MATERIAL HANDLING: SQUARE TRANSFER AND PROGRAMMED HOIST SYSTEMS

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Introduction

This presentation segment regarding system design will focus on indexing and programmed hoist application systems. Advantages and disadvantages of each type of system will be discussed. An examination will be made of design considerations that match system capabilities with product and process demands. Best applications for use of each system and relative costs of purchase and operation will also be considered.

Because electrocoating is an immersion process, electrocoat equipment design is constrained by the primary goal of complete product immersion in a paint tank for sufficient time to build the desired coating thickness. Monorail systems meet this goal by gradually dipping, holding and raising product into and out of long, narrow tanks on continuous conveyors. Indexing systems and programmed hoists meet the same requirements by vertical immersion into tanks only marginally larger than their maximum work envelope.

Although no one system type is superior in all electrocoating operations, indexing systems and programmed hoists can, in many cases, offer the electrocoater several advantages in terms of floor space usage, tank charge costs, operational expenditures, and pretreatment options.

Square Transfer Indexing Systems

(Figures 1 and 2)

Indexing electrocoat systems process multiple loads of product stage by stage by transferring them simultaneously from one tank to the next at pre-programmed time intervals . A typical cycle begins with the loadbars and product suspended over the process tanks. The system lowers all product vertically into their respective process tanks where it is held for the time required to electrocoat the product in the paint tank (this is normally the limiting stage for process timing). The loadbars with attached product are then simultaneously raised above the tanks and left suspended for 30 to 45 seconds to enhance drainage and minimize carryover. The loadbars and product then shuttle a distance sufficient to position each of them over the next process tank, then the cycle begins again.

A typical process sequence for an electrocoat system consists of one or two cleaning stages, rinse stages, pickling stage, rinse stages, phosphating stage, rinse stage, seal, and a final high quality rinse in the pretreatment section, followed by the E-coat stage and three post rinse stages. Parts may then continue through an extended drip-off area over a drain pan, or proceed directly to an oven that is most often located directly over or alongside the process tanks. However, the parts may also be transferred to a conventional monorail conveyor for transport through an oven.

Figure 1. Square transfer indexing electrocoat system. Load/unload carousel conveyor is at the far end; cure oven is top, near end; forced cooling zone is top, far end. Water treatment equipment is in the foreground.

It is immediately apparent when comparing the operational aspects of an indexing system to a monorail system that the size of the paint tank in the indexing system will be much smaller. And, given that immersion pretreatment is very often more effective than spray pretreatment (especially in the case of complex part geometries), an indexing system can supply total immersion processing in a small fraction (typically 30% - 50%) of the plant space required for a typical monorail conveyor system of similar capacity. This is not to say that spray stages are impractical in indexing systems. Clean and post rinse spray stages are quite common in indexing systems. Fixed or oscillating risers are installed inside the appropriate tanks.

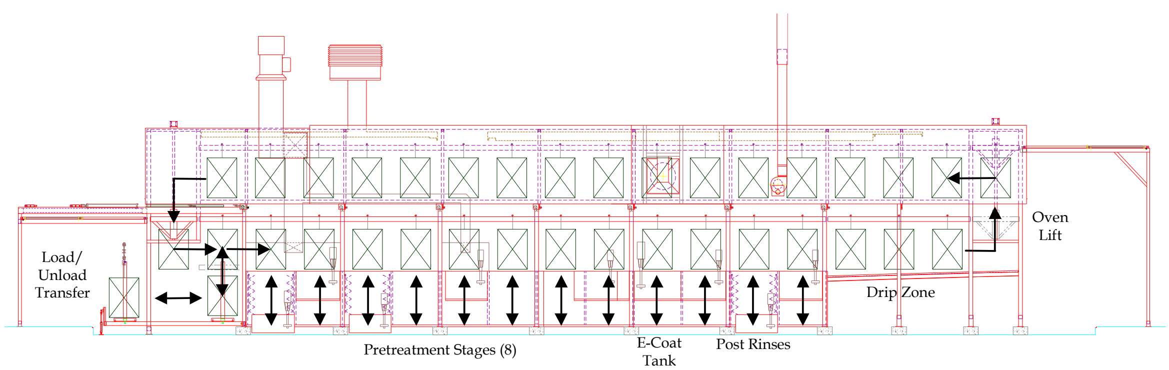

Figure 2. Side elevation drawing of square transfer indexing electrocoat system. Part progression is from left to right on lower (process) level and right to left on upper (oven and cool down) level.

Another benefit arising from smaller tanks is the reduced charge costs for paint and chemicals. Monorail system immersion tanks are typically four to ten times larger in volume than an immersion tank on an indexing system of similar throughput capacity. Although the use of paint and chemicals will be similar during operation, significant savings can be realized by requiring less paint and chemicals for startup. A comparison can be made to Just in Time (JIT) manufacturing, where supplies of component materials are kept to a minimum to reduce the amount of capital tied up in inventory. Smaller tanks will also reduce replacement cost and waste generated in the unlikely, but possible event of catastrophic stage contamination.

An indexing system offers the ability to load and unload parts on a stationary conveyor. This maximizes efficiency, as workers at the loading position will always be near the unpainted part supply. Offloading is also accomplished at one or more motionless conveyor stations, allowing faster packing of the painted product. Small parts can often be loaded directly onto the paint line, rather than off line racked elsewhere in the paint department. Stationary conveyor positions decrease worker error due to improperly racked parts, and can minimize possible damage to the coated parts during offloading.

Indexing systems also allow for closer spacing of product, resulting in higher density rack loading than on monorail systems. Whereas racks and parts on monorail systems may only be hung outside of the "swing zone" on line rises and dips (**Figure 3**), they are processed in complete segregation (one rack per stage) on indexing systems.

Indexing systems feature great versatility. Substrates of different types – for instance, steel and aluminum – may be processed in random load order. Product information for each load is fed into the control panel, which will then hold a rack of steel parts up when they reach the aluminum pretreatment stages (etching), and vice versa for the aluminum parts over the steel stages (pickling and phosphating).

Multiple color application is also feasible. After the pretreatment stages, paint stages may be arranged paint, rinse, rinse, rinse; paint, rinse, rinse, rinse; etc. The lightest color paint is

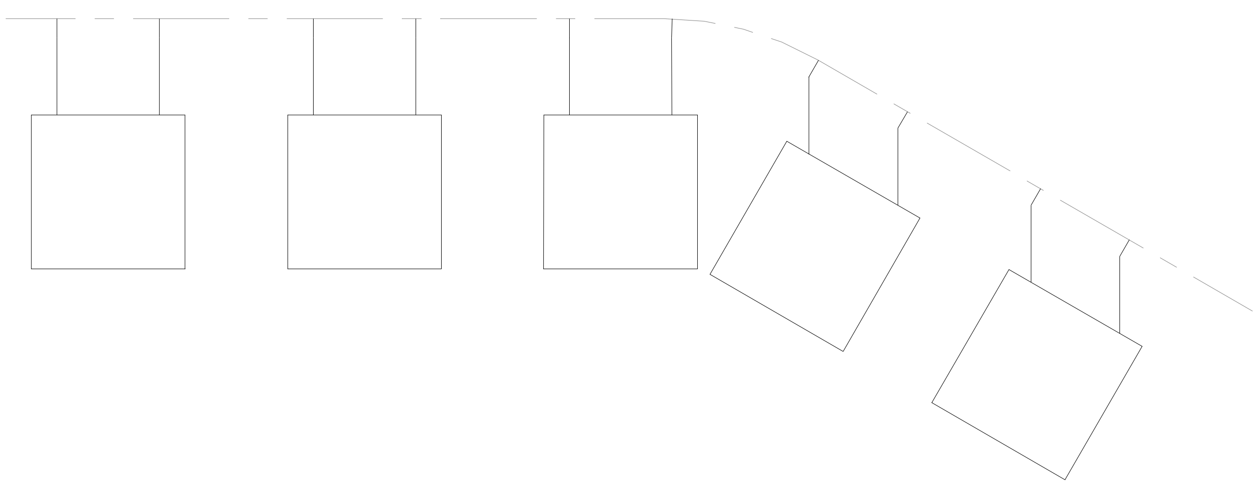

Figure 3. Parts on a monorail system will swing closer together on ascending rises and descending drops - especially when hung from two hooks. The swing zone allowance increases with the height of the part and the degree of conveyor incline (30 degrees shown).

first, with the darkest paint on the end. This minimizes the possibility of color contamination that may build up over time from the small amount of permeate which drips from the parts as they pass over the top of succeeding paint and permeate tanks.

An indexing electrocoat system that includes a topcoating process can “bunch” loadbars for higher throughput of small parts. A good example would be a manufacturer that paints both large enclosures and several smaller components which are then assembled after painting. The tanks would be sized for the largest loads (the enclosures), which would be processed through the system at one loadbar per station. Meanwhile, smaller parts must be racked single thickness to permit proper spray topcoat application. An indexing system may be programmed to automatically “bunch” these small part loadbars through the electrocoat system at two or three loadbars per process station, increasing small part product throughput. Upon exiting the electrocoat system, these small part loadbars would be automatically “unbunched” for topcoat application.

Indexing systems are usually equipped with dead entry voltage application, meaning that electric current in the tank is active only when the parts are completely submerged. This completely eliminates striping, an uneven application condition which leaves visible horizontal stripes.

The control system can also be programmed to ramp voltage to a level that matches the square footage of product in the tank, based on the amperage draw through the rectifier. Use of this Automatic Voltage Control (AVC) prevents undercoating or overcoating of parts and may cut yearly paint usage by up to 20% if loads exhibit widely variable surface areas. Some systems, in fact, are able to reset their cycles to allow extra immersion times for densely packed loads that actually exceed the rated maximum square footage of the system.

Indexing systems are more complex than monorails due to relatively complicated load movements. Monorail systems essentially transport parts one dimensionally, following the conveyor rail. Energizing the drive motor pulls the parts along on the chain and immersion times are simply a function of time and line speed. With an indexing system, conveyance of product through the process requires computer control to regulate elapsed time between several consecutive movements made by energizing different elements of the system. Alterations to the operational process require a well-trained technician to adjust programming parameters through the control panel.

This difference in equipment complexity does not normally translate into increased maintenance costs. More time consuming cleaning and charging of larger tanks, spray nozzle cleaning and upkeep on larger pumps and piping on monorail systems balance the higher preventative maintenance required for monitoring and servicing the indexing system stops and switches.

Another consideration in system choice is part geometry. Parts with relatively low surface area to volume ratios, such as three-sided appliance wrappers, cannot be densely racked. High throughput electrocoating for this type of product can best be met by a monorail conveyor system.

Because of smaller tank sizes and negligible conveyor length between stages, indexing systems have lower capital costs than monorail systems of similar capacity. They can coat products as large as truck frames, as well as extremely small parts held in baskets or barrels. Their versatility makes them useful in any number of electrocoating operations for automotive, agricultural, recreational, appliance and general industry applications.

Programmed Hoist Systems

(Figures 4 and 5)

Programmed hoist electrocoating systems utilize one or more traveling hoists to move racks or barrels of product between process tanks. Unlike indexing systems, in which multiple loads move simultaneously, each traveling hoist can only move one rack or barrel of product at a time.

The system operator selects a process procedure based on the contents of the load. The hoist then picks up the load, carries it to the designated process station and lowers it into the tank. The control system has been programmed with a computer optimized timeway outlining the immersion intervals in each stage and the process sequence for each type of product. When a load reaches its target time in a tank, the nearest available hoist will pull it out, allow for drainage, and move it to the next stage in the process sequence.

Maximum times are specified to ensure that product does not become damaged by exposure to any one stage for an extended period. For instance, a phosphate coating can become less effective if it is applied too thickly, or electrocoat material may be partially removed from the parts if they stay immersed too long in a post rinse stage.

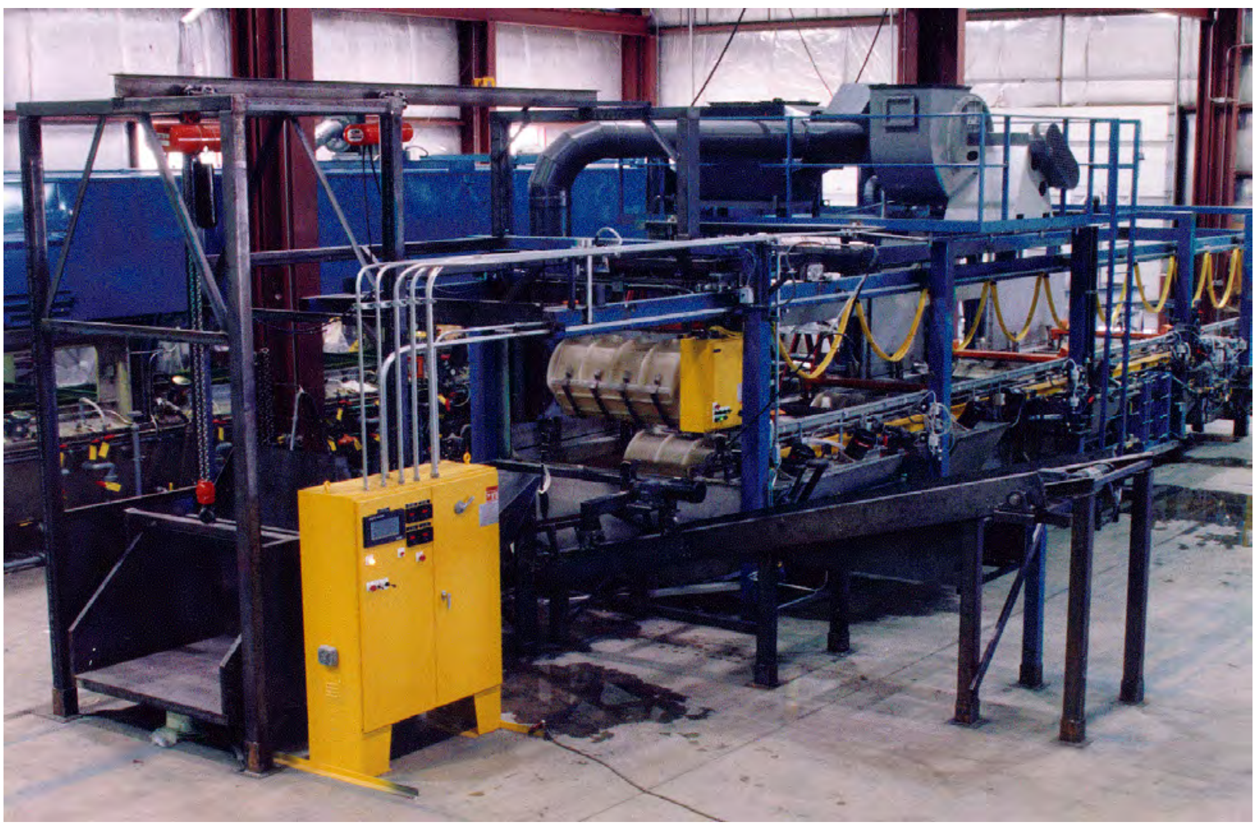

Figure 4. Example of a programmed hoist system. This system has a single, multi-speed traveling hoist for load transfers.

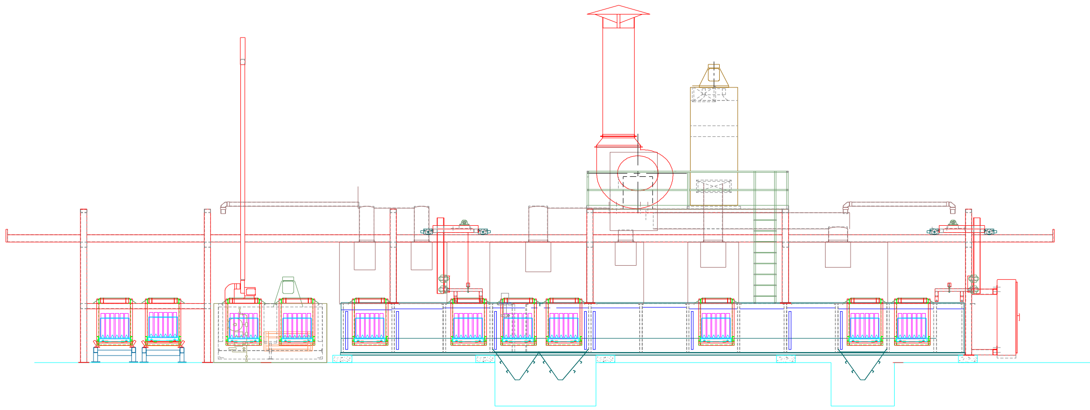

Figure 5. Side elevation of a programmed hoist system. Parts need not follow an end-to-end progression and may skip stages if not applicable to the process specified for that load.

Many of the advantages listed previously for indexing electrocoat systems also apply to programmed hoist systems. Once again, hoist systems have smaller footprints than monorail systems because of vertical entry into the process tanks. The smaller tanks have lower charge costs for paint and chemicals. Spray and immersion capabilities are possible, along with multiple pretreatment and color options. Dead entry and automatic control of applied tank voltage are both feasible.

Non-sequential processing is also practical with a programmed hoist system. When a load is picked up by a hoist, it may be moved to any tank in the system, regardless of where that tank is located. An indexing system, in contrast, can only move product in one direction one stage at a time. Processing time in an indexing system is the same in every stage, and usually reliant on paint bath immersion time. If two minutes are required to achieve the desired paint build, all the other stages will also receive two minute immersion times.

A programmed hoist system, however, can vary the time parts spend in any one stage. For instance, the paint tank immersion time may still be two minutes, but the rinses may be cut back to 30 seconds. Of course, the efficiency of the system is compromised in that throughput is still based primarily on the paint tank immersion time. It will do no good to increase the speed of pretreatment by cutting back on rinse times if there is no paint tank available to accept the pretreated parts.

The true value of non-sequential programmed hoist operation can be realized in the case of multiple pretreatment or paint color options. For example, a hoist system can transfer parts directly from the final pretreatment rinse to the second color paint tank and skip over the intervening color and post rinse stages.

Despite this advantage, hoist systems have lower production rates than indexing systems because of the inability to move large groups of parts simultaneously. Also, a hoist must be available to move parts to the next tank in the treatment sequence, and the next tank in the sequence must be ready to accept those parts. In other words, a load cannot be transferred into a tank until the previous load has been cleared to another tank, and so on down the line. Using an indexing system guarantees that this problem will not exist, and that there will always be a tank waiting for every load. A programmed hoist working at maximum efficiency can still only move product one load at a time.

Although painted parts are frequently transferred to some type of continuous conveyor oven to maximize throughput, they may also be cured in individual oven cells.

Complexity of operation is obviously a consideration. Processing sequences must be expertly pre-programmed into the control system, and reprogramming must be thoroughly examined to prevent sudden pileups of loads demanding entry to the same tank.

On most systems of this type, increased flexibility can only be achieved at the expense of throughput. Programmed hoist electrocoating systems have lower capital costs than comparable indexing systems, which must be weighed against lower production capabilities. Hoist systems are fairly versatile for a wide range of industrial uses, and are often employed in rack or barrel electrocoating of very small parts such as fasteners and other hardware items, and for large, low volume parts.

Conclusion

The vertical immersion capabilities of indexing and programmed hoist electrocoat systems give them certain advantages over monorail systems. Among these are:

- Smaller process tanks and shorter conveyors for reduced capital costs
- Greatly reduced use of plant floor space
- Lower tank charge costs and overall operating costs
- Stationary loading and unloading of product
- Multiple pretreatment and color option capabilities

Indexing and programmed hoist electrocoat systems offer the user of these types of systems reliable, high capacity coating capabilities in a versatile package with a very attractive return on investment.

About The Author

JIM MILLER has been employed since 1996 by Therma-Tron-X of Sturgeon Bay, Wisconsin as a sales engineer specializing in the design and sale of electrocoating systems. He is a licensed professional engineer, holding a civil engineering degree from Ohio State University. Prior to joining TTX, Miller was Engineering Manager, responsible for multiple electrocoating lines at Lima Register in Lima, Ohio and served as Manager of the Equipment Division at MetoKote Corporation, also of Lima, from 1988-1996.