The Electrocoating and Topcoating Of Large Enclosures

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Introduction

Because it is an immersion process, the electrocoating of large enclosures can present various difficulties. Among them are concerns regarding air entrapment, thorough draining, carryout and bath contamination, striping and low mil build. This paper will examine how and why a manufacturer of truck bodies added e-coat to the finishing operation at their new facility and relate how the design and execution of a electrocoat/liquid spray topcoat paint system addressed the problems listed above, among others.

The Company And Its Products

Altec Industries is a manufacturer of heavy truck bodies and related equipment used by the electric utility, telecommunications, tree care and sign/outdoor lighting maintenance industries (Figure 1). It has 25 manufacturing, final assembly and service facilities across North America and Canada, including a new facility in Burnsville, North Carolina, which opened in 2006 to produce truck bodies.

Prior Finishing Process

The previous facility used a combination cleaner/phosphate pretreatment followed by a rinse – both using a spray wand system. Two coatings were then applied by liquid spray: an epoxy primer and acrylic topcoat. The nature of the product required that application of each pretreatment step and paint coat be thorough in coverage and

Figure 1. Two common Altec truck body products equipped with boom manlifts.

thickness to provide adequate protection. Given their complexity, it is no surprise that manual spray methods did not always result in the truck chests receiving optimal coating.

Spray painting alone was therefore found to be inadequate in terms of corrosion protection due to missed areas and insufficient film build. At the other extreme, paint waste also resulted due to operators overcompensating in their attempts to achieve adequate coverage. When the decision was made to invest in the new building, the coating process was also given an overhaul by adding an electrocoat primer.

Automated process

As an immersion process, e-coat reaches all surfaces of the product – both inside and out. Electrocoating is self-limiting, meaning that the film thickness can be closely controlled through the applied voltage because the paint insulates the part as it is deposited. Undercoating is eliminated as long as there is sufficient access to all areas and, coupled with a transfer efficiency of 95% or more, paint waste is minimized.

Altec decided on a square transfer electrocoating system (Figure 2) for two reasons. First, the large product size and penchant for retaining fluids with relatively long drain times meant that a conveyor system with a high load limit was necessary. Secondly, a square transfer system can outperform a programmed hoist in terms of throughput. Although their initial workload was expected to be low, the square transfer system offered significantly higher capacity for future sales increases. This was in addition to the standard advantages of smaller tanks, lower chemical and paint tank fill costs and lower utilities and water usage.

Figure 2. Square transfer electrocoating system at Altec Industries, Burnsville, North Carolina. A tree care truck body is in position to begin the pretreatment process.

The pretreatment regimen in the Altec electrocoating system consists of a nine stage zinc phosphating process:

Stage #	Process	Temperature
1	Alkaline Cleaner	135 degrees F maximum
2	Plant Water Rinse	Ambient
3	Plant Water Rinse	Ambient
4	Plant Water Rinse	Ambient
5	Conditioning Rinse	Ambient
6	Zinc Phosphate	128 degrees F maximum
7	Plant Water Rinse	Ambient
8	Non-Chrome Seal	Ambient
9	Reverse Osmosis Rinse	Ambient

The third stage is equipped to become a heated acid pickle bath. Because Altec currently uses galvanized steel in the construction of their products, the pickle is not needed. They have the option to process hot rolled steel, however, which would require removal of surface scale and welding smut from the substrate prior to electrocoating.

The cream color cathodic epoxy electrocoating bath is maintained at 90 degrees F. Only two post rinses are necessary due to extended process cycle duration and a greater than usual counterflow rate, which helps to maintain a lower percentage of paint solids in the second rinse. The first post rinse consists of recycled permeate counterflowed from the second rinse, which is fresh permeate from the ultrafilters plus reverse osmosis (RO) makeup water.

Truck bodies and auxiliary parts are targeted for 30 minutes dehydration and bake time in the overhead cure oven before entering a cooldown zone. They continue to cool as they exit the square transfer system and are transferred to power and free conveyor for topcoating.

Process Concerns

Air entrapment is always a problem in the immersion treatment of any complex enclosure. The utility bodies manufactured by Altec Industries have many interior surfaces and, despite propping all compartment doors open during processing, air release was expected to be difficult. Extensive testing was carried out to determine the optimal orientation for product hanging. In addition, the utility boxes were re-engineered with small release points added to the design that did not compromise product performance.

For the same reasons as air entrapment, thorough drainage of process fluids during tank transfers is critical. Dragout and bath contamination is problematic in many immersion finishing operations; processing of complex enclosures can make the effect much more dramatic. In addition to re-engineering, therefore, drain time was extended between stages from 40 seconds initially to 99 seconds (Figure 3).

Figure 3. An Altec utility truck body is lifted from the electrocoat tank.

Some design features are known to cause coating problems. For instance, unsealed joints where steel is lapped may allow liquids to seep in. Solution retention in these tight areas on a "first in, last out" basis means that cleaner which gets trapped in the initial stage may not be fully released during draining, and could still be concealed in the lapped joint when curing begins – at which point it boils out and mars the finish. The best way to address this difficulty is to remove overlapping metal joints from the design altogether. Less effective is an initial hot water rinse applied prior to the cleaner solution with an extended oven dehydration zone to slowly evaporate trapped fluids prior to curing.

The square transfer system is equipped with a rocking mechanism (Figure 4) that tilts the loadbars back and forth six degrees both in and out of the tank to encourage air release and drainage. It is critical that the truck bodies be properly hung on the loadbar with their gravity centered to minimize wear and tear on the mechanism. Centering the load also ensures that both ends of the enclosures are tilted above level, which releases

Figure 4. A rocking mechanism tilts truck bodies to assist with air release and drainage.

all trapped air while in the tank and trapped water during drainage. It was found that uneven weight distribution due to poor hanging practices prevented the rocking mechanism from working properly. As a result, drainage was incomplete – allowing tank residue to settle on flat surfaces and compromise coating smoothness.

Striping

Striping is a condition often found with live entry monorail tanks, where a lined effect occurs in the finish as the parts are immersed into the paint solution. This problem is eliminated on the Altec square transfer system because the voltage is not activated until the parts are completely immersed in the electrocoating solution.

Low Film Build

Problems with low film build may occur due to the size of the largest truck bodies. Areas nearest the tank anodes (the exterior) will easily reach the desired film thickness while deep recesses may not be coated at all, due to the limitations of throw power. To combat this condition, the racking mechanism was designed so that an auxiliary anode could be positioned on it to assist in promoting deposition inside the enclosures. Although this additional anode did its job adequately, the only products that required its use were chopper boxes for the tree care industry (Figure 5). Because the interiors of these truck bodies were sprayed with a thick rustproofing solution which protected them from the wear and tear of flying wood chips, the electrocoat primer was not required and Altec discontinued use of the auxiliary anodes.

Use of a square transfer system allows Altec to closely control film build elsewhere through the use of Automatic Voltage Control (AVC). When a load enters the tank, the Programmable Logic Controller (PLC) determines its square footage from the amperage draw. Rectifier voltage is then applied in four increasing steps, based on the load size: 100, 165, 230 and 270 volts. Truck bodies will undergo exposure to all four steps, while auxiliary parts having lower square footage may only experience the first or second voltage levels. In this way, smaller loads are not overcoated.

Figure 5. The interiors of these tree care chopper boxes are sprayed with a thick corrosion-resistant coating and do not require electrocoating.

During system startup and the subsequent adjustment period, Altec erred on the side of too much voltage, resulting in film builds of up to 1.5 mils. This has now been dialed back to a thickness between 0.8 and 1.0 mils – more than sufficient for a corrosion resistant electrocoat primer.

Overcure

Due to current low production levels, the system operator releases loads into system manually. This can result in irregular cycle times, almost always longer than the 4:19 automated cycle. However, the cream colored epoxy electrocoat paint is formulated with double overbake capabilities. Even though overexposure in the oven results in a darker military drab/greenish brown color on the product, adhesion properties are maintained and, as a primer, color matching is of secondary concern.

The paint is self limiting, so coating will cease when the target film build is reached. Extreme overexposure to certain baths can result in rejects; for instance, too much zinc phosphate build can result in adhesion failure, and too long in the post-rinse tanks may actually wash the electrocoat off of the parts. Normal time variation between operator load releases, however, do not reach a duration significantly affecting the performance of the process solutions.

Load Capacity

The square transfer system hydraulics were originally sized to process one full size truck body out of every three loads without difficulty. As production increases, a second hydraulic unit will be added to handle two bodies in every three loads. In case of maintenance or repair, the system will still be able to continue electrocoating at the old one in three rate using only one operational hydraulic unit.

Topcoating

Electrocoated parts are transported by 4" x 4" power and free conveyor from the load/unload area of the square transfer system to a series of booths involved in the topcoating process (Figure 6). The addition of the e-coat primer to the overall coating process completely changed the original scheme, which was envisioned as follows:

Wash Booth
Dryoff Oven
Caulking Station (sealing seams)
Prime Coat Booth – Powder
Powder Cure Oven
Cool Down Area
Topcoat Booth

Figure 6. Topcoating booths at Altec Industries, Burnsville, North Carolina.

Topcoat Cure Oven

Cooldown/Masking Area

Undercoating Booth

All pretreatment and rinsing would be carried out with a spray wand system. Obviously, this method would not be as efficient and thorough as an automated dip system, given the complex design of the Altec truck bodies. Using powder for the prime coat would be problematic due to Faraday Cage effects encountered at interior corners. Another concern found in powder coating large, complex parts stems from the unavoidable fact that manual application is necessary to reach all interior areas. Applicators often over apply powder in their attempts to achieve total coverage, leading to powder waste and uneven film build.

Changing the primer from powder to electrocoat eliminated operator error in the application process, ensuring better overall coverage with less paint waste and a thinner, more even coating. As a result, the topcoating process was also reworked, as follows:

The wash booth was no longer needed to clean the product due to the superior automated immersion pretreatment applied by the square transfer system. It is now used as a sanding booth where visible surfaces of the truck bodies are touched up prior to topcoating to achieve a Class A finish. Gross residue is sprayed off before proceeding to the dryoff oven, which operates at 250° F. Rollup doors segregate all topcoat process ovens from adjoining booths to minimize heat loss and maintain comfortable working conditions.

The caulking booth allows the bodies to cool before seams are sealed. The product is also wiped down manually to remove any remaining grit from the sanding process.

The original powder booth has been converted to a topcoat booth with downdraft filter (Figure 7). A paint kitchen automatically mixes and delivers the white paint, which is applied to 95% of Altec's product line. Other colors are sprayed from five gallon pots. The undersides of the truck bodies are not sprayed because they will receive an undercoating layer further along in the process.

The topcoat oven was constructed against the exterior of the building and runs at 200° F, a much lower temperature than originally intended as a powder curing oven. Because the dryoff and curing ovens used in the topcoating process do not require high heat, the conveyor requires less lubrication. Throughout the topcoating area, loadbars remain disconnected from the power and free conveyor to make sure line workers have sufficient time to complete their tasks. Loads are then manually pushed into place at pickup points where the conveyor connects to the loadbar and moves it to the next station, as monitored by the PLC.

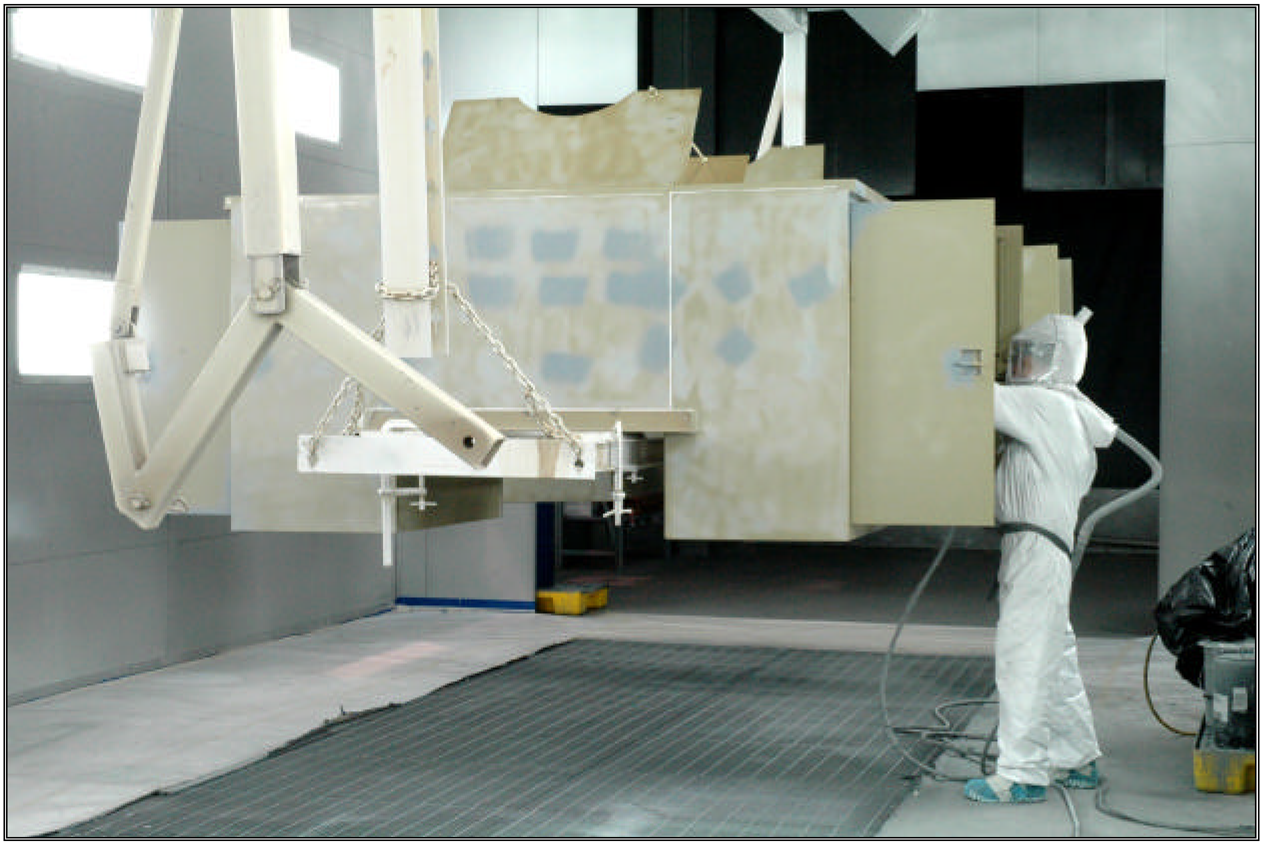

Figure 7. A white topcoat is applied to approximately 95% of Altec products.

Originally intended as an extended cooldown area, the next booth is used for visual inspection and touchup. The gray interiors of tool chest drawers are also coated here. Parts then proceed to a second downdraft touchup booth and the touchup oven, set at 175° F. After exiting the touchup oven, the parts are allowed to cool before being masked for undercoating. The undercoating step is now not as essential for rustproofing due to the excellent corrosion protection afforded by the electrocoat primer, meaning that less undercoating material is required to shield the finished product.

Parts are transferred by forklift to the final assembly line where the bodies are dressed out. A final touchup booth used for inspection and catching any spots missed previously will be moved from its current position and the final assembly process reworked for better flowthrough.

Conclusion

Employing an electrocoat primer allowed Altec Industries to achieve a more thorough, corrosion resistant finish on their truck utility body products. Choosing a square transfer system gave Altec that superior prime coat in a fraction of the space necessary for a monorail due to smaller process tanks. The square transfer concept is also better able to handle the weight of large, complex parts with interior cavities as they are immersed and withdrawn from each stage, and can out produce a programmed hoist of similar weight capacity.

Process concerns regarding air entrapment and solution drainage were solved through the use of a load rocking mechanism, as well as reengineering release points in the product enclosures. Low interior film build is increased with auxiliary anodes. The electrocoat primer as applied by the square transfer system gives Altec's products better pretreatment and even streamlines the topcoating process.

About the Author

BLAKE ECKARD has been a Manufacturing Engineer at Altec Industries since the startup of the Burnsville facility in 2006. Prior to Altec, he was employed by Thermo Electron, Carrier Corporation and Lockheed Martin. He holds a Bachelors degree in Industrial Engineering from the University of North Texas.