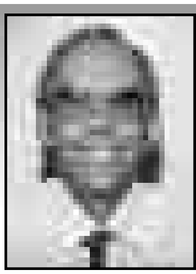

Finishers' Think Tank

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2001: A Plating & Surface Finishing Odyssey The Journey Continues ...

Our review trip encompasses many stops. These include: surface preparation, plated deposits, post finishing, and new terminals, paid for by dedicated research & field work, now under construction. If and when our journey ends, then it will be a sure sign of industry stagnation. Make a safe bet against this ever happening! For several years, the plating and surface finishing industry has contributed at least four percent annually to our GNP (gross national product). Be proud that every one in 10,000 of you shares in quality productivity. Whether it's computers, the space station, that new car, personal care implements, surgical instruments, assorted tools, plumbing, or nuts and bolts, this world can't function at optimum without us. Be proud of what you accomplish, yet remain challenged by current and future demands. Our world, as a whole, will be better for it.

Zinc: It Fights More Than the Common Cold

Corrosion is probably the most important reason we all have a job. A major function of plating and surface finishing is to prevent or greatly retard corrosion. Simply put, corrosion is the reason for our industry's very existence. One of our most effective discoveries to control corrosion has been the element zinc. We can thank Andreas Marggraf, who discovered this element in 1500. Centuries before Andreas broke new ground in metal finishing, civilization used brass to fabricate assorted items and fixtures. Archaeologists found brass implements dating from the period 1400-1000 BC, in Palestine. An 87-percent zinc alloy was found in Dracula country (Transylvania) prehistoric ruins. Inhabitants of Cyprus are credited with learning the technique of smelting zinc and copper, passing their proficiency to the Roman empire. Early chemists in 13th century India obtained metallic zinc by reacting zinc carbonate with wool. More than 400 years ago, Portuguese traders brought zinc back from their China and India commerce routes. The Industrial Revolution of the 1800s made great strides to refine zinc and implement its many applications. Currently, the U.S. is the world's largest producer of zinc.

Under the Hood

Why has zinc been a choice of material for thousands of years? What have metal finishers known and learned over such a long period? Let's begin with some zinc facts:

- Bluish to pale gray, brittle solid at room temperature.
- Malleable at 100-150°F.
- Good electrical conductivity.
- Not particularly toxic.
- Essential element in growth of all plants and animals.

Dynamics of the Dynamo

Zinc forms workable alloys with many metals. Commercial solder, spring brass, nickel/silver, aluminum solder, and soft solder, all contain zinc. More than one third of all the zinc produced is used to protect iron and steel from corrosion. This makes zinc the acknowledged clean-up batter in the line-up against corrosion. In addition, zinc has been and still is the cheapest metal to plate, returning exceptional payback in protection in various finishing applications. Protection is accomplished by electroplating and hot dip galvanizing. Zinc, by its relative position to iron in the electrochemical series, will sacrificially protect that base metal surface. This unique mechanism permits the zinc coating to be attacked preferentially, say by humidity, thereby protecting the iron or steel surface. Platers always improve this protective feature by applying a top coat over the zinc deposit. The most common and effective of these is the chromate conversion coating. After zinc plating or galvanizing, the coated parts are dipped into a specially formulated solution of chromium (hexavalent or trivalent). Chromium reacts with the zinc layer, forming a complex compound, further increasing corrosion protection. These films—chromates—offer a wide range of finish colors: clear, blue, yellow, iridescent, olive drab, and black. Post dips after the chromate extend anti-corrosion mileage even further. Treatments include: lacquers, oiling, paints, and sealers. Overall, the corrosion protection offered by the zinc deposit is a critical factor of its thickness. This, in turn, is affected by the plating current density and surface area of the part. Complimenting the effectiveness of protection are: surface preparation, purity and chemical balance of the zinc bath, condition of post treatments, and drying and post-handling.

Multi-functional MVP

Plated finishes of zinc include: assorted hardware (nuts, bolts, nails, washers, etc.), tools, spring steel, automotive, marine, aircraft, and computer chassis, to name some. Popular galvanized finishing encompasses road barriers, lamp stanchions, electric power transmission towers, and roofing. Other industrial and commercial applications for zinc include: batteries, paints, rubber products, health & beauty aids, floor coverings, plastics, soaps, textiles, electrical products, and hard currency. U.S. and Canadian pennies are zinc coated with bronze plate.

Zinc sulfides, because of their luminescence, are used in X-rays, fluorescent lights, and television screens.

Line-up of Choice

There are three major zinc plating processes available: chloride, alkaline non-cyanide, and cyanide. Each has its distinct benefits and drawbacks. This review covers some of the basics. More detailed information and background (operating parameters, analytical control methods, and trouble-shooting) can be obtained by consulting the AESF technical library and its bookstore, both easily found at **www.aesf.org**. Bath of choice should be related to the finishing requirement, applicable specification, and in-house handling capability. Many customers address quotes to platers for zinc plating jobs, requesting a bright or functional commercial finish. "Zinc plate it, give it a good dip, and make it last." Some add this popular line: "But, the price can only be value X."

Of course, there is more to it. After some quality questions and investigation, sufficient information is obtained with regard to the parts: post finishing application, process limitations, specifications if any. Getting the facts helps the plater decide how to price the job, set it up, and most important: finish it right.

Acid Chloride Zinc

This functional process gave way to a bright bath, commercially developed in 1940. It offers these advantages:

- Excellent brightness & leveling at relatively moderate concentrations of organic addition agents.
- Ductile deposit with excellent chromate receptivity.
- More than 90-percent cathode efficiency (close to nickel).
- Zinc is not complexed or chelated. Two benefits - Contribution to high process efficiency and electrolyte is easier to waste treat (except baths containing ammonium chloride).
- Bath operates at pH range categorizing it as noncorrosive.
- Elimination of cyanides.
- Metallic contaminants, such as iron, are chemically removed without interrupting the plating process.
- Chemical purification and carbon filtration remove organic contaminants and additive overloads.

Barrel and rack plating offer reasonable, high productivity finishing of a wide range of fabricated and stamped steel parts. Castings can be plated as part of a standard process cycle. Hydrogen over-voltage is also avoided, and hydrogen embrittlement is minimized. Process control involves routine analysis of bath components (zinc metal, total chloride, optional boric acid), pH measurement, and Hull cell testing. The organic additives are a wetting agent to condition the surface, emulsify the brightener, and complement the brightener's effect. A brightener is added on an amp-hour basis to maintain desired characteristics of the zinc deposit. The brightener is mainly consumed in the plating process. The wetter co-deposits to a small degree, but is mostly consumed by solution drag out. Brightener and wetter are best controlled by hull cell testing and record keeping of surface area plated versus required consumption of the organic additives. Iron is perhaps the most critical metallic contaminant. Additions of hydrogen peroxide or potassium permanganate will oxidize the ferrous iron (Fe+2) to insoluble ferric iron (Fe+3), which is readily removed by filtration (activated carbon, filter aid, or a sand filter).

There are three chloride-based plating solutions in use:

- Potassium chloride—Contains no complexors or chelates. Requires boric acid for solution buffering at the substrate interface and prevent high current density burning. Slightly higher brightener and wetter levels required to provide equivalent deposit brightness to all ammonium chloride and mixed salt baths.
- Ammonium chloride—The ammonium ion provides greater tolerance to iron contamination, high current density anti-burn activity, enhances brightener performance, and provides buffering for pH control (boric acid not required). Ammonium is a chelator and its presence in the waste stream (segregated or general) increases labor and cost to condition water prior to its compliant discharge.
- Mixed chloride salts (ammonium & potassium chloride)—In most applications, a mix of these salts (80:15 or 80:20), provides the benefits of each, while minimizing the described drawbacks of these individual chloride salts.

Some drawbacks to the acid chloride zinc process include:

- Mild acidity is corrosive to plating line and ancillary equipment that is not lined or of the wrong basis material.
- Cleaning and activation must be "right on," since the plating solution offers no surface conditioning action.
- Thicker deposits (above 0.0004 in.) tend to lose ductility.
- Operating temperatures above 120°F can lower distribution of the zinc deposit thickness across current densities. Brightener consumption increases with plating bath temperature.
- Brightener/wetter composition may oil out of solutions that are contaminated or out of analytical balance. High levels reduce ductility and affect chromate receptivity.
- Iron contamination causes deposit spotting and reduces chromate receptivity.
- Hexavalent chrome contamination (from chromate drag-in) causes blistering, dull and thin plate.

Every plating process requires the use of high purity anodes, salts, maintenance, process control, and periodic purification treatments. The first steps, cleaning & activation, are the most important. Acid chloride zinc has become a very popular and cost effective method to put zinc's superior corrosion fighting ability to work.
Next month, we'll discuss alkaline zinc and cyanide zinc. Find out if "cyanato to cyanide zinc" has any merit. *P&SF*

Trivia

- Excess wetting agents added to mechanically agitated nickel baths contribute to deposit haze and reduce post plate rinsing characteristics.
- Electrocleaners for zinc die castings are silicated. The silicate forms an inhibitor film that prevents base metal pitting and burning.
- Trivalent blue bright chromates over zinc provide these benefits: easier and less costly waste treatment, higher tolerance to metallic contaminants, meets salt spray characteristics, and longer bath service life.