THE USE OF SQUARE TRANSFER INDEXING MATERIAL HANDLING EQUIPMENT IN FINISHING SYSTEMS

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There is a wide variety of material handling equipment on which product can be moved through an automated finishing system. Generally, the material handling equipment may be broken down into two basic types: monorail and square transfer.

Monorail systems transport parts in a continuous line along a chain conveyor. The chain conveyor classification includes overhead power conveyor, and power and free conveyors in both overhead and floor mounted configurations.

In square transfer systems, each load travels through the finishing operation on a step-by-step basis. A load is lowered vertically into each process tank, held there for a prescribed period of time, then raised vertically from the tank, shuttled a set distance to the next station, and lowered into the next process tank. Programmed hoists are one type of square transfer system in which loads are individually transferred from one process to the next by one or more hoist mechanisms. Indexing square transfer systems (See Figure 1), on the other hand, move all loads simultaneously. This offers the advantage of having all process tanks full at all times, and minimizes material handling time for maximum throughput.

Indexing square transfer systems have many advantages over monorail systems; perhaps most important is the reduced floor space requirements. Square transfer systems allow immersion pretreatment and coating in a fraction of the space required for monorail systems due to their ability to vertically immerse product into tanks only marginally larger than the maximum work envelope. The use of the square transfer arrangement in the cure oven minimizes oven volume, resulting in capital and operating costs savings. In addition, the oven is typically positioned directly above the process tanks, further optimizing the system footprint.

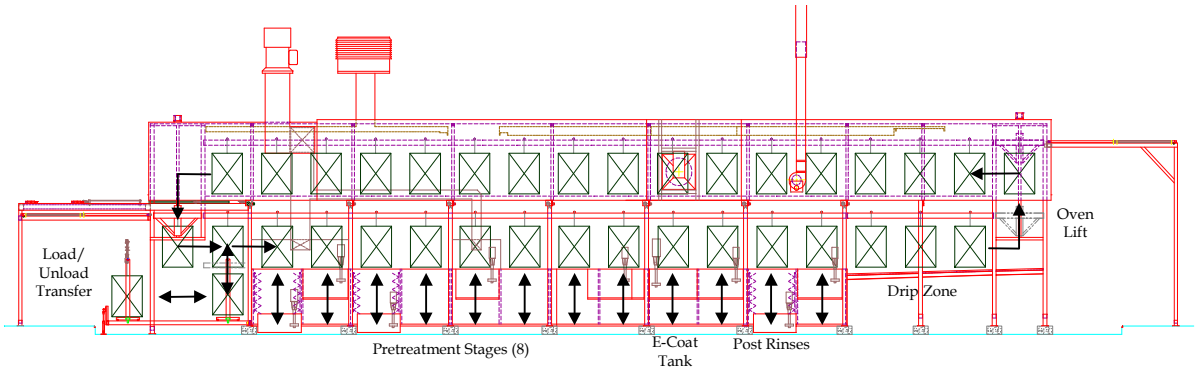

Figure 1. Side elevation drawing of square transfer indexing electrocoat system. Part progression is from left to right on lower (process) level and right to left on upper (oven and cool down) level.

These types of systems have a lower capital cost for equivalent production capacity, due to less quantity of materials required for tank and oven construction, and the elimination of drain zones between process stages. (After exiting the process tanks, parts are held stationary over the process tanks prior to advancing the next tank to allow process liquids to drain directly into the process tank.) Additional front end project cost savings is obtained because the initial fill costs of the much smaller process tanks are greatly reduced. Lower utility costs are realized because it takes less energy to heat and circulate the much smaller volume tanks. The smaller, bottom entry ovens also contribute to operational cost savings by minimizing fuel usage.

Other advantages provided by square transfer indexing systems is that parts are loaded and unloaded from a stationary conveyor which maximizes worker efficiency. Plus, the modular design of these systems allows for faster installation and easier relocation.

Indexing square transfer finishing systems exhibit great versatility. They can economically handle both large numbers of small parts and small numbers of large, heavy parts due to a much greater weight capacity than monorail systems. Indexing square transfer systems can be equipped to process parts on racks, on trays and in barrels. Barrel electrocoating, in fact, is a new technology in which the system excels – operating much like a barrel hoist while greatly increasing throughput, because all tanks are occupied and all loads are moved simultaneously.

Indexing systems also exhibit multiple processing capabilities, as a Programmable Logic Controller (PLC) allows racks to skip certain process stages based on varying pretreatment regimens or color choices (in painting systems). Differing metals may therefore be simultaneously processed on the same line, and different parts given different finishes. They can serve to reliably and economically take parts through both spray and immersion treatments, then transfer to an in-line conveyor for application of powder or liquid coatings.

Pretreatment

Immersion pretreatment is generally considered to be superior to spray pretreatment, although a combination of both is even more effective in removing certain types of contaminants. An indexing square transfer material handling system can be configured to economically deliver both spray and immersion pretreatment processes for all types of products. Spray stages may also be equipped with covers that nestle down over the top of the tanks as the parts are lowered. This eliminates overspray and minimizes evaporation and heat loss.

Aqueous cleaning can be problematic where tough to eliminate cutting and forming oils resist removal. A heated immersion stage followed by a heated spray stage has been found to be effective in softening oils first, then blasting them from the substrate. Multiple immersion cleaning stages may be necessary with complex parts or enclosures that must be coated inside and out. The quality of phosphating and sealing processes tend to be better when applied in an immersion bath.

Because of the much smaller sized immersion tanks, the more immersion tanks required in a finishing system, the greater the advantage a square transfer system has over a comparable capacity monorail system.

Electrocoating

As an immersion coating process, the space saving design of the indexing square transfer system is immediately apparent (See Figure 2). Using a paint tank only slightly larger than the maximum work envelope saves greatly in initial fill costs and minimizes loss in the unlikely

event of catastrophic contamination. These savings multiply in systems that apply more than one color, or two coat E-coat. Indexing square transfer systems also operate using dead entry paint tank immersion to prevent striping of the paint. Voltage is not applied to the paint bath until the product is fully immersed in the solution.

Figure 2. *Example of an indexing square transfer 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.*

Dead entry also allows the use of Automatic Voltage Control (AVC), an option that matches applied voltage to the square footage of the load in the tank. In monorail systems, parts are constantly entering and exiting the paint tank, which contains several loads at any one time, making it difficult to automatically adjust the voltage to match each load. AVC in square transfer systems can cut paint usage by up to 20% on a yearly basis by automatically reducing applied voltage on smaller loads. In the same way, the PLC can be programmed to extend tank immersion time to prevent undercoating if a certain load exceeds the recommended maximum square footage of the system.

Powder and Liquid Coating

In powder and liquid spray coating systems, the indexing square transfer material handling concept can still serve an important role by providing economical immersion pretreatment and dryoff prior to the painting operation (Figure 3). This is especially true for pretreatment processes in which immersion is the preferred application method, such as cleaning, phosphating and pickling.

Individual racks cannot be densely loaded in three dimensions due to line of sight concerns for spray gun applicators during the coating process. However, racks that hold a single line of product can be automatically bunched two or three to a loadbar in order to achieve maximum pretreatment throughput. After dryoff, the loadbars are individually transferred to an in-line conveyor for procession through the paint booth. Because the rack density can not be varied between the pretreatment and painting sections of a monorail system, the pretreatment system must be sized for the less efficient lower density racks, resulting in higher costs for purchase and operation. Rack bunching in an indexing square transfer system is a unique feature that allows greater throughput in the pretreatment section without sacrificing thorough pretreatment.

Figure 3. *In this powder coating system, aluminum parts undergo immersion pretreatment and dryoff in an indexing square transfer system (shown). Loadbars are then transferred to a power and free conveyor for powder application.*

Square transfer ovens allow density to be maximized in minimum space. Once again, transfer devices are used to automatically switch loadbars from the in-line conveyor running through the spray booths to the square transfer configuration in the oven. Once inside the oven, load bars can be processed closely, whereas multi-pass monorail ovens must provide sufficient room between racks for "swing room" so that racks and parts do not hit each other on vertical and horizontal turns.

Combination Coating Systems

Indexing square transfer systems have been adapted to apply both an electrocoat primer and a powder or liquid topcoat to the same parts. The advantages in the use of this type of system are the same as with the individual coating processes. Immersion pretreatment in general allows higher quality cleaning, phosphating and rinsing in less floor space than spray washers. An electrocoat primer is applied using Automatic Voltage Control technology in a much smaller tank requiring lower fill costs. Load bunching allows for high density processing of product in the pretreatment and electrocoating processes. A square transfer curing oven saves space and fuel costs, also due to close packing of product.

After transfer to a short monorail or power and free conveyor, the individual load bars proceed through the paint booth to undergo the topcoating process. They can then be cured in a monorail or square transfer oven.

The following table quantifies the possible savings realized in the use of an indexing square transfer electrocoating system as compared to a monorail system of equal capacity:

CAPITAL SAVINGS	Square Transfer Indexing	Equivalent Monorail	Capital Savings
Floor Space Requirement (Estimated Building Cost savings at $75/Ft^2)	4,200 Ft^2	12,800 Ft^2	$645,000
Initial System Cost	$1,620,000	$1,835,000	$215,000
Paint Tank Fill Cost (Electrocoating)			
Paint Tank Volume (gallons)	2,925	14,330	
Paint Cost @ $10/gallon	$29,300	$143,300	$114,000
	TOTAL CAPITAL SAVINGS		$974,000
OPERATIONAL SAVINGS			
Estimated Utility Costs per hour (@ 100% Loading)	$53.17	$72.02	$18.85
Annual Utilities Savings (Per 8 Hour Shift of Operation)			$37,700

Conclusion

Indexing square transfer conveyor systems exhibit a decided advantage over monorail conveyors in many applications in that they allow equivalent throughput to be carried out in a much smaller footprint. Their versatility can be seen in the ability to automatically apply differing pretreatment regimens and electrocoat paint colors, bunch loadbars for maximum pretreatment processing capacity, and apply primer and topcoat – all on the same finishing line.

Savings with this type of system are realized on both capital and operational costs. Capital costs (building, equipment and installation) for the system are lower and operating costs significantly less than on a comparable monorail system. In addition, smaller process tanks mean much lower fill costs for chemicals and paint. The use of square transfer ovens also saves fuel costs by drying or curing product in less volume than a standard monorail oven.