

CASE HISTORY

Conversion to new nonphosphate pretreatment technology

A study in the proper approach to convert a powder line from iron phosphate to fluorozirconic, or TMC, metal preparation

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In the September 2006 issue of Powder Coating, we introduced a new development in pretreatment with the first part of a two-part article “Dry-in-place conversion coatings creating excitement in finishing—part I.” Part II was published in the February 2007 issue. In 2010, we followed up with “History and development of TMC and new conversion technology.” In this issue, we offer an actual metal finisher of national acclaim who took that advice and went further in its own testing to prove out and implement a transition metal conversion (TMC). This is how the company did it and benefitted from doing it correctly with the assistance of Circle-Proscio, a specialty chemical company.

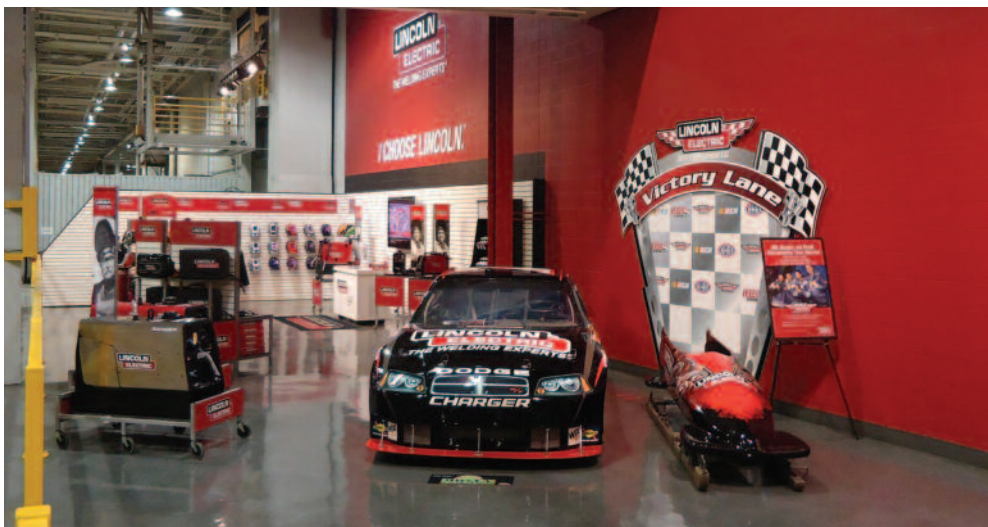
Lincoln Electric, with world headquarters in the heart of Cleveland, has been leading the way in welding equipment and supplies for the world metal manufacturing industries for more than 116 years. The company has 42 manufacturing plants in 19 countries. Producing more than \$1 billion in sales annually, the company powder coats in a 1,500,000-square-foot manufacturing plant, operating three 8-hour shifts, 6 days a week. Lincoln’s history is centered in quality products, safety, and customer satisfaction.

This conservative company doesn’t make changes in key processes without serious due diligence. “We began seeing and hearing of a replacement for zinc and iron phosphating back in 2007,” said Ben Young, manufacturing engineer. “We read the articles in *PC* magazine and attended the CCAI finishing show in Indianapolis to see what companies were offering this new technology. Lincoln doesn’t make changes in a process unless someone can really wow us. We typically do not change critical processes for small advantages in quality or cost. As a matter of fact, we don’t change vendors very frequently, and we like to have partnerships—long-

term partnerships—so change is something we take seriously.”

In-house team investigates TMC

Lincoln’s product line of welders ranges from home-owners’ units to oil pipeline automated systems for OD and ID welding. For home/agricultural models to industrial models, the company basically offers two versions, standard and heavy duty. The heavy-duty ones are cathodic epoxy primed and polyurethane powder top coated with stainless steel covers. The standard industrial line consists of a specialty-designed powder with performance standards to meet environments where gaso-



Lincoln Electric’s Cleveland plant includes a showroom of welding equipment and company sponsors.

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line, diesel fuel, battery acid, and strong ultraviolet (UV) stability are required.

Substrates are 91 percent cold rolled steel (CRS), 8 percent aluminum (Al), and 3 percent hot rolled, pickled and oiled (HRPO). Gauges range from 10-20 gauge with the HRPO up

to 5/8-inch thick. In-house receiving of metals includes coils, sheets, bar, and tube stock. Lincoln Electric, unlike most manufacturers of metal finished products, has a very elaborate laboratory, including scanning electron microscopy (SEM), gas chromatograph, and a carbon/sulfur analyzer for substrate carbon detection.



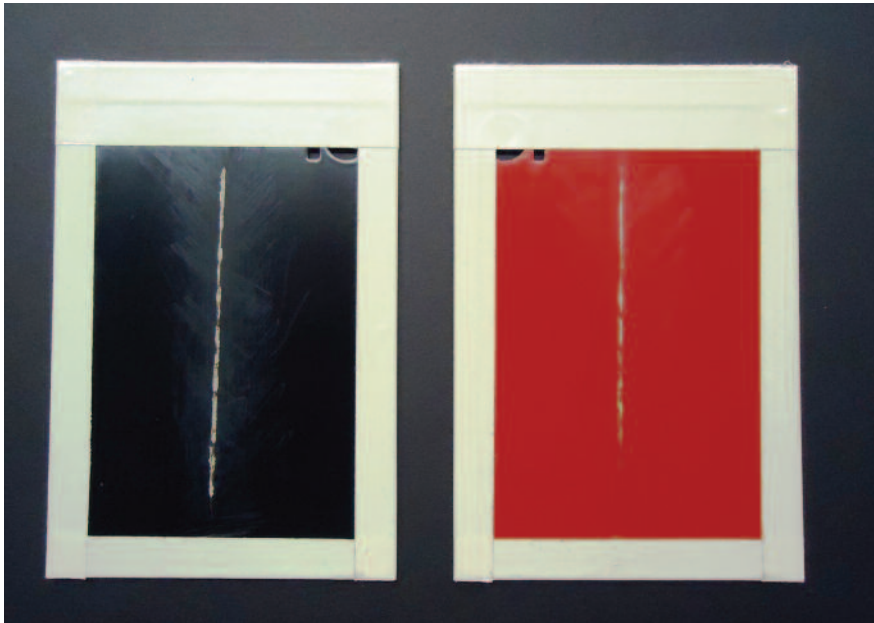
Lincoln Electric’s laboratory includes a scanning electron microscopy (SEM), gas chromatograph, and a carbon/sulfur analyzer for substrate carbon detection.

The laboratory is primarily used for the welding consumables division in the development of welding wires, fluxes, and quality control. This capability has allowed Lincoln to really understand and qualify incoming steel. “Understanding the incoming quality of our steel substrates from a surface carbon standpoint has really assisted our Engineering department to maximize both the effect of the new transition metal conversion coating and the finished powder coated product,” said John Mitchell, coordinator of International Quality.

In the beginning, Lincoln formed an in-house team to investigate a transition from conventional iron phosphating to the new technology being offered. The group consisted of Manufacturing Engineering, Production, Purchasing, and Quality personnel. Team members identified what they thought were the five leading companies offering TMC and supplied each of them with 40 panels of the company’s in-house production stock.

Each chemical company was to apply its cleaner and conversion within Lincoln’s washer process parameters and bring the panels back for coating. The team understood that a 5- to 20-hour delay from pretreatment processing to actual coating was not ideal but thought that for the first round of testing it would bring the best products forward for additional screening. Minimum requirements to pass the first round were 300 hours ASTM (American Society for Testing and Materials) B-117 with a rating of 7 or better and a battery of dry film adhesion testing. Panels from the line pass a 1,000-hour salt spray, ASTM B-117.

During this testing, the team also reviewed its current baseline of performance and re-calculated and identified all the costs of the iron phosphate operation, including chemical costs for alkaline cleaner, cleaner iron phosphate, and seal rinse initial costs, usage costs, heating costs, water usage operation costs, and effluent treatment and



Five leading companies offering TMC each received 40 panels of the company's in-house production stock for testing.



Lincoln Electric powder coats parts in a 1,500,000-square-foot manufacturing plant, operating three 8-hour shifts, 6 days a week. The part in the photo is pretreated with the new transition metal conversion.

direct maintenance labor costs associated with both finishing lines. It was important to re-visit this information to qualify the proposed new TMC pretreatment when the trial was completed after a 5-month test.

The manufacturing process includes stamping, forming, shearing, laser cutting, and welding operations. The laser process does affect edge performance. Some areas are noncritical, while others are critically important. Because of this, the company currently treats highly visible laser cut edges both mechanically and chemically. Cleaning of organic soils was one of the areas needing improvement to fully achieve the positive results claimed by the chemical companies and a fluorozirconic-type of conversion.

The recommendations for process modification varied greatly from one chemical company to the next: Some preferred double cleaning, others preferred double rinsing, and most desired reverse osmosis (RO) or deionized (DI) water for charge-up, final rinsing, or both. One producer advised a final seal. Ultimately, Lincoln selected to update risers and nozzles and run the process in the existing wash process.

Two main finishing lines run the production; both lines are GLA stainless steel washers manufac-

tured in the 1980's. The updates made were in new risers and nozzles and the installation of a final DI halo rinse. Testing indicated no need for the DI for corrosion resistance, but it was a method of reducing water and mineral spotting for some of the previously mentioned e-coated, or cathodic epoxy primed, subcomponents.

The initial chemical company panel screening and testing refined the group to two contenders. The Lincoln Electric finishing team used the following criteria as qualifications:

1. Best performance accomplished on the panels
2. High level of competent technical service
3. Consistent, reliable product
4. Ease of transition from iron phosphate to TMC
5. Reduced maintenance times and cycles on the pretreatment process tanks
6. Total cost

Supplier selection. Based on the criteria, the team chose Circle-Prosco, Bloomington, Ind., for the first trial run. Its TMC process was placed in the production line that produces the famous Lincoln

Electric 225 welding product, the most prolific single welding device ever manufactured, with more than four million sold.

The successful trial of the TMC technology went so well that Lincoln Electric placed the TMC (Steelcote 1400) in the second larger production line after the 5-month trial. Table 1 shows this process.

The goals for the trial run were to compare and ensure that the initial testing was duplicated, improved, or both during the production trial. Titrations were run every 2 hours, and panels were analyzed every 2 hours for adhesion, conical mandrel, gloss, and film thickness.

TABLE 1

The new TMC process at Lincoln Electric

Stage	Line 1	Line 2
1	Alkaline cleaner	Alkaline cleaner
2	City rinse	City rinse
3	TMC (Steelcote 1400)	Laser descale
4	City rinse	City rinse
5	City rinse	TMC (Steelcote 1400)
6		City rinse
7		City rinse

TABLE 2**Comparing conventional iron phosphate with TMC**

	Conventional iron phosphate	TMC (Steelcote 1400) zirconium
Sludge	Buildup on walls, floor	Virtually none
Nozzle	Daily cleaning and replacement	Monthly
Labor	1.5 hours daily/15 hours weekly	4 hours weekly
Bath life	Recharge weekly	Every 9 months
Total labor costs		Reduced 30%
Water use		Reduced 9%
Chemical costs		Reduced 17.5%

*Parts enter the washer system at Lincoln Electric.*

The first week review ran like clockwork without one single issue, but it wasn't until the month-long initial trial concluded that the team understood some of the benefits of its decision to look at this new pretreatment technology.

Cleaning. Cleaning was improved especially on the formed welder shrouds where the thixotropic drawing compound must be removed totally in the first stage. The previous system required a cleaner iron phosphate in stage four to ensure total organic soil removal.

Rinsing. Rinsing was improved with an overflow rate of 3.5 gallons per minute.

Conversion coating. The TMC fluoro-zirconic conversion deposition, although visibly different from the iron phosphate, appeared to be far more uniform without the powdering and streaking seen in the past.

Powder coating. The coatings applied, cured, and appeared to flow consistently without minor imperfections on edges where mil coverage is sometimes heavier than that of flat surfaces.

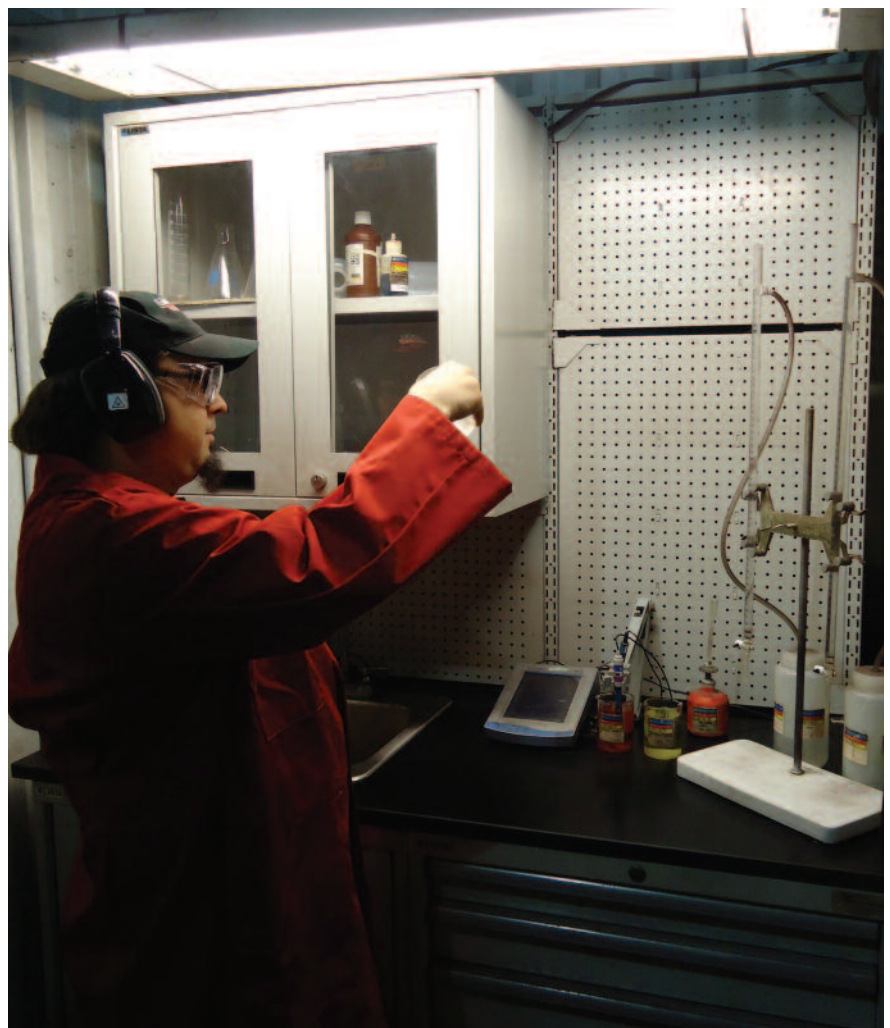
TMC opens eyes

The surprising results really came from the reduction in sludge, nozzle maintenance, labor hours, and bath life. (See Table 2 for a comparison.) Said Young: "The results obtained have really opened our eyes to the value of seriously investigating non-phosphate technology."

Proper research, investigation, and testing proved essential, he said. Baseline testing on performance and total cost of the old system really were important keys in today's environment for a company that strives to maintain and increase customer

satisfaction and improve quality on a continuing basis.

"In the future, we look forward to implementing a smaller finishing footprint that is higher in quality and leaner on environmental impact,"

*All processes are diligently tested, recorded, and maintained by lab personnel at Lincoln Electric.*

Young said. "With the assistance and partnerships from our key suppliers in pretreatment and powder we are ahead of the curve, but we will continue. The elimination of phosphate, reduction of energy and water usage, and savings in labor while increasing overall performance is a direct result of our resolve to satisfy Lincoln Electric customers around the world." **PC**

Editor's note

For further reading on the topics discussed in this article, see *Powder Coating* magazine's Web site at [www.pcoating.com]. Click on Article Index and search by subject category. Have a question? Click on Problem Solving to submit one.

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