Electrocoating
In Five Colors

Bradley Andreae & Chad Andreae
Therma-Tron-X, Inc.
Sturgeon Bay, WI

Introduction

Electrocoating with multiple colors in a single production line poses many challenges – including segregation of paints, color variation due to dragout and space requirements. This paper describes the design and operation of a system that e-coats fasteners in baskets in any one of five colors (with a future option for a sixth color). Consideration will be given to system layout, concerns about paint contamination, material handling automation, load tracking, paint handling and wastewater disposal.

The Challenge

Finishing in the fastener industry has changed greatly in the past dozen years. Dip spin coating was the widely accepted method employed in fastener production until it was discovered that bulk electrocoating on trays or in baskets provided better corrosion protection along with a tightly controlled film thickness and, therefore, greatly reduced paint usage. In addition, e-coat eliminated head fill, clogged threads and minimized clumping during the curing process. As a result, dip spin coating was quickly relegated to small batch colors while e-coat became the coating of choice for high volume products. This usually meant one, two or – at the very most – three colors applied by the same system.

A noted fastener manufacturer sought ideas on an electrocoating system able to provide high output in any one of five colors, with a future option for a sixth color.

Besides color, the product also varied by fastener type, length, diameter and thread configuration (Figure 1). In addition, the manufacturer had limited floor space available; packaging equipment and warehousing space already claimed a large portion of the facility.

Figure 1. Fastener coating can be complicated by wide variations in color, length, diameter, thread configuration and head shape.

The challenge was to provide an electrocoating system that maximized product flow – preferably in more than one color at a time – with an automated material handling system to bulk load and unload fasteners and manage their trip through the coating process. Fastener "nesting" should be minimized and cross contamination of different products with one another non-existent.

Due to the limited facility area available for the system, special consideration was given not only to the size of the system itself, but also to auxiliary equipment. To maintain consistent throughput during color changes, each paint color would require its own rectifier, ultrafilter skid and storage tank. Room was also required for pretreatment storage tanks and a wastewater treatment system. Any space-saving opportunities that could be incorporated into the design were, therefore, critical to the viability of the project.

Square Transfer System

Based on the available footprint, a full immersion, five color monorail system would have been impractical. Belt processing lines would also have been too long, and required several systems for multiple color processing. Due to flexibility requirements for running various colors and fastener types, a square transfer system was chosen with dual processing lanes – each capable of applying three colors (Figure 2).

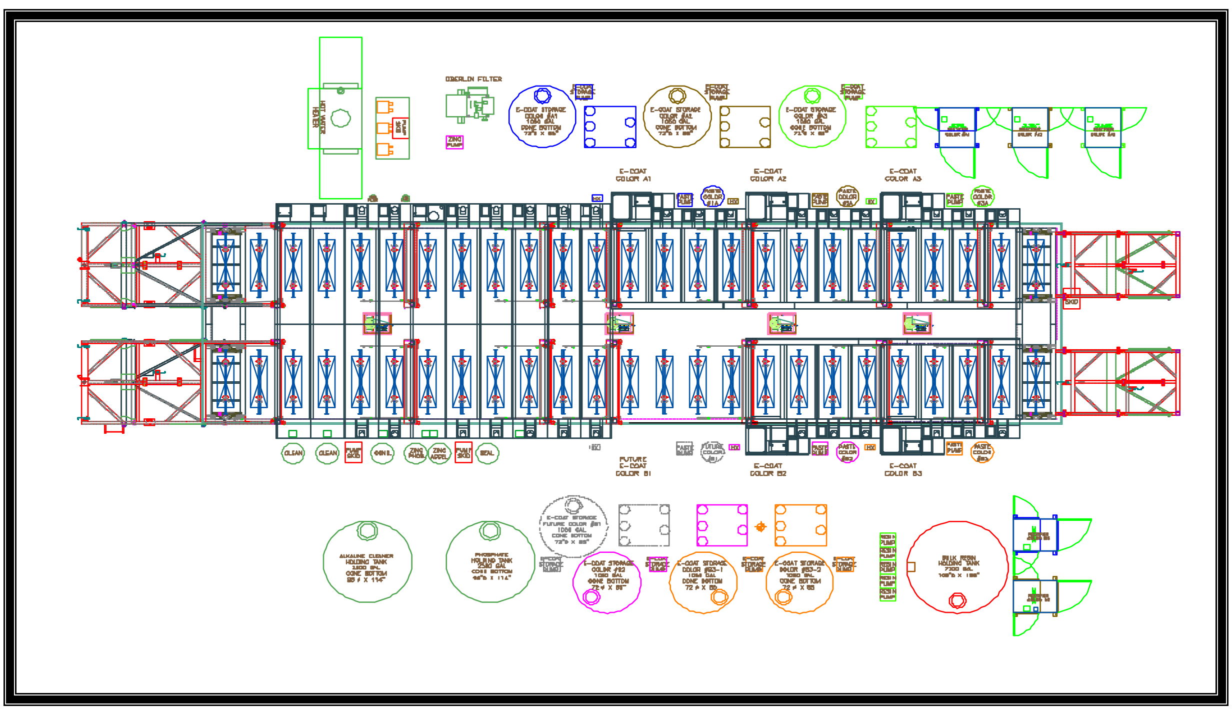

Figure 2. Plan view of square transfer electrocoating system showing dual processing lanes. The four stations at bottom center indicate space available for a sixth color.

The square transfer concept greatly reduces floor space requirements because loads enter and exit the process tanks vertically. This allows the tanks to be only marginally larger than the work envelope. The use of baskets maximizes throughput and makes bulk electrocoating feasible by increasing load size. Because tanks are smaller, a square transfer system allows immersion pretreatment for more thorough cleaning and phosphating in a limited footprint. Tank charge costs are lower, as less paint and chemicals are needed to fill tanks at startup. The cure oven and cooldown zone are located above the process tanks, further minimizing system footprint (Figure 3).

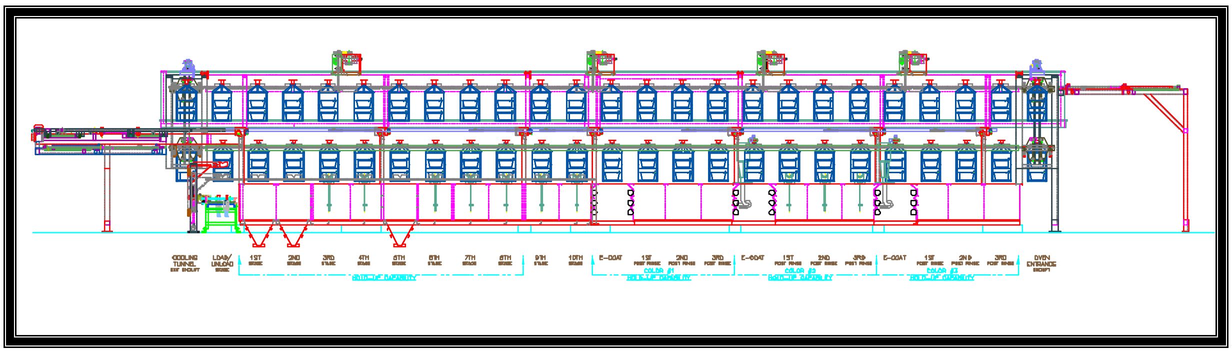

Figure 3. Side Elevation of square transfer electrocoating system. Cure oven and cooldown zone are located above the process tanks.

The square transfer layout also allowed the two adjacent processing lanes to share common pretreatment tanks, oven and cooling tunnel. The design saves on capital expenses and costs of maintaining two pretreatment systems, two ovens and two cooling tunnels.

The layout of the system is such that three colors can be sequenced in each processing lane. Each electrocoating bath has three dedicated post-rinses behind it. Colors are aligned from lightest to darkest to minimize potential contamination from dragout. The rinses are designed to be supplied with permeate from ultrafilters or made up with high purity reverse osmosis (RO) water. Anodes in the e-coat tanks are arrayed horizontally instead of the normal vertical orientation for even throw power across the entire width of the tank (Figure 4).

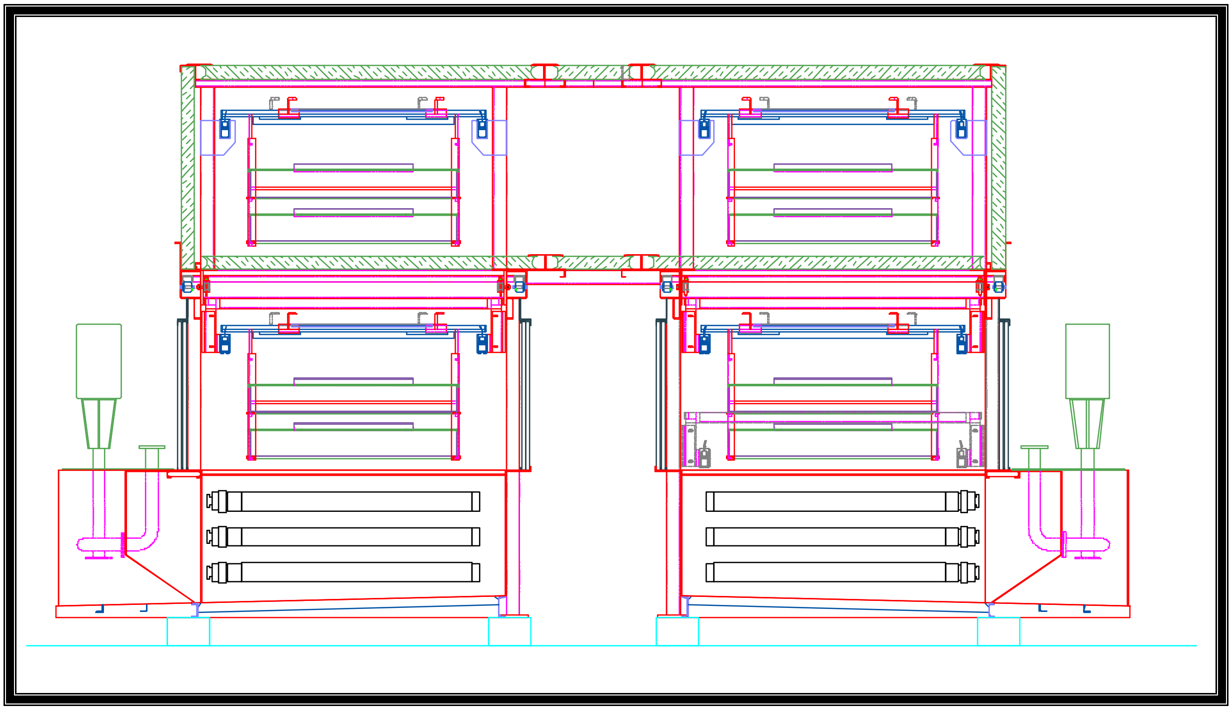

Figure 4. System cross section illustrates horizontal anode orientation.

The square transfer concept allows for maximum throughput of different fasteners in different color tanks with the use of holdups. The line operator enters the process parameters for each load into the Programmable Logic Controller (PLC). Baskets are then dipped into the correct color e-coat tank and subsequent post-rinses, and held up over the other e-coat and post rinse tanks. Unlike a programmed hoist, each processing cycle will deliver a completed load to the unload station – or in this case, one load from each processing lane.

It is possible for other methods to be employed for multiple color application on square transfer systems. For instance, the e-coat tank and subsequent rinses may be transferred sideways out of the process line and a new color tank and post rinses slid into place. The drawback of this method is that painting can only be done in one color at a time on a batch basis. The same paint and post rinse tanks could be used for different colors by pumping their contents into holding tanks, rinsing the process tanks and then refilling with another color paint and solution from other holding tanks. Obviously, this would be time and labor consuming, greatly reduce throughput and still only offer single color processing at any one time. Both alternate methods limit flexibility.

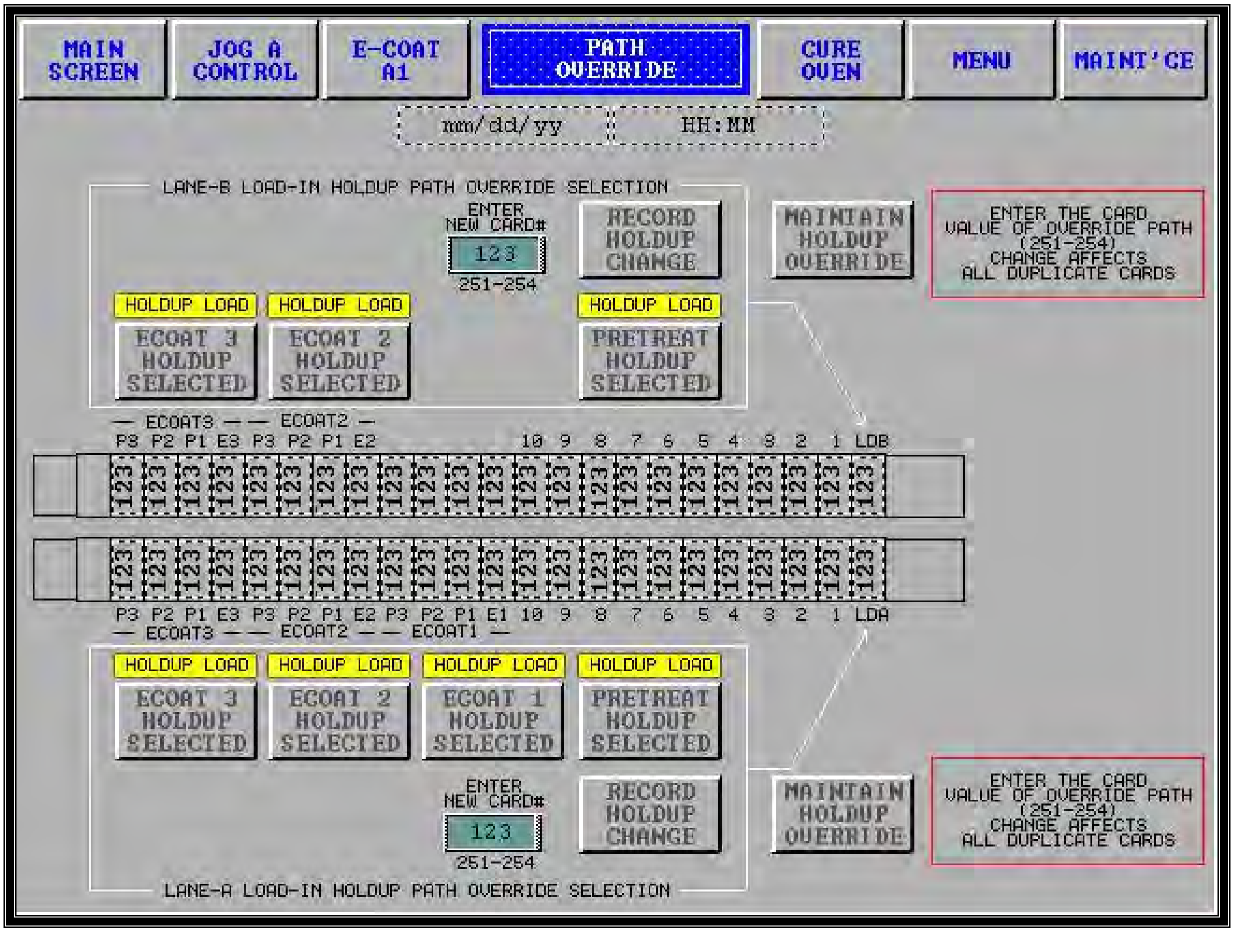

Figure 5. Bar code readers relay the location of each load to the PLC, which manages the entire electrocoating process based on information entered by the system operator.

Load Tracking

Information such as fastener type, weight, color and painting voltage is entered by the system operator or by scanning a bar code. Loads are then tracked by the bar codes on each basket as they proceed through the system. Readers relay the identity of each basket to the PLC, which then assigns the fastener information entered at the load station. Advances in RF technology may provide another option for load tracking.

Because the PLC monitors the loads while they are processed, a color touch screen display allows the operator to view what product is at each station in real time – both in the tanks and in the oven (Figure 5). It also permits corrections to be made in the event of a misread or incorrectly assigned process.

Loading/Unloading

Manual loading is performed for long fasteners and for small production batches. Otherwise, an automatic loading system is used (Figure 6). The primary difficulty with bulk loading is to break up clusters of fasteners so that they may be more evenly loaded into each basket to facilitate better processing through the tanks and oven.

Totes or large boxes of fasteners are dumped into a live bottom hopper, which forcefully shakes the product to separate clumps of nested parts. The fasteners then fall onto shaker tables which spread the fasteners evenly to facilitate gravimetric loading. Larger fasteners cascade over three tables before being shaken into a basket. Smaller fasteners are processed with two tables, as they are easier to separate. Even using live bottom hoppers and shaker tables, it is still sometimes necessary to have workers “rake” the longer fasteners with hand tools to aid in the procedure.

The PLC closely monitors the weight of the fasteners being dumped into each basket. When nearing the optimal load, the PLC will fine tune the amount of vibration on the final shaker table in order to reach the target weight without overloading.

Baskets are then delivered to the square transfer electrocoating system by roller conveyor – although any number of methods could be used in similar systems: indexing monorail, power & free or chain conveyors are other options. Each lane load consists of

Figure 6. Live bottom hoppers and shaker tables measure fasteners into baskets by weight to prevent overloading.

two baskets stacked vertically; four baskets are processed per system load. After cleaning, coating and curing, the baskets are automatically unloaded into totes or onto other conveyors for further processing.

Paint Handling

Although the use of three post rinses is very effective in removing excess paint from the product, some small amount of color contamination in subsequent paint tanks due to dragout is still possible. By arranging paint colors in order of lightest to darkest in each processing lane, the risk of modification of any paint color is effectively minimized.

The paint used in each tank has the same epoxy formulation, other than color. This allows the use of a bulk resin system with distribution manifold for all the colors, lowering costs and eliminating the handling of totes, their disposal costs, and the associated wasted resin. The PLC regulates individual paint pumps that add tint to each tank, based on the square footage of fasteners processed.

Wastewater Disposal

Wastewater treatment for the five colors is similar to that required for other electrocoat systems of comparable square footage. Anolyte waste, permeate to drain and RO water (if required) is collected in an e-coat waste manifold and pumped automatically to either an e-coat waste tank or an equalization tank for further processing (Figure 7).

Figure 7. The wastewater treatment system handles discarded paint from all five color tanks, along with pretreatment waste.

Conclusion

Fastener finishing has undergone significant improvement through the use of electrocoating. The process greatly reduces paint usage while enhancing performance. Fasteners in several colors may be bulk electrocoated in baskets at high volumes using a square transfer system (Figure 8). The square transfer material handling concept makes best use of available floor space, minimizes operating costs and, unlike a programmed hoist, delivers a completed load at the end of every process cycle. Multiple product colors are sequenced in line with baskets held up over specific tanks. Automated bulk loading and unloading allows the system operator to measure out optimum fastener quantities in each load for maximum throughput.

Figure 8. Five color square transfer electrocoating system with automated basket load/unload conveyor loop.

About the Authors

BRADLEY ANDREAE has been a Project Engineer at Therma-Tron-X since 1998. Prior to Therma-Tron-X, he was a Design Engineer for Oshkosh Truck. He received Bachelors degrees in Mechanical Engineering and Management Systems from the Milwaukee School of Engineering.

CHAD ANDREAE has worked as a Design Engineer at Therma-Tron-X since 2004. Before Therma-Tron-X, he was employed as a Design Engineer for Kimberly Clark. He holds a Bachelors degree in Mechanical Engineering from the Milwaukee School of Engineering.