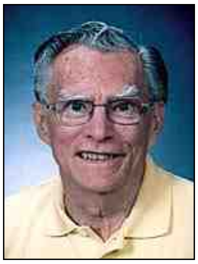

Do's & Don'ts

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Do's & Don'ts of Bright Zinc Plating
Part I: Alkaline Zinc

A little history

Zinc plating became popular when in 1933 the automotive industry took on the cadmium bearing. They bought up all but about 40% of the available cadmium. Cadmium plating had been useful for corrosion resistance applications. The result was a shortage of and a high price for cadmium. The alternative was to use zinc for corrosion protection applications.

Today there are many choices of zinc plating solutions. The oldest solutions used sodium cyanide to complex the zinc. The deposits were very good. The brightening addition agents were capable of producing very bright and attractive zinc coatings. The deposits were relatively easy to chromate. Clear bright chromates were possible and light and dark yellow chromates provided significant corrosion protection. Zinc plating could support lubricants and were used for fasteners of all kinds.

When cyanide solutions lost favor, alkaline non-cyanide solutions were developed. There was only a small change in brighteners and no change in the use of chromates. The acid chloride electrolytes (plating solutions) were the next generation of zinc plating solutions. The success of the cyanide-based deposits depended on the complete purification of the zinc plating solution. This was accomplished by treating the solution with zinc dust, wherein metallic contaminants were removed by chemical replacement of the zinc dust. DuPont introduced sulfides as a purification process. A number of zinc plating solution brighteners were developed that produced bright durable zinc deposits.

The next generation was alkaline non-cyanide zinc plating solutions, including alkaline zinc-nickel, followed by acid zinc chloride processes developed by Max Schloetter. The acid chloride formulations allowed the use of alloying metals such as zinc-cobalt, zinc-iron, zinc-manganese, zinc-nickel and zinc-tin

Bright dips and chromates were used as post plating steps, including dilute nitric acid and Dubpernell and Soderberg's chromic acid and sulfuric acid. The least popular was the hydrogen peroxide and sulfuric acid solution of Kepfer of DuPont. The next development was chromate technology by Allied Research. The Allied Research olive drab became the standard for Army Ordnance and is still used for camouflage and zinc protection.

Zinc and zinc alloys: Which one should I select?

There are alkaline-cyanide formulas, alkaline non-cyanide, alkaline zinc-cobalt, zinc-iron, zinc-nickel and acid zinc formulas, including zinc alloys such as zinc-cobalt, zinc-copper, zinc-iron, zinc-manganese, zinc-nickel, zinc-tin, and variations of each one. Each process has specific applications, depending on the desired deposit characteristics, the zinc post-plating coating characteristics and the ability to accept post treatments.

Selection

This is the controversial part of this editorial. I prefer acid zinc-nickel where the nickel content is 9.5 - 10%. At this nickel concentration the reception of chromates and other post treatments is good. The neutral salt spray performance ranges from 750 to 1,000 hours. It is the most ductile and is suitable for plating cast iron, malleable and carbonitrided surfaces.

Zinc-cobalt can also plate onto the above metals. Zinc-iron deposits are weldable and are the most ductile, but they deteriorate when exposed to heat.

Cyanide zinc plating solutions and typical formulas

Formulations	1. High cyanide	2. Low cyanide
Zinc as metal (usually added as zinc cyanide)	4 - 6 oz/gal (30 - 45 g/L)	1.0 oz/gal (7.5 g/L)
Total sodium cyanide	10 - 19 oz/gal (75 - 142 g/L)	2.0 oz/gal (15 g/L)
Ratio: total cyanide-to-Zn metal	2.5 - 3:1	2:1
Sodium hydroxide	10 - 15 oz/gal (75 - 112 g/L)	10 oz/gal (75 g/L)
Sodium carbonate (Max.)	3 oz/gal (22.5 g/L)	15 oz/gal (112 g/L)
Proprietary brighteners	As required	As required
Temperature	85°F (30°C) max	85°F (30°C) max
Purifier	As required	As required

Sodium carbonate increases with bath age. The maximum is about 15 oz/gal (112 g/L). High carbonate decreases cathode efficiency. Carbonates are absorbed from the air and from decomposition of sodium cyanide.

Because of the high cost of treatment for waste disposal and the danger of poisoning, cyanide solutions are chosen less often for zinc plating than the other options.

Periodic treatments or freezing-out for removal of carbonates are required. Proprietary brighteners are added to improve the smoothness and eye appeal of bright deposits. Post treatments can increase the corrosion resistance of these deposits.

Anodes are usually zinc balls held in a long basket made from steel. There can be a build-up of zinc dissolved from the anodes if left in the tank when the plating bath is not in use. Most platers raise the anodes above the solution overnight or for other down time when not plating.

Alkaline non-cyanide zinc plating solutions and typical formulas

Typical formulation	
Zinc	1.0 oz/gal (7.5 g/L)
Sodium hydroxide	12 - 13 oz/gal (90.0 - 97.5 g/L)
Brightening agent	As required
Operating temperature	70 - 80°F (21 - 27°C)

The need for pollution control and ecology considerations drove the industry to develop non-cyanide plating solutions. Non-cyanide zinc plating systems provided the answer. They not only eliminated cyanide, but there also were operational and functional improvements made possible by research into non-cyanide zinc processes. These included eliminating the need to remove anodes when the bath was not in use, brighter deposits, acceptance of post treatments, economics of operation, minimal build-up of carbonates, improved covering and throwing power, and ease in bath control. Alkaline zinc formulations are available for both barrel and rack operation.

Since there are no cyanide or complexing agents, many of the typical impurities will have limited solubility. Impurities that may be introduced can be easily controlled. For example, chromium is removed by adding small amounts of sodium hydrosulfite. Copper, lead and cadmium are removed by low current density dummy plating. Iron has no detrimental effects unless it is complexed. Some proprietary chromium control additives contain a complexor.

Anodes should be 99.99% pure zinc. Anode area is important. The anode-to-cathode area ratio should be 1:1 to 1.4:1.0. Looking at the anodes after or during use, they should have a light gray appearance. If there is a dark film, decrease the anode area. If the anodes have a bright appearance or no film, increase the anode area. *P&SF*

DO'S - High cyanide zinc	DON'TS - High cyanide zinc
• Use pure zinc for anode balls. 99.99% Zn in wire baskets. Use high grade chemicals.	• Allow the anode to cathode area fall below 1:1
• Maintain the temperature between 65 and 85°F (18 and 29°C).	• Allow the temperature to rise above 85°F (29°C). This destroys brighteners.
• **Caution**: Add sodium hydroxide slowly.	• Add to a hot solution.
• Use high-grade chemicals	• Allow carbonates to exceed 15 oz/gal (112.5 g/L).
• Use purifier (sulfides)	• Use the zinc plating solution for additional cleaning.
• Maintain the correct Zn-to-CN ratio of 2.7:1.0.	
• Maintain the NaOH-to-Zn ratio at 2.3:1.0.	

DO'S - Non-cyanide zinc	DON'TS - Non-cyanide zinc
• Maintain the correct anode-to-cathode area ratio.	• Use polysulfides to purify the bath
• Purify by using zinc dust, low current density dummy plating	• Use the plating solution to aid cleaning
• Clean the items to be plated very well	• Try to plate cast iron or high strength steels (no deposit).
• Maintain the ratio of sodium hydroxide to zinc at 10 to 1	• Air agitate
• To prevent delayed blistering, use good cleaning.	
• Keep zinc bath temperature above 70°F (21°C)	
• Keep thickness less that 0.005-inch (0.127 mm)	
• Use a 13 oz/gal (97.5 g/L) caustic soda pre-dip.	
• Remove copper contamination.	