Finishers' Think Tank

Stephen F. Rudy, CEF • Enequist Chemical Co.
100 Varick Avenue • Brooklyn, NY 11237 • 718/497-1200 • E-mail: sfrudy@aol.com

2001: A Plating & Surface Finishing Odyssey
The Journey Continues, Part 7

After refreshing ourselves at the Alloy Arms Hotel, we took the 90/10 subway express to Zinc Nickel Field, to watch a crucial divisional game. The NiZinc Bombers played host to the TinZinc Solderzips. As predicted, both teams were closely matched in strengths and capabilities. It was a battle down to the home team's last possession. The Bombers squeezed an extra score, breaking a stalemate and winning the match. In a post game interview, Nick Stannous, the Solderzips manager, promised an exciting rematch when the Bombers visit Tin II Stadium. He acknowledged the near equivalence and performance of both alloys, but stressed the home field advantage.

Our itinerary includes a visit to the Tin Zinc alloy state. Perhaps our scouting can discern some advantages favoring one team over the other. Comparisons usually transcend into technical capabilities.

Checking out, we had breakfast at the High Efficiency Grill. Their famous double eggs over easy is reputed to increase performance and stamina, while not sacrificing the waist. On the way to our train, the bus exited off Anti-Corrosion Boulevard, to the NiZinc Technical Center. The director met us for a final Q/A and short presentation. Afterwards, we each received a packet of assorted zinc-nickel-plated parts: automotive, electronic, fastener, marine, and outdoor fixtures. Back on the road, the bus traversed Chromate Parkway, switching to W. Sacrificial Avenue, bringing us to the Zinc Alloy Depot.

Reviewing the schedule with our tour director, the next visit will be to the Zinc Iron district. We hop aboard the 30/26 express, anticipating more fact-finding on our extended trip. Soon, industrial developments give way to a slightly hilly terrain. Lush, forest-green vegetation mixes with splotches of iridescent, black, and yellow. This gradually gives way to a bluish-gray landscape, dotted with a lustrous metallic tinge. The rail marker reads "65.39/55.84." Coincidentally, the intercom announces our entry into the Zinc Iron state. Rolling along, we are captivated by the scenic panorama before us. It's the famous Zinc Iron Black Hills. We agree that, so far, nothing matches this deep black, majestic color. A few miles onward, the black hills geographically change into beautiful fields of yellow and bronze. At the horizon, we see the Zinc Iron industrial complex taking shape. In short order, our express pulls into the FeZn depot. We assemble at track 8/12. Walking to our bus, I catch a newspaper headline: "FeZn Jets Look to Knock off Bombers & Solderzips." It's great to know there is lots of competition to improve corrosion protection and wear resistance!

We climb on the bus. It's black, of course, and the road we travel is the Jet Black Expressway. After a short ride, our bus zips along Alloy Terrace, to the FeZn Technical Center. Our special tour guide, Zinco Ironia, meets us for a planned presentation and tour. His zinc/iron roots are traced back over 500 years in Europe. His English connection is from Coalbrookdale, where the industrial process of reducing iron oxide with coke (carbon) to yield iron was developed. The continental European connection dates to the 1500s, with the discovery of zinc by Margraff. Following his introduction, Zinco gave us some pertinent facts.

Zinc as a sacrificial coating has always been highly regarded, and still is a metal finishing "heavyweight." In fact, the potential to improve corrosion protection and wear resistance resulted in an unprecedented boom of activity in all of Zincmalia. A simple approach has led to important developments.

Zinco described a technical conference, over 20 years ago, calling together representatives from each state in Zincmalia. Their agenda was how to advance the favorable properties of alloy deposits. Everyone agreed that alloying a small quantity of their particular element with zinc would open the door to a family of new plating processes. It was a unanimous consensus: nickel, cobalt, iron, and tin, would each find a niche with zinc. This resulted in acid and alkaline systems, rack and barrel, raising the bar of performance and deposit quality.

Let's take a closer look at the zinc iron alloy deposit.

A Good Deal

- Primarily plated from an alkaline solution, similar to alkaline zinc.
- Readily applied in rack and barrel operations.
- Very cost-effective for the finish protection.
- Resides a few notches above zinc.
- Exceptional corrosion protection when plated & chromated per specification.
- Approved by leading appliance, automotive, and hardware manufacturers.
- Aesthetically pleasing, deep black chromate finish.

There are specific bath formulations for rack and barrel. Complementary additives help to maintain properties of the alloy deposit. Operating parameters keep the system at the set point.

An off-line zinc generator for dissolving zinc anodes in the caustic solution for zinc replenishment is suggested. Never place zinc anodes in the process tank; otherwise, deposit roughness will occur. The process tank anodes should be low-carbon steel plates. A heat exchanger may be required to maintain desired bath temperature. This is very important to provide the optimum iron content in the alloy deposit.

Under the Hood

Alkaline Zinc Iron
Typical Rack Plating Solution

Component	oz/gal Range	oz/gal Opt.	g/L Range	g/L Opt.
Caustic Soda	14.7-21.3	18	110-160	127.5
Iron	200-500 ppm	350 ppm	0.2-0.5	0.35
Zinc	2-4	2.0	15-30	22.5

Typical Barrel Plating Solution

Component	oz/gal Range	oz/gal Opt.	g/L Range	g/L Opt.
Caustic Soda	14.7-21.3	18	110-160	127.5
Iron	200-500 ppm	350 ppm	0.2-0.5	0.35
Zinc	2.1-3.3	2.7	16-25	20.5

The following addition agents are required:
- A purifier additive is recommended to minimize the activity of metallic impurities.
- Soluble iron replenishment concentrate.
- Organic brightener and grain refiner.

Alkaline Zinc Iron
Typical Rack Operating Parameters

Temperature	65-80 °F	18-27 °C
Agitation & Filtering	mechanical (no air)*	continuous light carbon
Anodic Current Density	15-60 amp/ft^2	1.5-6 amp/dm^2
Cathodic Current Density	10-40 amp/ft^2	1-4 amp/dm^2

Typical Barrel Operating Parameters

Temperature	61-80 °F	16-25 °C
Agitation & Filtering	mechanical (no air)*	continuous light carbon
Anodic Current Density	15-60 amp/ft^2	1.5-6 amp/dm^2
Cathodic Current Density	4-20 amp/ft^2	0.4-2 amp/dm^2

* cathode rocker type is best

Neutral Salt Spray Protection—Zinc Iron & Black Chromate

Deposit Type	Hr to White Rust	Hr to Red Rust
*0.4-0.6% Iron	250 (min)	750 (min)

Remainder of alloy deposit is zinc (ex. 99.4-99.6%)

Process Thumbs Up

- Total cost (chemical & equipment) to deposit the zinc iron alloy is closest of any alloy deposit to plain or conventional zinc.
- Good chromatability.
- Blackens with a silver-free chromate.

Process Thumbs Down

- Delayed blistering may occur if excess of co-deposited iron (similar to alkaline zinc).
- Black chromated parts may exhibit poor high-temp. performance.

Zinc-iron deposits can be chromated to black, blue (clear), bronze, iridescent yellow, and deep yellow.

The black chromate is unique, because it's silver free. This significantly improves the economics of the chromate finish versus traditional silver types. In addition, process control of the silver-free chromate and reproducible finish is facilitated. Heating zinc-iron-plated and black chromated parts above 250°F (121°C) drastically reduces salt spray protection. This would restrict the field use and application of parts, such as under the hood in automotive finishes. Incorporating very small ppm quantities of phosphorous into the zinc iron alloy deposit improves the tolerance to heating the black chromated finish.

Maintenance & Tune Up

The following procedures help keep the system purring under the hood.

- Wet analytical titration for zinc and caustic soda.
- Spectrophotometric analysis for iron.
- Hull cell plating evaluations for purifier and organic brightener additives.

Deposit thickness is rapidly and accurately determined by non-destructive X-ray method. The same instrumentation can be used to determine the ratio of zinc to iron in the deposit. Other methods—such as thickness by deplating, strip and weight loss, and magnetic determination—can also be used. Corrosion tests of the deposit can be determined by specific ASTM methods, such as the neutral salt spray.

Fix It Guide

- Low & Excess Brightness. Correct bath wet analysis, Hull cell test for brightener addition, adjust temperature, add purifier & dummy for metallic contaminants.
- Blistered Deposits. Poor surface preparation, correct bath wet analysis, add purifier & dummy for metallic contaminants.
- Brittle Deposits. Reduce excess iron concentration in bath, optimize surface preparation.
- Low Corrosion Resistance. Correct bath wet analysis, add purifier & dummy for metallic contaminants, correct post treatment.
- Poor Yellow Chromate. Adjust chromate bath or replace, correct for iron concentration in deposit.
- Poor Black Chromate. Adjust chromate bath or replace, correct for iron concentration in deposit.
- No Deposit. Manually trace buss connections from tank to rectifier. Surprised?

Adhering to a routine analysis and maintenance schedule should keep the system running properly. The wet analysis, especially iron concentration, is very important.

Upon completing his presentation, Zinco invited us to enjoy some light refreshments during the Q&A period. Having quenched our thirst and charged our memory banks, we offered a gesture of appreciation. The tour guide presented Zinco with tickets for the upcoming Jets versus Bombers game. Our host was most appreciative.

As we boarded the shuttle bus, the FeZn technical center staff gave out complimentary packets of assorted automotive, fastener, and hardware parts, plated in alkaline zinc-iron with yellow and black chromate.

As we blended in with traffic on RonZin Parkway, the consensus was, let's get to our next Alloy Zinc district, and keep the information coming. ***P&SF***