finer than ground pepper but coarser than flour, and applied directly to the surface being coated. Powder is purchased in the ready-to-use form, but is manufactured to meet your specifications. Blending various components (binders, resigns, pigments, fillers and additives) and putting them through a process that incorporates extruding, grinding, and a pulverizing process powder coatings are created. Upon being extruded, this homogeneous mass is cooled and broken into small chips, which are then pulverized into the smaller powder particles. Each particle contains within it the necessary components to allow forming of the finished coating. After the powder is applied to the part, using an electrostatic spray process, the part passes through an oven, melting the coating into a smooth film on the surface of the part.

Powder Formulation

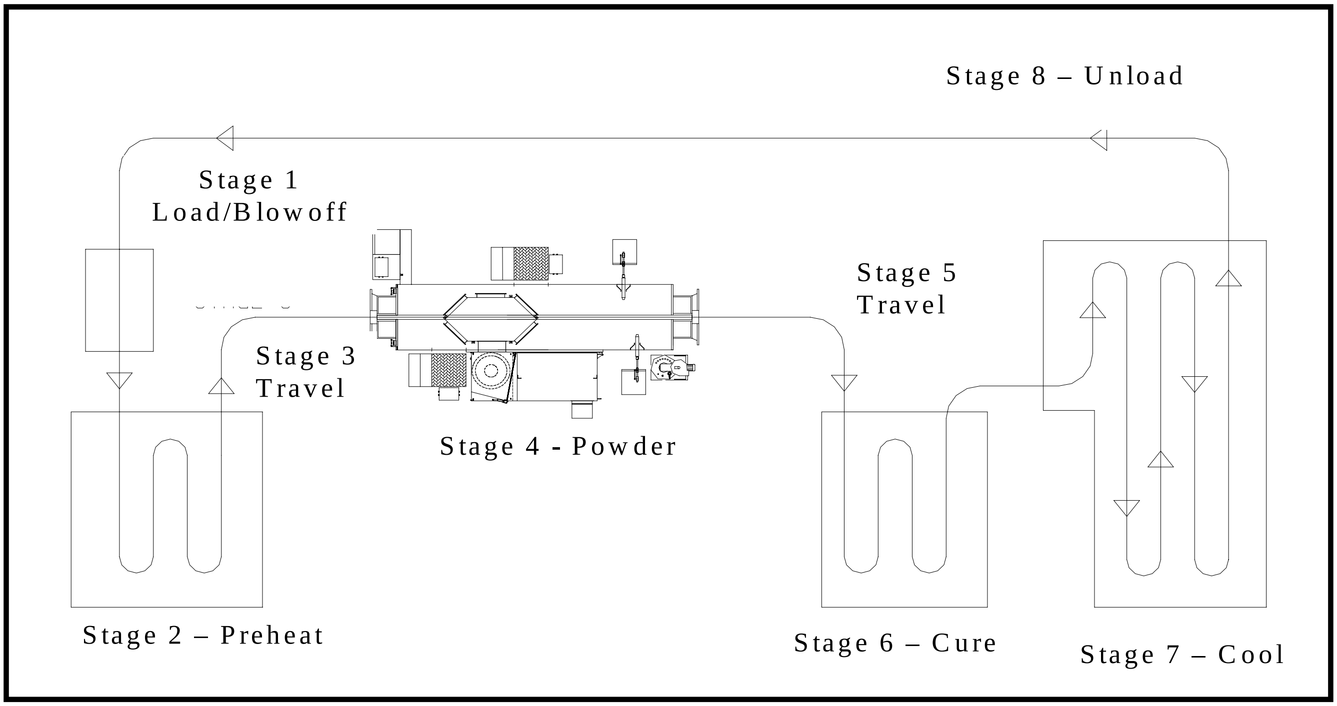
There are two distinct types of powder, thermoset and thermoplastic. The thermoset powders are reacted, which means that in the curing process there is a molecular change. This change is the result of a chemical "cross linking", so that, once cured, the coating will not re-melt. Epoxies, acrylics and most hybrids are examples of thermal set powders, making up over 90 percent of the current powders used in the metal finishing market. Thermoplastic powders do not "cross link" when cured but simply melt and flow over the surface of the part. The film hardens on cooling, but if it is reheated, it will re-melt. Vinyl, nylon and fluorocarbon are examples of thermoplastic powders. However, for the engineered wood industry, thermoset powders are used to obtain the desired performance characteristics.



Example of the Electrostatic Process

Application To Wood

A product is cut to the desired shape from a sheet of MDF. This process may include routing or profiling the surfaces and edges. Once the desired shape is achieved, some board preparation may be required. This may include but not limited to light sanding of the surfaces and edges. In order to ensure defect free finishes, removal of any wood fibers by use of compressed air blow-off or a vacuum process is important.. Once cleaned the product must be arranged on a fixture (or hanger) that allows for transportation to and from the ovens and coating booth. At this point the product is transported to an oven that preheats the product to a predetermined temperature. This baseline temperature specification is provided by the powder supplier and then adjusted to match with your finishing system equipment performance and production needs. Once the product reaches this temperature, it is quickly transported it to the coating booth. Once in the



Example System Layout for Powder Coating of Wood Products

powder coating booth, the spray guns atomize the powder and electrostatically charge the powder particles, while directing them towards the product. The heat that is "soaked" into the wood is used to assist in building the film thickness required for coating performance. Once coated the product is then transported to a curing oven, where the final heating step is performed. The powder that has been applied is now held on the surface until it is completely melted and cured into a smooth continuous coating. The final step is to allow the product to cool down to a temperature that allows workers to physically touch the parts and ready them for assembly or package them for shipping.

Electrostatic Spray

The application process involves applying an electrostatic charge to the powder particles as they are sprayed from an applicator (or spray gun). A typical powder coating system for metal relies on a conductive substrate to complete the coating process, however, wood is considered to be non-conductive and therefore should not work in this application. Nonetheless, engineered wood does have some inherent conductivity that allows for a limited amount of powder to be electrostatically applied to MDF. Furthermore, to achieve the film thickness levels required for coating performance, heat must be added to the wood prior to coating. This "pre-heat" along with the electrostatic attraction developed by the spray guns, allows the wood to be coated evenly and uniformly.

The two most important aspects of this process are :

1) Accurately and uniformly heating the wood to the predetermined temperature,
2) Arrangement and manipulation of the spray guns in order to achieve the correct film thickness and coverage.

Operational Benefits

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

Economy

- With powder coatings being applied in a one step process, the amount of energy and labor consumed to produce one unit can be less than traditional liquid finishing and laminating process. Since the powder coating process uses a vertical orientation on an overhead line arrangement, production throughput can be increase as well. Especially compared to vinyl membrane press operations.

- Material utilization is high with powder, potentially bringing your material cost much lower. As much as 98% of the powder you buy will be utilized. Compare this to a conventional liquid system with an material loss of 60—80% or a vinyl membrane press operation with material waste of 10-40%.

- Since most material is used on the part, there is little waste to be disposed of. In addition, powder is not considered hazardous waste, so disposal cost is minimal compared to toxic waste disposal.

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

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

- Powder is easier to spray, so less skilled labor is needed, training is easily done and less errors are made in coating. All of which reduces scrap, labor, and ultimately, operating cost. No primer materials are required, providing more savings in time and materials.

Curvilinear shapes are perfect for powder coatings

- No primer materials are required, providing more savings in time and materials.

Excellence

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

- Powder coatings provide excellent adhesion and hardness for approved resistance to chipping, abrasion, and chemicals.

- One of the many unique advantages of powder coatings is the toughness of the coating. Many users of powder coatings have experienced superior resistance to marring, scratching and abrasion. Specifically for the wood industry powder coatings offer greater design flexibility. Curvilinear design capability allows product designers to develop exciting new shapes and edge profiles. With powder coatings, the issue of edges is eliminated and now products can be produced with "Seamless Edges."

Ecology

Powder is the overwhelming preference by the EPA, dramatically reducing:

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

- Elimination of potentially toxic sludge and water, that contaminates the earth. No hazardous waste to dispose of.

- The cost of complying with regulations and disposal of toxic and flammable waste is constantly rising. Wood manufacturing companies are looking for less expensive methods of application that bring their current plant operations into compliance. With strong financial arguments providing the necessary stimulus, powder coatings are expected to evolve quickly.

System Operation

Powder systems are available in all degrees of technical sophistication, and can be designed to meet a wide range of requirements for performance, cost and space constraints. From a basic manual, one gun operation with a batch booth, to a highly complex multi-gun, totally automated configuration, there are guns, booths and other peripherals to meet all production requirements.

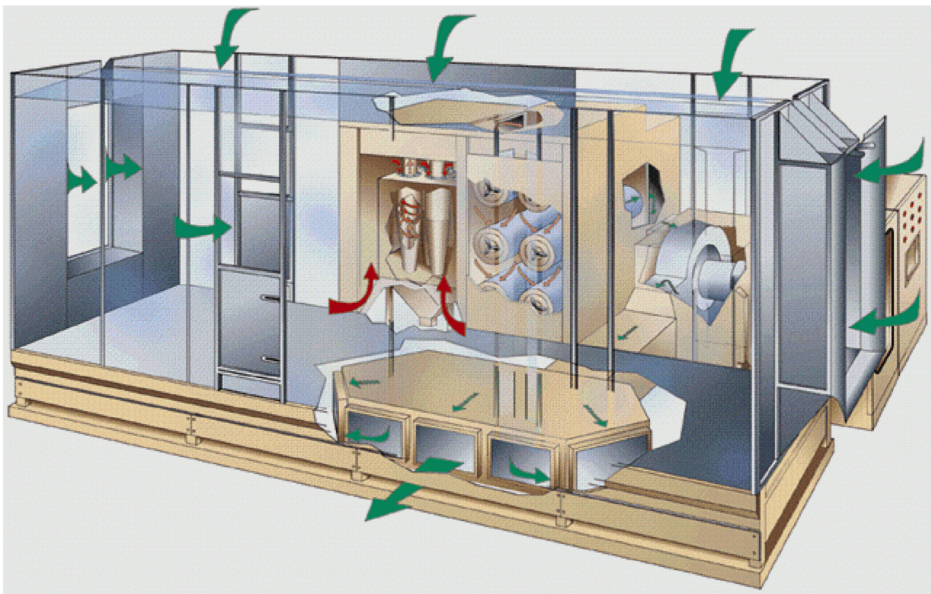
Application Equipment

Guns used for this process are designed to generate an electrostatic charge and apply it to the powder particles. Each gun has a control unit that regulates the voltage being generated and the powder delivery rate from the hopper. Areas to review when selecting application equipment are the efficiency of the charge, the consistency of the powder flow, and the accuracy with which both can be adjusted to provide the right level of performance. Application uniformity and repeatability are extremely important to achieving success in a powder system. Therefore, once the optimal settings have been established it is important that they can be repeated systematically each time they are used.

Booths and Recovery

The spray process takes place inside a booth designed to contain the oversprayed powder and makes it possible to recover the overspray and ultimately reclaim for reuse.

The oversprayed powder suspended in the air contained in the powder booth is then passed through a separation process that permits the powder particles to be recovered. The clean air is fed back to the work environment, eliminating the need for makeup air. The recovered powder is mixed with the proportionate amount of fresh, virgin powder for reuse in the reclaim process. This process can provide up to 98 percent material utilization.



Cut away view of a powder recovery booth

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

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

Now that we have covered the basics, you should have a better idea what powder is all about. The following pages contain more information that will illustrate the advantages and savings produced by powder coatings. Upon review of this information you will be pleased at how quickly a powder system will pay for itself and add value to your products.

A Glossary of Common Powder Coating Terms

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

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

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

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

Cyclone: A type of recovery unit using a centrifugal process to separate oversprayed particles from airflow.

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

Edge Coverage: Ability of a powder to flow over, build and adhere to sharp corners, angles and edges.

Edge Cracking: Delaminating or separating of MDF layers due to heat stress from pre-heat process.

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

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

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

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

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

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

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

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

Micron/Mills: Common unit of measurement of coating thickness. 25.4 microns equals one mil (one thousandth of an inch)

Out gassing: Blistering of the coating during the curing process; caused by heat forcing volatiles through the coating.

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

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

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

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

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

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

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

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

Finishing Line Components Comparison

Component	Liquid Paint	Powder
Board Preparation	Sanding of surface and edges may be required	Sanding of surface and edges may be required
Preheat Oven	No	10-20 minutes/350-375°F
Spray Guns	Non-electrostatic manual and automatic air spray guns	Electrostatic powder manual or automatic spray guns
Spray Booths	2 automatic or 2 manual booths	1 automatic or 1 manual or a combination booth
Flash-off Tunnel	Yes	No
Bake Oven Time/Temperature	20-30 minutes/250-300°F	5-15 minutes/350-375°F
Solvent Exhaust	Yes	No
Air Make-Up Required	Yes	No
Paint Room Mix	Yes	No
Paint Circulating or Routine Maintenance	Minimum Once/Day	Minimum Once/Day
Average Maintenance Time/Gun	10 minutes	2 minutes
Major Cleaning (Except Color Change)	Minimum Once/Week	Minimum Once/Week
Average Cleaning Time (Except Color Change)	2 Hours	1 Hour

Typical Material Cost Comparison

Low Solids Paint

Cost: $12.00 per gal (mixed)

Solids Content: 35% (mixed)

Efficiency: 20-40%

Coverage per mil thickness:

30% x 35% x 1,600 = 168 sqft/gal

Applied cost per mil thickness:

$\frac{\$12.00}{168}$ = $0.071 per sq ft

High Solids Paint

Cost: $17.00 per gal (mixed)

Solids Content: 55% (mixed)

Efficiency: 20-40%

Coverage per mil thickness:

30% x 55% x 1,600 = 264 sqft/gal

Applied cost per mil thickness:

$\frac{\$17.00}{264}$ = $0.064 per sq ft

Powder

Cost: $10.00-$15.00 per pound

Specific Gravity: 1.3

Volume Solids: 99%

Material Utilization: 98%

Coverage per mil thickness:

$\frac{98\% \times 192.3 \times 99\%}{1.3}$ = 144 sqft/lb

Applied cost per mil thickness:

$\frac{\$10.00}{144}$ = $0.069 per sq ft

1600 sq ft per gallon of paint at 1 mil thickness with 100% efficiency and 100% solids is industry standard

192.3 sq ft per pound of powder at 1 mil thickness with 100% efficiency, 1.0 specific gravity, and 100% solids is industry standard

Clean-Up and Waste Disposal Cost Worksheet

Variables	Paint	Powder
A Clean-up Frequency	50 per year (typical)	12 per year (typical)
B Number of Operators	2 (minimum)	2 (typical)
C Hourly rate plus fringe	$ ___________	$ ___________
D Hours required	8 hours (typical)	2 hours (typical)
E Clean-up cost per year: A x B x C x D = $ _______ /yr	52 x 2 _______ x 8 = $ ______ /yr	12 x 2 _______ x 2 = $_______ / yr
F Disposal Cost	$ _________ /bbl	Not Applicable
G Waste Volume per year	___________ bbl per year	Scrap Powder 2% min.
H Disposal cost per year: F x G = $ __________ /yr	_____ x _____ = $ _______ /yr	Not Applicable
Total Clean-Up and Waste Disposal Cost per Year: E + H = $	______ + ______ = $ _______	______ + ______ = $ _______

Alternative Material Cost Worksheet

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

Variables	Waterborne Paint	Solvent Paint	Powder
A Coating cost	$ _____ /gal	$ _____ /gal	$ _____ /gal
B Percent volume solids (as received)	___%	___%	99%
C Specific gravity	Not applicable	Not applicable	____
D Additive (solvent or water) cost	$ _____ /gal	$ _____ /gal	Not applicable
E Percent of additive (solvent or water) per gallon of mixed paint*	___%	___%	Not applicable
F Cost of usable coating (as sprayed) **(D x E) + [A x (1-E)]**	$ _____ /gal	$ _____ /gal	Not applicable
G Volume solids, usable coating **B x (1-E)**	___%	___%	99%
H Dry film thickness	____ mils	____ mils	____ mils
I System utilization efficiency	___%	___%	___%
J Coverage, sq ft/gal	(1600 x G x I) / H or 1600 x G x I H mils 1600 x _____ x _____ _____ mils = ______ sq ft/gal	(1600 x G x I) / H or 1600 x G x I H mils 1600 x _____ x _____ _____ mils = ______ sq ft/gal	(192.3 x B x I) / (C x H) or 192.3 x B x I (C x H) mils 192.3x _____ x _____ _____ x _____ mils = ______ sq ft/lb
K Applied cost, $/sq ft	(F / J) or _______ / ______ = $ _______ /sq ft	(F / J) or _______ / ______ = $ _______ /sq ft	(A / J) or _______ / ______ = $ _______ /sq ft

* Suppliers recommended reduction ratio = P:S

Where P = Gallons of full body paint and S = Gallons of solvent

Performance Characteristics

Kitchen Cabinet Industry		
Property	**Test Method**	**Results**
Shrinkage and Heat Resistance	KCMA 9.1	ΔE of up to 1.5 units No change in texture
Hot and Cold Check Resistance	KCMA 9.2	No effect
Chemical Resistance	KCMA 9.3	No effect under vinegar, lemon juice, orange juice, catsup, coffee, olive oil, 100% proof alcohol, detergent,
Crosshatch Adhesion	ASTM D3359	5B
Humidity Test	ASTM D2247-94	No change after 2,000 hours
QUV	ASTM G-53-88	No gloss or color change through 1,000 hours of expo-
Pencil Hardness	ASTM D3363	2H (scratch) 6H (gouge)
60° Gloss	ASTM D523	10 to 50 units
Taber Abrasion Resistance	NEMA LD3-3.13	90 to 120 mg/100 cycles
Solvent Resistance	MEK, 50 double rubs	No effect

Furniture Industry, Office and Ready-To-Assemble		
Property	**Test Method**	**Results**
Boiling Water	NEMA LD3 3.5	No effect
Heat Aging	MPTM	No effect
Hoffman	MPTM	Pass 500-700
Cleanability/Stain	**Test Method**	**Results**
Coffee	Nema LD3 3.4	No effect
Household Detergent	Nema LD3 3.4	No effect
VM&P Naphtha	Nema LD3 3.4	No effect
Tea	Nema LD3 3.4	No effect
Grape Juice	Nema LD3 3.4	No effect
Ink Felt Pen (non perm., black)	Nema LD3 3.4	No effect
Critic Acid Solution	Nema LD3 3.4	No effect
Household Ammonia (non sudsing)	Nema LD3 3.4	No effect
Vegetable Cooking Oil	Nema LD3 3.4	No effect
Mustard	Nema LD3 3.4	No effect
Catsup	Nema LD3 3.4	No effect

Performance Data Provided By Morton Powder Coatings for LAMINEER powder

Surface properties of LAMINEER powder coatings may vary depending on board quality and process conditions