casestudy

SUBMITTED BY CHAUTAUQUA METAL FINISHING SUPPLY, ASHVILLE, N.Y.

It Is Easier Being Greener

Finisher chronicles progress of total conversion from hexavalent chromium to trivalent chromium.

With RoHS/WEEE/ELV mandates in force and OSHA tightening allowable exposure limits to hexavalent chromium, Jamestown Electro Plating Works, Inc. (JEP), in Jamestown, N.Y., decided it was time to convert from hexavalent to trivalent chromium plating.

JEP is a seasoned family business, in operation since 1921, with a forward-looking consciousness. Initially a nickel plating company, JEP added chrome and copper plating cycles in the late 1920s, and zinc, cadmium, tin, silver, aluminum anodizing, lead, and indium plating departments under new ownership after 1953. That owner, Lawrence Davis, also invested in sophisticated waste treatment systems as early as 1966. Current owner John R. (Jay) Churchill has continued the proactive approach to business operations and the environment since purchasing JEP in 1984.

With a dedicated team and a worldly perspective, JEP is ISO 9001:2000, ISO 14001, Nadcap accredited, and now RoHS compliant. The firm specializes in decorative plating for a number of industries, including automotive, aerospace, furniture and decor, fasteners, building and construction products, and computer and electronics components.

This high level of plating performance was what the JEP team had to maintain as they honored their sense of environmental responsibility and the knowledge that hexavalent chromium's days are numbered.

With all of the certifications and accreditations listed after their name—many linked to planning and thorough implementation—it should come as no surprise that JEP took a thoughtful, organized approach to converting from hexavalent to trivalent chromium.

"This was one time when we knew not to try to outguess our suppliers," said Churchill, whose team worked with Chautauqua Metal Finishing Supply (CMFS) of Ashville, N.Y., and Plating Process Systems (PPS) of Mentor, Ohio.

Project steps included:

1. **definition of the new process;**
2. **in-house testing of the process with a specially constructed demo tank;**
3. **specification of the production equipment;**
4. **removal of the hexavalent chromium and contaminated equipment; and**
5. **commissioning of the fully operational trivalent chromium line.**

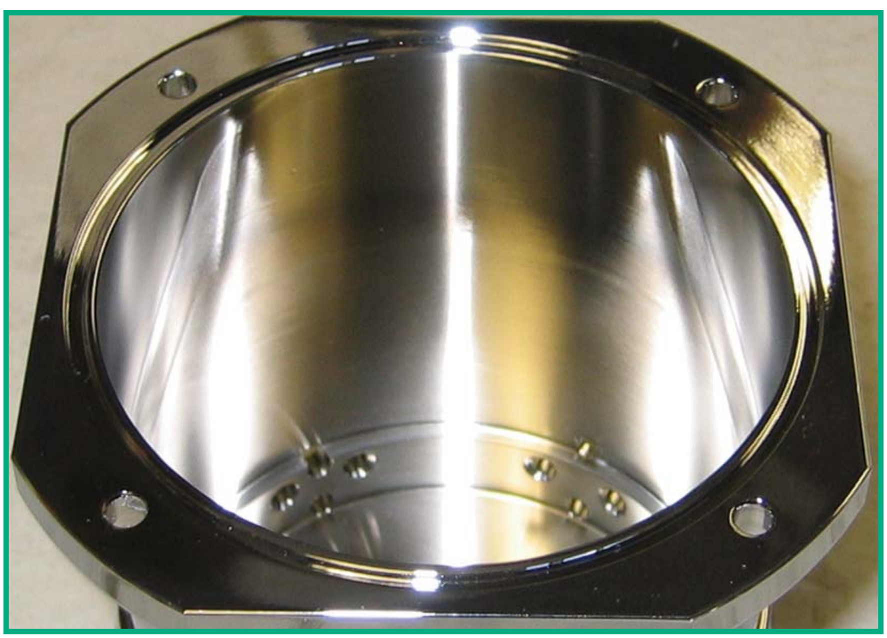
The implementation of the conversion program began with the allocation of $80,000–$100,000 to fund the project. Churchill says that "we used every penny," although some was applied in ways that they had not initially anticipated.

TRIVALENT CHROMIUM PROCESS

The trivalent chromium plating process has been available since the early 1970s. Originally not as bright as hexavalent chromium, trivalent chromium has at least pulled even with its predecessor. Tests performed by ASTM prove that trivalent chromium performs better than standard hexavalent chromium and is equal to microporous hexavalent chromium. Improvements mean today's decorative-plated finish is virtually indistinguishable from a hexavalent chromium–plated finish.

"In everyday light with the naked eye, even most experts cannot tell the difference," Churchill said.

Mark Schario, executive vice president of PPS, which developed the



Unretouched image showing production trivalent chromium plating over bright nickel plate (0.0005) on finely machined bronze.

casestudy

Chautauqua Metal Finishing Supply (CMFS) has served the metal finishing industry since 1951, providing base and specialty chemicals, equipment, process development, and technical support. The CMFS team can be reached at (716) 763-4114 or via e-mail at service@cmfs.com. Website: www.cmfs.com.

Jamestown Electro Plating Works, Inc. can be reached at (716) 664-5406. Website: www.jamestownelectroplate.com.

trivalent chromium chemistry used by JEP, points out that PPS' trivalent chromium has more than 15 years of performance in the over-the-road truck market, proving its durability to outdoor exposure.

Now at least on par in terms of performance, trivalent chromium offers significant environmental advantages over hexavalent chromium that JEP expected to benefit from, as well as some additional paybacks that even JEP had not anticipated.

Trivalent chromium is a simpler process in terms of both application and waste handling. Whereas hexavalent chromium plating required nine process steps, trivalent chromium has six. Four process steps are eliminated in the change from hexavalent chromium: the sulfuric acid activator followed by a cold water rinse before hex chrome; the conversion rinse; and the supplemental conversion rinse (see Fig. 1). The two conversion rinses that have been eliminated also have environmental implications: they were designed to convert the hexavalent to trivalent chromium for safer disposal.

The first step in the new process is the trivalent chromium tank itself, followed by four rinses. One step has been added at the end of the trivalent configuration: a water-based corrosion inhibitor for ferrous steel parts, which might otherwise flash rust on bare surfaces, such as the interior of some parts.

ION EXCHANGE

Another major difference between the hexavalent and trivalent lines is the ion exchange unit that recirculates on the trivalent chromium tank. The ion exchange resin removes the three big contaminants from the tank: nickel, zinc, and copper. Both JEP's chief chemist, Tom Fardink, and Churchill emphasize the importance of following your suppliers' guidelines on this component and do not skimp! At JEP, the IE unit operates four hours a day while the line is plating. Resin regenerations are performed every few weeks on site. PPS' Schario reports that it is not unusual for resin to continue to perform for as many as 15 years with regular regeneration before requiring replacement.

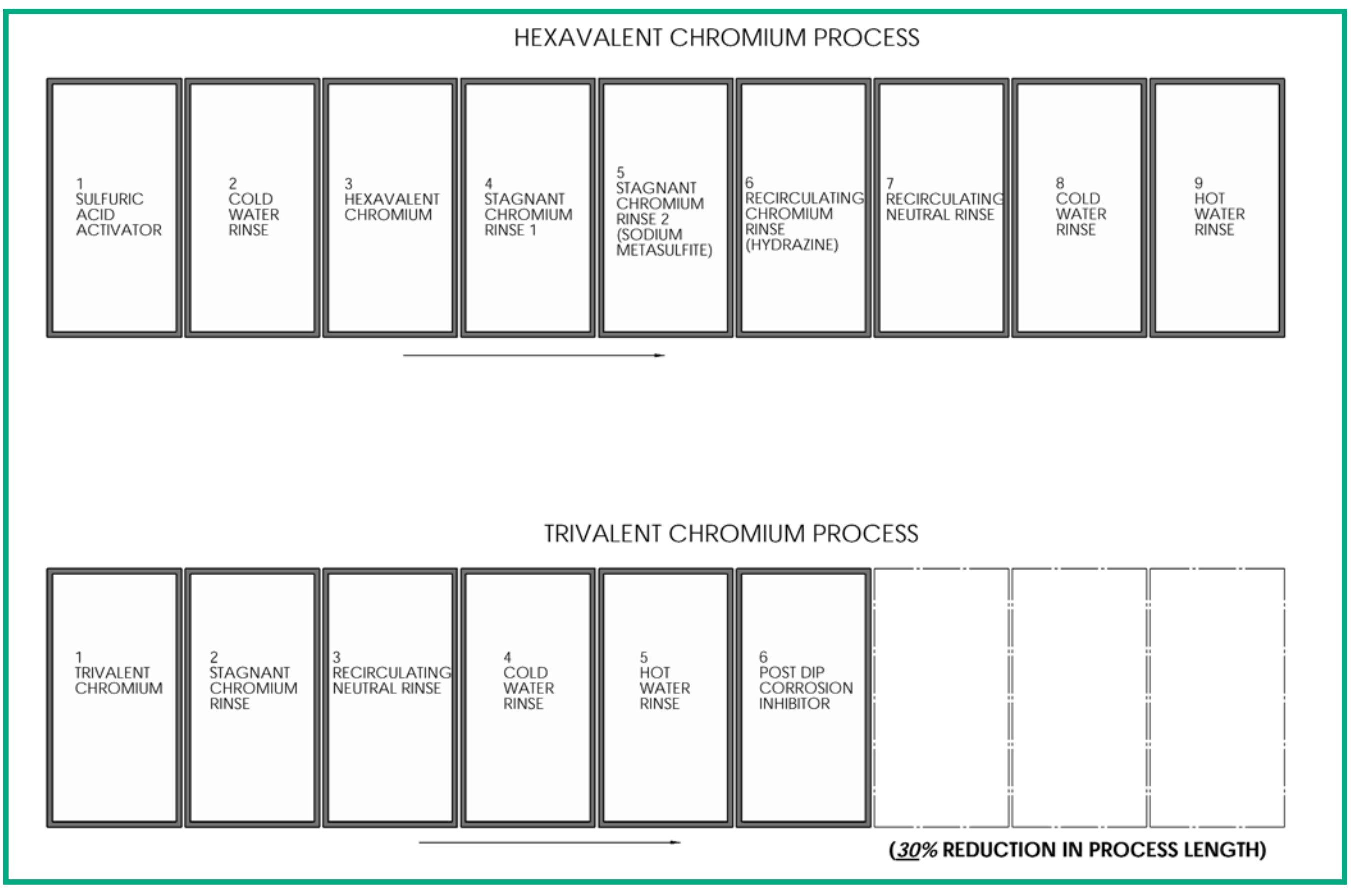


Figure 1: Hexavalent versus trivalent chromium processes.

Hexavalent Chromium	Trivalent Chromium
Inferior throw	Superior throw—three times better, in some cases
Poor plating around holes	Excellent coverage around holes
Occasional burning requires rework	No burning
Loss of contact causes whitewash	Loss of contact causes no problem—parts can be removed from tri chrome and examined, then reintroduced to bath and successfully plated
Careful control of load size to minimize burning	Loaded limited only by space in tank and correctly sized rectifier
Test catalyst via pH and specific gravity	Test catalyst via pH and specific gravity—time-wise, same as hex chrome
Difficult rinsing—often had to also hand wipe	Quicker, cleaner rinsing—half the time of hex chrome in some cases
More rework and rejects, fewer parts per load	Less rework and rejects, more parts per load
Bright, durable finish	Bright, durable finish
Slightly lower chemical costs	Slightly higher chemical costs
Odor	Virtually no odor
Higher disposal costs, more monitoring and reporting	Lower disposal costs—goes through normal waste treatment, fewer reports

Table 1: JEP's Experience With Hexavalent vs. Trivalent Chromium

JEP'S HEX TO TRI CONVERSION STRATEGY

To minimize down time and additional rejects and rework, in addition to taking pressure off the operator learning curve, the on-site project began at JEP with what PPS called "an excellent plan": a new demo tank for the trivalent chromium that could then run in parallel with the hex chrome.

"We were really concerned about our operators and how they would respond," Churchill noted. "In fact, that was the reason we waited as long as we did to make the change."

Fardink reported that the operator response to the trivalent process was positive and immediate, almost making management wonder why they had bothered with the demo tank step (more on that later).

"The trivalent process doesn't smell—no odor at all," said one operator. The fumes from trivalent chromium are not considered a safety risk either—scoring a major point for a better and safer work environment.

Using trivalent instead of hexavalent chromium has eliminated what used to be the first job of the day at JEP on the hexavalent line: manual paddle agitation of the hexavalent tank by the operator to film the anodes, followed by a dummy-plating run.

With trivalent chromium, the anodes do not need to be filmed, so manual agitation is not required to start the day. Agitation during the production day is supplied by air spiders in the trivalent plating tank—which could not have been considered with hexavalent chromium given the safety hazard presented by hexavalent chromium vapors.

Operators have found that starting the day is quick and easy with trivalent chromium: push a button to turn on the air entering the tank, and start plating a production load. This is a win-win for JEP, because operators are happy to forego the manual paddling (and exposure to hexavalent chromium fumes), and management is delighted that the first run of the day benefits the bottom line.

BETTER RINSING

Operators also quickly pointed out that trivalent chromium rinses better than hexavalent chromium, so the yellow residue that use to require hand wiping at JEP after hexavalent chromium (even with multiple rinses) is no longer required with trivalent chromium. One operator estimated that based on more efficient rinsing alone, the trivalent chromium process takes half the time.

ADDITIONAL PAYBACK BONUSES

At the same time, JEP found, through experimentation with the demo process, that more parts could be plated per load using trivalent chromium. This ranges from 15% to 100% more parts per load depending on the parts. As long as the rectifier is appropriately sized for the space, the only limitation to the load is space. To take advantage of this characteristic of trivalent chromium, JEP's capital investment included a new 10,000-A rectifier for the tri chrome line to replace the 5,000-A rectifier on the hex chrome line.

Trivalent chromium will not burn, unlike hexavalent chromium, so the rework/polishing associated with removing the burn has been eliminated. "We haven't burned a piece yet, and we're running little screws and big plates at the same time," said one operator after six months of running trivalent chromium.

An additional benefit of trivalent chromium is that it has better throwing power than hexavalent chromium—three times more as evidenced on one particular part at JEP. This is a cylinder on which the non-critical interior does not require plating and shows ½″ coverage from a hexavalent chromium process and 1 ½″ coverage from a trivalent chromium process.

Trivalent chromium also covers

around holes better. "It's much easier to work with—less time, no guesswork," the operator said.

David Klice, JEP maintenance supervisor, adds that another benefit of trivalent versus hexavalent chromium is that parts can be removed from the trivalent chromium, checked, and re-introduced to the bath with no negative consequences—no whitewash. "Loss of contact does not pose a problem with trivalent chromium like it does with hexavalent chromium," noted Tom Pembridge of CMFS, JEP's regional supplier and specialists in metal finishing production processes and equipment.

In addition, JEP has found that there are two other areas of costs savings when using trivalent versus hexavalent chromium. One is the lower operating temperature of the trivalent chromium plating tank (90°F for trivalent, 105°F for hexavalent). The other is the elimination of the ventilation system—the blower and the fuel to heat the exhausted air—which was mandated to maintain acceptable air quality when plating hexavalent chromium, but it is no longer a requirement with trivalent chromium.

PROCESS MONITORING

JEP's Fardink expected that the trivalent chromium tank would be more work to monitor than the hexavalent tank had been, but this has not been the case. The catalyst in the trivalent chromium tank is automatically fed based on amp hours, and Fardink's team manually verifies the levels via specific gravity and pH tests once a week.

Waste treatment costs have also been reduced. In six months of operation, zero sludge had been shipped offsite for disposal. The stagnant rinse also had not yet been dumped, although when the time comes it will go through JEP's regular waste treatment system without additional steps being required.

In terms of regulatory compliance, the monitoring (monthly or after 40 hours of use) of hex chrome has now been eliminated from Fardink's duties and from environmental chemist Mike Gray's annual report list.

PROJECT SUMMARY

The conversion from hexavalent chromium plating to trivalent chromium plating at JEP took a total of three months and because of the demo tank, was tested and validated before the hexavalent chromium tank was taken down.

The original plan was to keep the hexavalent tank and simply purchase a new liner for the conversion to trivalent chromium. But this idea and the hexavalent tank were scrapped along the way because of the impetus to remove all traces of hexavalent chromium. The spent hexavalent solution was pumped out and hauled away as hazardous material, as were the tank and liner. The ductwork associated with the hexavalent line also proved to be hopelessly contaminated. This, plus the blower, were ripped out and disposed as hazardous materials. Because OSHA has no requirements regarding trivalent ventilation, the blower and ductwork were not replaced.

A new trivalent tank and liner were brought on line to replace the scrapped hexavalent tank. The trivalent solution used to charge the new tank came from the demo tank that had been functioning on site. The new production tank also features a new buss bar, and JEP purchased the 10,000-A rectifier and the ion exchange unit to optimize performance.

JEP decided during the project to upgrade the facilities electric service as well, which had not originally been part of the expenditure projections.

CONCLUSION

The conversion has exceeded JEP's expectations in a number of ways:

1. **more throughput;**
2. **fewer rejects;**
3. **less re-work;**
4. **improved operator morale;**
5. **far less hazardous material on site and for disposal;**
6. **fewer regulatory reports to file; and**
7. **slightly higher chemistry costs "more than offset" by lower energy and waste disposal expenses as well as increased production.**

The change has been so effective that JEP has just recently reactivated the demo tank for another purpose: they now offer trivalent black chromium.