

APPLIED COSTS OF ELECTROCOATING:

Considerations and Calculations

Your guide for evaluating costs associated with electrocoating technology to make an informed decision for your coating success.



Introduction

Today's competitive business environment requires companies to maximize efficiency and profit while minimizing cost; finishing operations are no exception. Finishing Managers are tasked with reducing operating costs, improving performance and lessening the environmental impact from coating operations. Oftentimes the challenge is obtaining accurate costing information to properly evaluate a myriad of coating options and variables.

The Electrocoat Association has developed a new tool with the Finishing Manager in mind. This brochure profiles cost components and calculations associated with electrocoating technology in the areas of pretreatment, paint, equipment and internal expenses. Costs that may not have been considered when looking at electrocoating will also be identified. Armed with more sound data, managers can then make an informed decision on whether electrocoating is best suited to meet their needs in maximizing productivity and quality at the lowest possible operating cost.

ELECTROCOAT FINISHING – FORMULATED FOR SUCCESS!

Electrocoat offers significant operational, performance and environmental advantages over other finishing technologies. Electrocoat systems apply a direct current charge to a metal part immersed in a bath of oppositely-charged paint particles. Because opposites attract, the paint is drawn to the metal part and forms an even, continuous film over its entire surface until the coating reaches the desired thickness. This process, better known as electrodeposition, allows electrocoat users to thoroughly coat complex parts with a uniform film thickness. Depending on the polarity of the charge, it is classified as either anodic or cathodic.

Anodic Electrocoat formulations are used primarily for interior and mildly aggressive exterior environments and offer excellent color and gloss control. In the Anodic paint bath, negatively-charged paint particles are drawn to positively-charged parts.

Cathodic Electrocoat formulations are high-performance coatings with excellent corrosion and chemical resistance and can be designed for exterior durability. In the Cathodic paint bath, positively-charged paint particles are drawn to negatively-charged parts.

ADVANTAGES OF ELECTROCOAT:

ECONOMIC

- High Material Transfer Efficiency (98% +)
- Low Applied Cost
- Precise Film Build
- Automated Processing (Reduced labor requirements)
- Dense Line Racking
- High Throughput

PERFORMANCE

- 100% Coverage of Complex Parts
- Uniform Film Thickness
- Benchmark Corrosion Protection
- Superior Edge Coverage
- One or Two-Coat Applications for Optimized Performance
- Product and Process Consistency
- Compatible with Other Coating Technologies

ENVIRONMENTAL

- Low to No HAPs (Hazardous Air Pollutants) Formulations Available
- Ultralow VOC (Volatile Organic Compounds) Formulations Available
- Heavy Metal-Free Formulations Available
- Closed Loop Systems for Minimal Waste Discharge
- OSHA Compliance

Our Mission is to drive electrocoat growth by providing access to information, education and networking with industry leaders.

To learn more about how we can help you, visit us at electrocoat.org



PRETREATMENT CONSIDERATIONS

Prior to any paint application process, most metal surfaces are processed through a pretreatment system which cleans the surface and applies a conversion coating to promote paint adhesion and corrosion resistance. To help determine an average pretreatment cost, we've identified four pretreatment options and the average cost per square foot of surface area for each. The options are a multi-step spray or immersion process capable of treating a wide variety of metal substrates. Average costs represent chemical usage only; operating costs between spray and immersion systems are different, therefore total process costs vary depending on which option is best suited for the product being coated.

TRADITIONAL ZINC PHOSPHATE

Typical chemical process steps are alkaline cleaner, surface conditioner, zinc phosphate and post rinse. This process is designed to meet paint adhesion and corrosion performance specifications.

TRADITIONAL ZINC PHOSPHATE WITH ACID PICKLE

Typical chemical process steps are alkaline cleaner, acid pickle, surface conditioner, zinc phosphate and post rinse. Acid pickle step is designed to improve the cleaning over weld or heat scale on cold rolled or hot rolled steel.

THIN FILM CONVERSION COATING

Typical chemical process steps are alkaline cleaner and thin film conversion coating. This process is capable of treating a high percentage of aluminum in addition to a wide variety of metal substrates. Compared to zinc phosphate, there are significant operational cost savings while meeting paint adhesion and corrosion performance specifications.

THIN FILM CONVERSION COATING WITH ACID PICKLE

Typical process steps are alkaline cleaner, acid pickle and thin film conversion coating. The acid pickle step is designed to improve cleaning over weld and heat scale on cold rolled and hot rolled steel and aluminum. The operational cost savings over zinc phosphate apply with this process as well.

CALCULATING ANNUAL PRETREATMENT CHEMICAL COST

Once the pretreatment option has been determined, select the average cost per square foot for that system:

TYPE	AVERAGE PRETREATMENT COST PER SQUARE FOOT (FT ²)
Traditional Zinc Phosphate	\$0.0053
Traditional Zinc Phosphate with Pickle	\$0.0067
Thin Film Conversion Coating	\$0.0055
Thin Film Conversion Coating with Pickle	\$0.0069

Finally, estimate the total square footage (ft²) per year of product to be run through the pretreatment system. For example: The calculated cost of 24,000,000 ft² of surface area pretreated through a thin film conversion coating system is:

Total Annual Pretreatment Chemical Cost = Total ft² per year of product X avg. cost per ft² of system choice

Total Annual Pretreatment Chemical Cost = 24,000,000 X 0.0055 = \$132,000

PAINT CONSIDERATIONS

Paint costs are analyzed in terms of applied cost per square foot coated. There are a few things to consider when calculating this value for electrocoat:

DRY FILM THICKNESS (DFT)

Thickness of a coating as measured above the substrate consisting of a single layer or multiple layers. DFT is measured for cured coatings (after the coating dries). A 1.0 mil (25.4 microns) average is typical when a specification is not known.

TRANSFER EFFICIENCY (TE)

Percent of paint solids in the ecoat bath that are ultimately applied to the part. 98% can be assumed for a closed-loop post rinse system if a true percentage is not known.

SHRINKAGE (S)

Percentage of initial weight or volume of dry electrocoat material that is lost in the oven during the crosslinking of the electrocoat. 10% weight shrinkage means that for each 90 mg of electrocoat on the finished part, you need to apply 100 mg in the electrocoat bath and is the basis for assumption if unknown. For purposes of cost estimating, % volume and weight shrinkage are the same. To begin the calculation of applied costs per square foot we must first determine the best paint technology to be used on the parts.

CATIONIC EPOXY (CE)

Best choice for exterior corrosion protection with many OEM automotive approvals. Provides excellent resistance to a wide range of chemicals. Often used as a primer only and should not be exposed to sunlight for extended periods due to its poor exterior UV durability.

CATIONIC ACRYLIC (CA)

Best choice when UV durability and good corrosion protection are needed. Wide range of colors available with good chemical and detergent resistance. Popular choice for use as a one-coat exterior finish or as a primer. Often used on agricultural equipment, appliances and sports and recreational vehicles.

ANODIC EPOXY (AE)

Best choice for low-cure applications or for heavy parts such as castings. Allows for a shorter footprint and lower capital equipment cost vs. cationic systems. Offers some corrosion resistance but generally not as good as cationic products.

ANODIC ACRYLIC (AA)

Best choice for interior applications, with a wide range of color and gloss options. Popular choice for metal office furniture, air diffusers or tool boxes. Not a good choice when exterior corrosion resistance is needed.

CALCULATING APPLIED PAINT COST

Use the table to estimate the average cost per ft² @ 1 mil and 100% TE for each of the electrocoat options.

The example below uses Cationic Epoxy at \$0.025 per ft² and 1.1 mil DFT with a TE of 98%. A 10% S has been assumed for the volume loss during the curing process.

TYPE	AVERAGE PAINT COST PER SQUARE FOOT (FT ²) @ 1 MIL
Cationic Epoxy	\$0.025
Cationic Acrylic	\$0.045
Anodic Epoxy	\$0.030
Anodic Acrylic	\$0.020

$$\text{Applied Paint Cost per ft}^2 = \frac{\text{Applied Cost per ft}^2 \times \text{DFT}}{(\%TE \times (1-\%S))}$$

$$\text{Applied Paint Cost per ft}^2 = \frac{0.025 \times 1.1}{(.98 \times (1-.10))} = \frac{0.028}{0.882} = \$0.032$$

$$\text{Total Annual Paint Cost} = \$0.032 \times 24,000,000 \text{ ft}^2 \text{ per year} = \$768,000 \text{ per year}$$



EQUIPMENT CONSIDERATIONS

Capital equipment costs reflect the entire system and any ancillary pieces that are used in the electrocoating process such as reverse osmosis systems, chiller equipment, and waste water treatment. Performance requirements and many other variables can affect these costs.

PRETREATMENT

Pretreatment can be all spray, a combination of spray and immersion, or all immersion depending on process needs and material handling type. This analysis assumes an all spray zirconium phosphate coating process with immersion tube heating systems and without pickle.

ELECTROCOAT, POSTRINSE, REVERSE OSMOSIS, CHILLER

The electrocoat tank typically is a 120 second duration immersion followed by 2-3 postrinse stages; either spray, a combination of spray and immersion, or all immersion depending on process needs and material handling type. This analysis is based on a 3 stage spray postrinse. Tank enclosure hood, platform, filters, ultrafilter, rectifier, anodes, anolyte system, reverse osmosis system, storage tank systems, and chiller system are also required and accounted for.

CURE OVEN

The cure oven is designed to hold the coated part at a temperature for a time duration. A common electrocoat paint requirement is 350F at metal temperature for 15 minutes. Depending on the metal thickness, the bring-up time can add 10-30 minutes. Also, a 5-10 minute low temperature 'dehydration' zone is commonly provided prior to the high temperature zone to allow some moisture evaporation to eliminate 'boil out' in recessed areas.

COOLDOWN TUNNEL

The cooldown tunnel is a ventilated enclosure after the cure oven to capture and remove heat from the cooling part and exhaust it outside the building. Also included is outside air intake equipment to have a zero net air requirement on the building.

MATERIAL HANDLING

Many types of material handling designs can be used for an electrocoat process, including continuous moving monorail conveyor, Power & Free conveyor, indexing programmable hoists, or indexing walking beam. This analysis is based on a continuous moving monorail conveyor.

WASTE WATER TREATMENT

Equipment is needed to process and treat the overflowing rinses and tank dumps from pretreatment as well as minor waste streams from the electrocoat process. Included are pumping systems, collection tanks, neutralization tanks, clarifier, filter press, chemical feed systems, and final pH adjustment.

AIR REPLACEMENT EQUIPMENT

Electrocoating typically has the smallest air replacement needs of any competing technology. Included here is an appropriately sized air replacement unit to handle the exhausted air of the total system.

Average equipment cost ranges based on system size are (in USD):

SMALL \$1.3 – \$1.8 mm*

MEDIUM \$2.5 – \$3.0 mm*

LARGE \$3.0 – \$4.0 mm*

* Assumptions and notes:

Small system design criteria:

Maximum design coated surface area – 50 ft²/min
Coated surface area/year – 4,050,000 ft²/yr[†]
Design monorail conveyor speed – 4 feet per minute
Product data – 1'-6" Long x 2'-0" Wide x 2'-6" High; 4,000 lbs/hr

Medium system design criteria:

Maximum design coated surface area – 100 ft²/min
Coated surface area/year – 8,100,000 ft²/yr[†]
Design monorail conveyor speed – 6 feet per minute
Product data – 2'-0" Long x 3'-0" Wide x 5'-0" High; 10,000 lbs/hr

Large system design criteria:

Maximum design coated surface area – 150 ft²/min
Coated surface area/year – 12,150,000 ft²/yr[†]
Design monorail conveyor speed – 9 feet per minute
Product data – 2'-6" Long x 4'-0" Wide x 5'-0" High; 25,000 lbs/hr

[†]Coated surface area/year based on an 8-hour single shift operation, 250 days per year, with 90% uptime and 75% loading efficiency.

A spray iron phosphate pretreatment process would have similar equipment costs to the assumed spray zirconium phosphate process system.

An immersion zinc phosphate pretreatment process would add approximately 10-15% cost to the assumed spray zirconium phosphate process system.

INTERNAL EXPENDABLES CONSIDERATIONS

Internal expendables capture other, less obvious costs of running not just an electrocoat system, but *any* finishing system.

DIRECT LABOR COSTS consist of employee wages (regular and overtime), bonuses, vacation and holiday pay for those who are directly associated with the electrocoating process (loaders, unloaders, material handlers, inspectors, line supervisors, etc.). FICA, unemployment, and other employment taxes are also considered. Industrial insurance, health insurance, and other employee insurances are reflected in this section as well as any contract labor used.

DIRECT MANUFACTURING COSTS are made up of consumables, supplies and small tools used in the manufacturing process. Consumables to think about are masking, gloves, personal protection equipment, banding, stretch-wrap, cardboard, packaging, touch-up, etc. Outside preparation of parts or racking could be considered in this section.

WASTE WATER TREATMENT COSTS include any maintenance, disposal, supplies and other costs associated with this process.

INDIRECT LABOR COSTS include employee wages (regular and overtime), bonuses, vacation and holiday pay for those who are indirectly associated with the electrocoating process (management, maintenance, technical, logistics, quality, administration, etc.). FICA, unemployment, and other miscellaneous employment taxes for those employees are also considered. Industrial insurance, health insurance, and other employee insurances are reflected in this section as well as any contract labor used that is not directly associated with the production process.

INDIRECT COSTS are those associated with mechanical or equipment parts and service, insurance, casual rental, leases, personal property taxes or racks and tooling.

BUILDING EXPENSE COSTS include building repairs and maintenance, insurance, rent, real estate taxes, janitorial supplies and/or services and security.

ADMINISTRATIVE EXPENSES consist of employee life and disability insurance, retirement, uniforms, physicals/testing and other fringe benefits. Travel expenses, meals and entertainment, training and education as well as dues and subscriptions are part of this category. Advertising, conventions and trade shows, office supplies, telephone expenses, shipping/postage and delivery costs belong here. Auto expenses such as fuel, repair and maintenance, insurance or rentals are administrative expenses. Professional consulting fees, state and city income taxes, sale and use taxes and other taxes and legal fees fall into this group. Donations, environmental costs, fines and penalties and any relocation costs are also associated with this section.

CALCULATING INTERNAL EXPENDABLES COST

The exact costs associated with each section can vary widely depending on the product to be coated, specifications, system size and location, geography, etc. At a minimum, a midpoint of each range shown in the table below may be used as a start in building your cost model.

EXPENDABLE COSTS	COST RANGE – ASSUME AN OPERATION OF 24,000,000 FT ² PER YEAR
Direct Labor (Hourly)	Total people X total hours per year X average wage plus benefits
Direct Manufacturing	\$92,000-\$164,000
Waste Water Treatment	\$29,000-\$150,000
Indirect Labor (Salaried)	Estimated total people X average salary plus benefits per year
Indirect	\$100,000-\$400,000
Building Expense	\$125,000-\$400,000
Administrative Expense	\$175,000-\$350,000

COST CALCULATION FORM

ANNUAL PRETREATMENT CHEMICAL COST (PAGE 3):

Total ft² per year of product Average cost per ft² of system choice \$ _____

ANNUAL PAINT APPLIED COST PER FT² (PAGE 4):

Applied Cost per ft² DFT
_____ Total ft² per year of product
(%TE (1-%S)) \$ _____

ANNUAL ENERGY CONSUMPTION COST (PAGE 7) :

\$ _____

ANNUAL INTERNAL EXPENDABLE COSTS (PAGE 6):

Direct Labor	\$ _____
Direct Manufacturing	\$ _____
Waste Water Treatment	\$ _____
Indirect Labor	\$ _____
Indirect Costs	\$ _____
Building Expense	\$ _____
Administrative Costs	\$ _____

TOTAL INTERNAL EXPENDABLES \$ _____

TOTAL ANNUAL COSTS FOR ELECTROCOATING PROCESS: \$ _____

TOTAL ANNUAL COST PER FT²: \$ _____

Additional Considerations:

TOTAL CAPITAL EQUIPMENT COST (PAGE 5): \$ _____

CAPITAL BUILDING COST (IF NOT RENTING): \$ _____



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