



# Making the Switch from Hex to Tri

## Massachusetts plater converts with the help of a university program.

BY PAM ELIASON UMASS TOXICS USE REDUCTION INSTITUTE

Faced with new regulations restricting emissions of hexavalent chromium from various plating operations along with increasing requests from its customer base for products that are environmentally preferable, Independent Plating in Worcester, Mass., decided to explore converting one of its hexavalent plating lines to trivalent chromium.

Such a conversion is consistent with Independent's overall approach, which relies on substitution and prevention as its principal techniques for toxics-use reduction. The company's philosophy emphasizes source reduction, drawing heavily on research and implementing safer and greener alternatives. With a commitment to providing safer, high-quality metal finishing in an environmentally sound manner, Independent plans to continue its proactive approach to growth well into the future.

Independent Plating is an employee-owned metal finishing company that has been in business since 1941. For more than 70 years, it has been finishing an array of primarily aluminum and stainless steel tubing and wire products for a variety of end products—from school furniture to high-end retail displays, medical devices and law enforcement tools.

Metal finishing processes conducted at Independent include zinc plating, electroless nickel, black oxide, nickel chrome, phosphating, pickling and powder coating. These processes contain various heavy metals, acids and other hazardous substances, which pose potential negative impacts on the environment and workers.

Ten years ago, Independent attempted to switch its nickel-chrome line to trivalent chromium but found that the technology available at the time did not achieve the quality its customers

required. However, the company continued to stay informed about new technological advances in metal finishing and, when customer demands for products with a lower environmental footprint began to increase, Independent made another concerted effort to find an alternative.

### Tri-Chrome Assessment

Independent Plating took a systematic approach to exploring its options for implementing a trivalent-chromium system. The first step was to conduct research into the technologies available, and the experience of its peers with the various options. One area of particular interest to the company was corrosion resistance. Because Independent primarily plates tubular products, the company was concerned that its plating treatments minimize corrosion on the insides of tubes.

Independent spent considerable time researching different tri-chrome systems to decide which would best meet all of its needs as well as the needs of its customers. The company paid particular attention to the uniformity and thickness of coverage and the color achievable by the various options, as well as ease of system maintenance and the level of support expected from the vendor. Independent staff visited several plating shops that were using tri-chrome systems, to learn about operational requirements and get feedback about experiences with various vendors.

After six months of research, Independent chose three vendors for further consideration. It sent each vendor parts that represented a range of products with which it typically works to assess the uniformity and thickness of coverage achieved, as well as the vendors' ability to closely match the bluish color of

hex-chrome-plated parts. Eventually, Independent decided on the vendor that provided a sulfate-based electroplating system: Pavco of Charlotte, N.C. This system is known by the trade name Hex-A-Gone.

Important factors in this decision to choose Pavco included consistency of coverage, ability to most closely match the color of customer's parts, operating cost savings (the sulfate system uses approximately half the electric energy required for the chloride-based system) and vendor support.

"The key for us was really educating the customer on the entire tri-chrome process, which meant letting them know what they need to do to make the changes and how they would implement those changes," says Brad Majoy, North American sales manager for Pavco. "The more they know about the process, the smoother the transition."

Tri-chrome takes approximately three times as long as hex chrome, at a reduced electric current (3 minutes at 50 asf) to achieve the desired thickness. Independent was able to modify one of its plating lines for the tri-chrome installation in a way that allowed it to meet customer requirements and get proper thickness and coverage. Specifically, the process flow was redesigned by moving from a 1,400-gallon tank for the hex-chrome system to a 3,500-gallon tank for tri-chrome.

The new tank was built in-house, which resulted in significant savings and allowed Independent to control the design and installation process. In addition, the company was able to modify an existing line to run either hex-chrome or tri-chrome, thereby cutting down on the time and costs of the project. This also allowed it to pilot the tri-chrome system without any interruption to customer service.

### Equipment Specs

Independent worked closely with Pavco to choose the appropriate process operating and control equipment. Specifically, the choice of an automatic amp-hour feeder and bath filter was vital to assure consistent quality and uniformity of the new plating process, and reduced much of the guesswork in maintaining correct process parameters. Much of the equipment required for the new tri-chrome system (filters, rectifiers, etc.) was already



Independent Plating owner Charles Flanagan receives an award from the UMass Lowell's Toxics Use Reduction Institute (TURI) for his company's conversion to trivalent chromium.

available in-house at Independent's Worcester facility, which also helped keep costs down. Care was taken to design the line to prevent contamination of the tri-chrome bath with existing hex-chrome solutions.

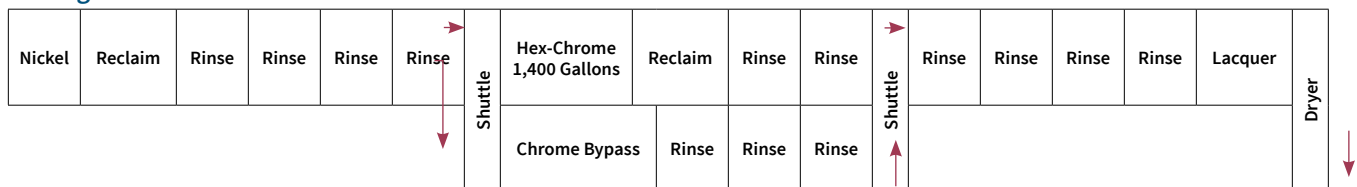
"Nothing in this process is simply 'plug in,'" Majoy says. "And because of those changes, it is important to do the homework upfront so that there are no issues later."

With the dedication and hard work of Independent's facilities staff and finishing line operators, installation of the new tank and equipment into the existing plating line went as anticipated and was completed without any interruption of service. The total time required to redesign the process flow and complete tank fabrication and installation was approximately 8 weeks.

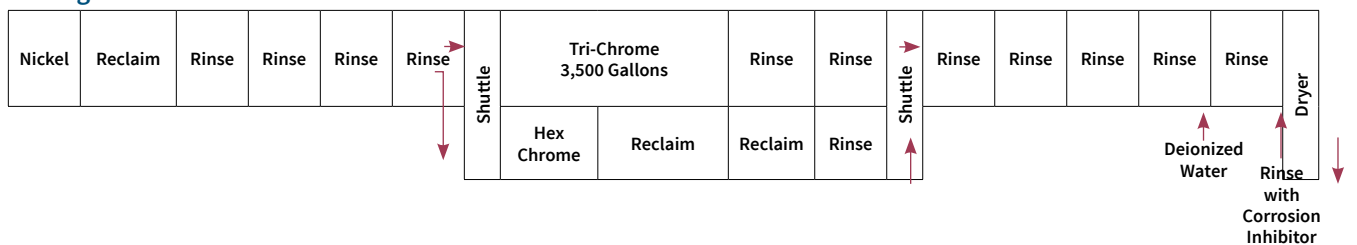
Independent worked closely with Pavco to train its lab personnel and metal finishing managers. The new system uses a dual-pump amp-hour feeder for automatic bath make-up additions. It was essential for operators to know how to properly use the automatic pH and temperature controllers, and analyze the tri-chrome bath for contaminant drag-out and buildup in the tanks.

Pavco introduced its Hex-A-Gone trivalent chrome chemistry into the Independent Plating system. According to Majoy, this

### Plating Line Before Installation of Tri-Chrome



### Plating Line After Installation of Tri-Chrome



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produces a decorative trivalent-chrome plating bath that provides a finish comparable to a hexavalent-chromium plate while offering numerous advantages, including being highly forgiving of high metallic impurities, greatly reducing waste treatment requirements and generating large energy savings.

Operators were also trained to use new rectifier settings to improve the current density of the tri-chrome process. Performance training focused on maximizing the throwing power of tri-chrome, visually inspecting parts to detect potential chrome burn (characterized by white or yellow spots on the plated surface) and modifying racking procedures to maximize rack densities. Overall, Independent found that its line operators required very little training to master the new tri-chrome system.

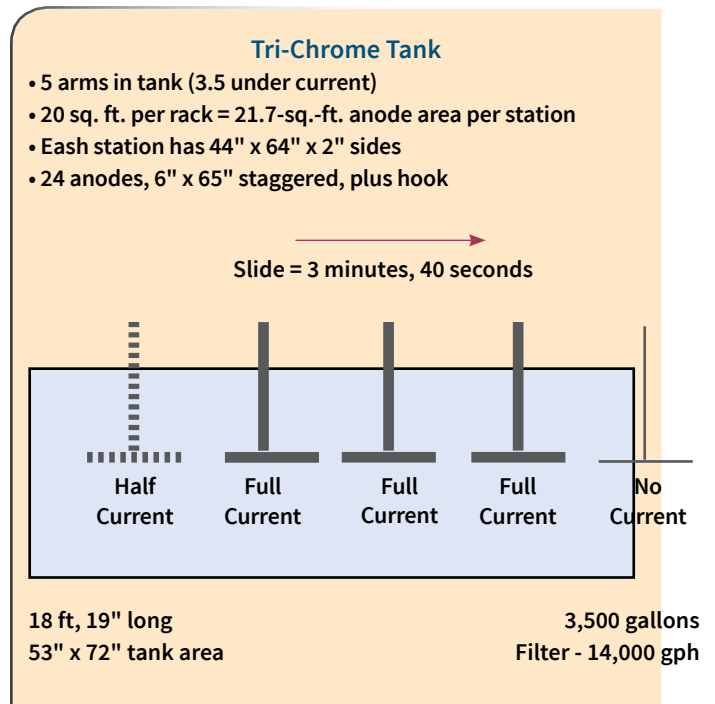
### Results

Upon implementation of the new tri-chrome system, Independent immediately noticed a reduction in rejects associated with whitewash and chrome burning. With tri-chrome, the company was able to virtually eliminate the need for color buffing. In addition, the superior throwing power and coverage of the tri-chrome system resulted in improved quality. The key factor, however, has been the process' ability to closely match the color of final products required by customers. Color matching allows customers to easily commit to the switch from the hex-chrome-plated parts to the new tri-chrome-plated parts. Additionally, the increased throw of the tri-chrome bath means better plating coverage on part crevices, internal openings and penetrations, thus improving overall product quality.

A unique capability of this new line is its ability to run a variety of parts through at the same time and to increase the overall racking density without fear of developing chrome burn. Although not yet realized due to the large size of parts currently being finished, Independent anticipates that it may be able to increase the number of parts per load by 15 percent or more once the size range of parts processed in this system expands. In addition, the superior rinsing characteristics of the tri-chrome system allow the company to reduce most of the cleaning steps, further improving process throughput potential.

"It's a continual work in progress," Majoy says of Pavco's partnership with Independent Plating. "We want to see our customers continually improving in how they use the chemistries."

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### O&M Costs

Independent has experienced increased costs associated with maintenance and analysis with the new tri-chrome line. The filters on the tri-chrome line turn over 3,500 gallons of solution five times an hour, resulting in the need for frequent filter maintenance and cartridge replacement. In addition, although an automatic amp-hour feeder is used for additions to the tri-chrome bath, analysis of the bath concentration and makeup needs to be performed twice daily (as opposed to the weekly analysis associated with the hex-chrome system).

Trivalent-chromium baths also tend to be more sensitive to metallic impurities than hexavalent-chromium baths. One of Independent's main concerns was its ability to minimize metal impurities, specifically iron, in the tri-chrome bath. It also needed to watch for a buildup of hex-chrome, which can result

Benefits of Trivalent Chromium	Challenges with Trivalent Chromium
Improved quality: Tri-chrome offers superior throw, better coverage around holes, less burning and whitewash, and easier cleaning. Need for color buffing is nearly zero.	Cost: Implementation and chemical costs are higher than hex-chrome.
Increased throughput: Larger load sizes and increased rack density are possible.	Appearance: Although generally acceptable, tri-chrome colors are not quite identical to hex-chrome.
Less hazardous waste generated and lower cost of hazardous waste management.	Technical capabilities: Tri-chrome is not capable of replacing every hex-chrome requirement and/or specification.
Lower toxicity (hex-chrome is a carcinogen).	
Minimizes employee exposure to toxic air emissions.	Bath control: Tri-chrome baths require increased testing and maintenance, and operate with higher current requirements.
Less likely to trigger future regulatory restrictions.	Still contains very small amount of hex-chrome in solution.

The following table summarizes key data associated with the two systems:

	Trivalent Chrome	Hexavalent Chrome
Chromic Acid (oz./gallon)	1.15	30.73
Current/Duration	50 asf for 3 min.	150 asf for 1 min.
Operating Temperature (range)	126° F (122°–136°F)	105° F (86°–122°F)
Plating Time Per Part	20 sec.	80 sec.
Treatment Chemical Costs: Sodium Metabisulfite Sodium Hydroxide	N/A N/A	55 cents/lb 55 cents/lb
Estimated Chemistry Costs Per Square Foot of Parts Plated	4 cents	2 cents
Anode	Iridium-oxide-coated titanium (40" x 65")	Lead
Equipment/Maintenance: Anode Replacement Filter Cartridge Replacement Automatic Pump Feeder	18-24 months Every 2 weeks Every 5 years	40+ years N/A N/A
Reject Rate	Low (whitewash and burning not likely)	As much as 15% (tendency to whitewash or burn)

from ionic conversion of tri-chrome in the bath from the anodes. Impurities are removed from the Independent system using hydrogen peroxide.

In addition, due to the configuration of the Independent line with hex- and tri-chrome baths running in parallel, the company was concerned about the possibility of hex-chrome carrying over into the tri-chrome bath. To reduce the potential for contamination, Independent designed a movable isolation wall to be installed between the two tanks.

### Benefits of Tri

There are important advantages associated with converting from hex-chrome to tri-chrome. Trivalent chemistries use lower concentrations of chromium in the bath, generally 5–7.5 g/L of trivalent chromium compared with 130–225 g/L for hexavalent chromium. Therefore, much less chromium enters the wastewater treatment process. Potential exposure of workers to toxic chemistries is also significantly reduced, as trivalent chrome is not carcinogenic.

Moreover, the reduction step associated with converting the highly toxic hexavalent chromium to trivalent chromium in the wastewater treatment process is not required. This eliminates the need for reducing agents like sodium bisulfite and additional acid for pH control, and significantly reduces the volume of sludge produced. In addition, anodes in hex-chrome systems deteriorate over time, creating an additional source of hazardous lead-bearing solids in the waste stream. The tri-chrome process produces approximately one-tenth the sludge volume of the hex-chrome system, which significantly reduces associated hazardous material handling and disposal costs.

Although the operational costs associated with tri-chrome are higher than those for hex-chrome, Independent is finding that, as it gains more experience with tri-chrome, its costs are still coming down. Moreover, improved product quality, reduced reject rate and the increasing desire for “green” products among its customers is helping Independent gain an ever-more-important market advantage. ■■

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