AN OPERATIONAL COMPARISON OF SQUARE TRANSFER AND MONORAIL ELECTROCOATING SYSTEMS

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Introduction

Midwest Products Finishing, Inc. is a custom coater located in Ottawa Lake, Michigan, which is in southeast Michigan near the Ohio state line. Currently, we specialize in the electrocoating of components for the Automotive Industry, utilizing two different systems. Both systems, one of which is a monorail e-coat system and the other a square transfer e-coat system, apply cathodic black epoxy.

There are several types of systems used to apply electrocoat technologies. The purpose of this paper is to provide a description of both systems and an operational comparison (including footprint, ease of operation, load flexibility throughput load capacity, part processing flexibility, maintenance, and operating costs) based on our experience.

Monorail Electrocoat System Configuration (Figure 1)

Midwest's monorail system has been in operation for several years. The system is comprised of an eleven (11) stage zinc phosphate pretreatment, followed by a 15,000 gallon electrocoat tank, three stage post rinse, a dehydration tunnel, cure oven, and cool down zone. The pretreatment system, sequentially, is spray, immersion, two more spray stages, immersion (phosphate conditioning), immersion zinc phosphate, followed by five spray stages.

System Capability:

- Load Size: 3' x 3' x 6' high
- Capacity of the system: 300 sq. ft. per minute
- Maximum Load Weight: 250 lbs. per rack
- Cycle Time: 18' per minute

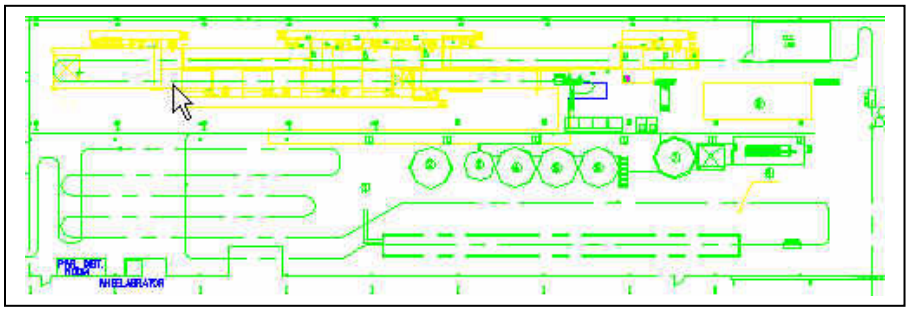

Figure 1: Monorail System

Square Transfer Electrocoat System Configuration (Figure 2)

Midwest's square transfer system is sixteen months old as of April, 2002. The system, which was added due to a continued increase in business, provides additional capacity. The square transfer system not only met that need, it was designed to offer more load flexibility, as well as the ability to handle larger parts. The system is comprised of a twelve (12) stage zinc phosphate pretreatment system, cathodic epoxy electrocoat system (dual tank), three stage post rinse, dehydration chamber, electrocoat bake oven, forced air cooling tunnel, SST conveyor system and automatic transfer unit to load and unload the load bars and part racks from a power & free conveyor system. The stages are all immersion with the exception of one cleaning tank and one electrocoat post rinse tank which are spray stages. The system does have acid cleaning capability.

Special features designed into our system include
:

- Station (Tank) Skip Capability
- Rack Burping System
- Load Weight Control System
- Automatic Chemical Feed
- Automatic Voltage Modulation
- Motorized Oven Exhaust System
- Exhaust Dilution System
- Cooling Tower Paint Cooling System
- Air Agitation in rinse tanks
- Sumpless Drain System
- Automatic Start-Up
- Documentation Package (Input devices and software program) for tracking costs

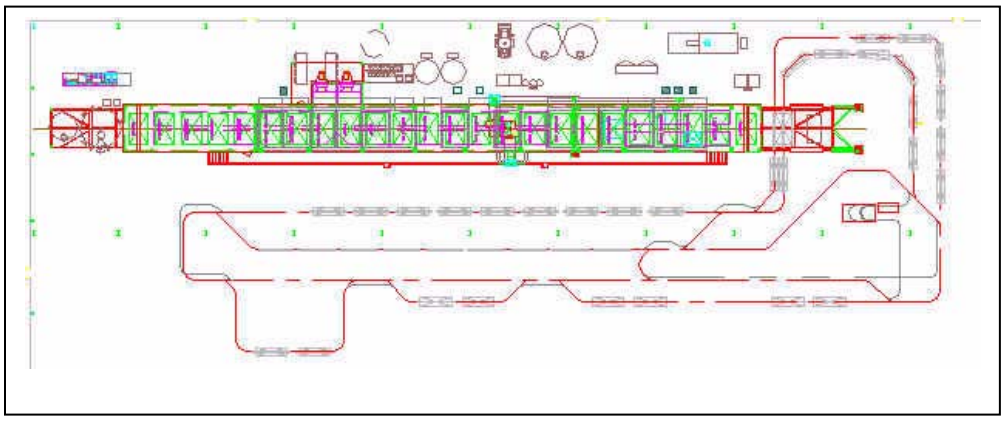

Figure 2: Square Transfer System

System Capability

- Ware package size: 9’ wide x 6’ high x 5’ deep
- Capacity of the system: 400 square feet per minute / 1200 sq. ft. per load
- Max. Load Weight: 4000 lb. loads (including parts, loadbar, hangers, and rack)
- Cycle Time: 3 minutes (20 loads per hour)

Floor Space Requirements

Monorail System

Midwest’s monorail electrocoat system occupies approximately 22, 100 sq. ft. (exclusive of the part load/unload area) Figure 3.

Immersing parts for pretreatment and electrocoat on a monorail system requires a very large tank volume, as the parts enter and exit the tank along inclined conveyor paths. The part load/unload area for this system is sized to accommodate the container/worker space required for Midwest’s custom designed parts racks.

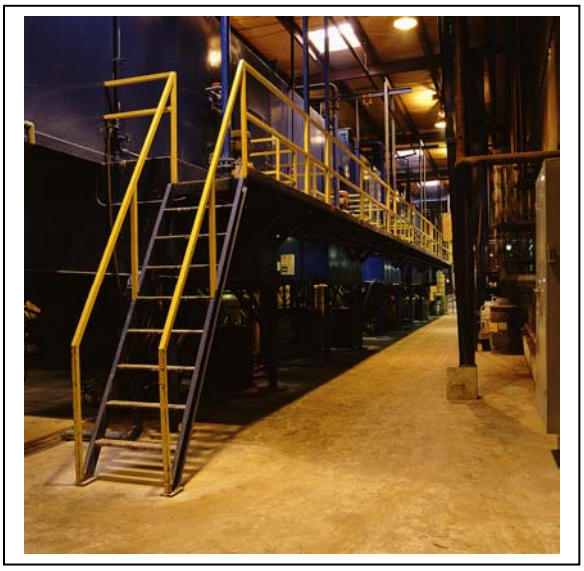

Figure 3: Monorail Pretreatment System

Square Transfer System

Midwest’s square transfer electrocoat system occupies approximately 11,250 sq. ft. (exclusive of the power & free load/unload conveyor system) Figure 4.

In the square transfer system, racks of parts enter and exit immersion tanks vertically before transferring to subsequent stages in unison. This means that process tanks can be smaller and still utilize immersion treatment in every stage, if desired. The tanks are situated directly adjacent to each other, therefore saving space. The cure oven is also located directly over the tanks, freeing up more space.

Figure 4: Square Transfer System

The intricate power & free conveyor system and load/unload spurs (Figure 5), add a significant amount of space to the footprint for this line.

Figure 5: Power & Free Conveyor System

Ease Of Operation

Both systems are "user friendly" from our perspective. Both systems have PLC's controlling the process. With Midwest's square transfer electrocoat system being much newer than the monorail system, it does provide operating advantages based on features such as automatic chemical and paint feed systems, automatic permeate and anolyte purge systems, sumpless drain system, etc.

Monorail Line

The processing path, which follows the route of the continuous conveyor chain, is less complicated than that of the square transfer line. The conveyor controls on the monorail system are very straightforward.

Square Transfer Line

The square transfer system moves parts in stages: up, over and down, transferring them tank to tank (figure 6). Parts are also transported up into the oven and down out of the cooling tunnel. Entry into the system (from the power & free loop) is accomplished utilizing a transfer cart.

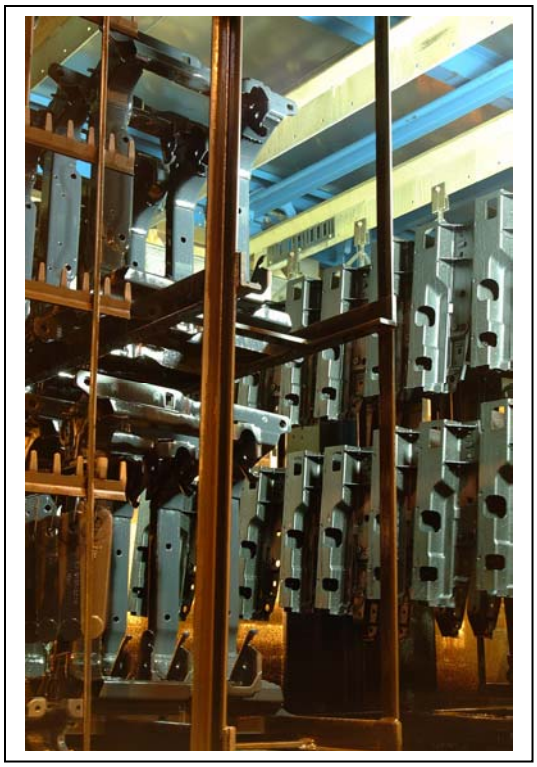

Figure 6: Square Transfer System

Stops, proximity switches, electric eyes and load identifying barcode readers can lead to occasional conveyor malfunction, although the problems are quickly located by the system's alarm detection function. (Figure 7)

Figure 7: Power and Free Conveyor System

Reprogramming or adjustment of square transfer system operation requires operator expertise (knowledge of the system and PLC control). The system offers a much greater degree of flexibility than the monorail – for instance "hold ups" (skip tank feature) located over selected tanks can be programmed to automatically prevent flagged loads from immersion. This allows simultaneous processing of different substrates; however, the tradeoff is in the complexity of the controls.

Ease of Load / Unload

Moving Conveyor – Monorail Line

A moving conveyor carrying paint racks provides a challenge (particularly on parts with small diameter hanging holes) to rack the number of parts desired. A custom designed fixed parts racking system is used on this line and the crew fill the racks as they proceed past each work station. The racks accommodate a substantial number of parts and therefore require a larger number of line workers to accomplish hanging and packing of parts.

Static Station – Square Transfer Line (Figure 8)

The power & free system conveyor system returns part paint racks to a spur that is stationary and therefore provides easier load/unload for line workers. This was an essential part of the system design, as the system was intended to handle larger and heavier parts than the monorail line. If the time required for release of loaded racks into the paint system is exceeded due to a large quantity of parts to be racked, it can be done "off line" and then returned to the line. Many racks of parts are loaded and unloaded from the conveyor system using a hoist and, in some applications, parts are loaded into paint racks using an end effector. It would be both difficult and dangerous to do so on a monorail line.

Figure 8: Power and Free Conveyor Load/Unload

Comparative Throughput

Monorail Line

Based on the configuration of Midwest's line, the monorail system lends itself to smaller size parts with high volumes that are suitable for the paint rack configurations used on this line. The time required in the electrocoat tank, and in the oven for paint cure (baking), are also factors. The custom racks are configured to provide flexibility through set-up of several different parts simultaneously on the same rack rather than batching one part configuration. Work flow is set-up to position containers of parts to be painted in sequence with rack location. In this way, Midwest is able to maximize throughput on a continuously moving conveyor. A case can be made for higher efficiency on a monorail system in that the moving conveyor "sets the pace" for line workers that have target quantities per rack for each part.

Square Transfer Line (Figure 9)

Although the system is capable of processing small parts, our experience thus far is that larger part applications are generally more suitable for this line as configured. Being a custom coater, we are faced with new work opportunities where the part geometry varies greatly. We have created some flexible paint racks that can be adapted for a variety of parts; however, we are utilizing quite a bit of specialized tooling (paint racks) for specific applications. The square transfer system compiles loads in it's power and free conveyor system, and releases them, one at a time, for entry into the pretreatment system at the beginning of their finishing journey. The loads (racks of parts) come from one of several spurs in our system, as has been discussed earlier. One aspect of managing throughput that is a current challenge as volume increases on this relatively new system for Midwest, is that of sequencing racks from several load/unload areas for maximum efficiency.

Figure 9: Part Racking on Square Transfer System

Load Capacity

Monorail Line

The weight of parts loaded on the monorail system is constrained by the distance between racks. Too much weight per rack can put strain on the conveyor motor and increase the wear and stretching of the chain.

Square Transfer Line

The square transfer system is designed for a much higher weight capacity per load (two tons), based on a conveyor that moves product hydraulically through system stages. Conveyor wear is greatly reduced within the system itself because no chains are used in the system. However, the power and free system does incur chain wear.

Part Processing Flexibility

Monorail Line (Figure 10)

This line is quite flexible by virtue of the fact that we can rack and paint a number of customer's parts simultaneously, which really helps us to be responsive to customer's turnaround requirements (that frequently can be hours not days). Our experience has been with a fixed rack system. We choose not to be changing out racks all the time on this line. This, of course, limits flexibility in terms of the size and geometry of parts that can be run on this line.

Figure 10: Monorail System

Square Transfer Line

We can be flexible on this line utilizing our universal paint racks which are designed with the capability to locate part-hanging hooks in different positions. However, we are batching a lot of parts using dedicated paint racks, particularly larger parts. This is effective for lot control. Our design requirements for this system provided a great deal of flexibility in terms of the size of parts that can be accommodated. This system was also designed with a number of special options that provide greater flexibility in successful processing of customer parts. This includes the rack burping feature which raises (after immersion) the loads, first on one side and than the other, to release trapped air from the parts. Although we are not currently doing so, the system can be programmed to process different substrates through different pretreatment regimens by using the station tank skip feature (hold-ups over specified tanks). Again, we are not doing it, but the same concept could be used to process parts in different colors.

Routine Maintenance

Both electrocoating systems have similar maintenance routines. Screens in washer tanks must be cleaned, bag filters changed, etc.

Monorail Line

Not as compact as the square transfer system and therefore more square feet to monitor. In our case, the tanks are mild steel, which have a tendency to scale up and require more cleaning time. In comparison to the square transfer system, the monorail system has more spray stages which require more nozzle maintenance. Also, the tanks on this system are larger and therefore require more time to transfer fluids prior to cleaning.

Square Transfer Line

With the system options that we elected to include in our new system (automatic chemical and paint feed, automatic permeate and anolyte purge, a sumpless drain system, etc.) our daily maintenance is less. The pretreatment tanks are stainless steel and therefore easier to clean (hose down).

Comparative Operating Costs Based On Our Experience

Direct operational cost comparison of these two systems presents some difficulties from several aspects. The significant age difference of the systems, the technology differences (oven operating temperature, premium efficiency motors, boiler vs. burner tubes, etc.) and the fact that the systems are essentially designed for different applications. The measure of maximum processing capabilities in terms of square footage would seem to be useful. However, in actual practice, it is difficult to meet loading requirements which result in maximum throughput.

Utilities Consumption

Heated spray pretreatment stages tend to lose more energy more quickly than heated immersion stages (the square transfer system being predominantly immersion). Heated square transfer pretreatment tanks also cost less to maintain at temperature, as they are partially insulated by each other. The square transfer oven also takes less energy because of its smaller size. Waste treatment costs will be similar, except when tank dumps are necessary (advantage square transfer system with its smaller tanks).

Paint Consumption

The square transfer system has an advantage over the monorail system in that the rectifiers in our two-stage e-coat system are operated using automatic voltage adjustment to the square footage of the load in the tank. This maximizes the consistency of the film thickness and eliminates excess paint consumption. The monorail system cannot be similarly equipped, as the voltage cannot be so closely monitored with parts continually entering and exiting the paint tank. Because the electrocoating tank is considerably smaller on the square transfer system, initial tank charging costs are less and, if a catastrophic contamination were to occur requiring dumping of the paint, the replacement cost would be substantially lower.

Midwest Operational Cost Data

This is based on our experience, our costs per unit for utilities, coating efficiency, our level of operating efficiency, and the configuration of our two systems. Keep in mind the aforementioned difficulties in making direct cost comparisons.

Operating Costs Per Square Foot	**SQUARE TRANSFER SYSTEM IS APPROXIMATELY 33% LESS THAN THE MONORAIL SYSTEM**

Summary Comments

Monorail and square transfer electrocoat systems both have appropriate application in industry. The appropriate system for you will depend upon many factors relative to your business. Key considerations among them would certainly include:

- Type of Business: Captive Shop vs. Custom Coater considerations
- Part size(s) and configuration
- Space availability
- Investment Capital
- Projected volume of work

BIOGRAPHIES

Kevin O'Brien is General Manager of Midwest Products Finishing, Inc. in Ottawa Lake, Michigan. Prior to joining Midwest in 1995, he managed several manufacturing companies with "in house" paint lines. He is a graduate of Boston College with a B.S.B.A. degree. He is a member of the Electrocoat Association Marketing Committee.

Dan Dutkiewicz is Plant and Environmental Engineering Manager at Midwest Products Finishing, Inc. in Ottawa Lake, Michigan. Prior to assuming these responsibilities, he has held positions as Plant Manager and Production Manager. Dan has attained over 25 years of experience in the operation, servicing, and troubleshooting of electrocoat systems.

Pete Schira is Production Manager at Midwest Products Finishing, Inc. in Ottawa Lake, Michigan. Prior to assuming this responsibility, he held the position of Quality Assurance Manager including responsibility for Midwest's test lab. He has over twenty-five years of experience in metal finishing that includes fifteen years in the operation and troubleshooting of electrocoat systems.