Do's and Don'ts of Bright Zinc Plating
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**Part I Alkaline Zinc**

**A Little history**

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

Today there are many choices of zinc plating solutions: The oldest solutions used sodium cyanide to complex the zinc. There deposits were very good. The brightening addition agents were capable of producing very bright and attractive zinc coatings. There deposits were relatively easy to chromate. Clear bright chromates were possible light yellow and dark yellow chromates provided significant corrosion protection. Zinc plating could support lubricants and were used for fasteners of all sorts. 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 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 as a purification process introduced sulfides. 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. Dilute nitric acid and Dubpernell and Soderbergs chromic acid and sulfuric acid. Least popular was hydrogen peroxide and sulfuric acid 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 alloy: Which one should I select?**

There are alkaline-cyanide formulas, alkaline no-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 application 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. Salt spray range 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 deteriorates when exposed to heat.

**Cyanide Zinc Plating Solutions, And Typical formulas**

<table>
<thead>
<tr>
<th>Formulations</th>
<th>1. High cyanide</th>
<th>2. Low cyanide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc as metal (usually added as zinc cyanide)</td>
<td>4-6 oz/gal. (30 - 45 g/L)</td>
<td>1 oz/gal (7.5 g/L)</td>
</tr>
<tr>
<td>Total sodium cyanide</td>
<td>10-19 &quot;</td>
<td>2 &quot; (15 g/L) &quot;</td>
</tr>
<tr>
<td>Ratio total cyanide to Zinc as metal</td>
<td>2.5-3:1</td>
<td>2:1</td>
</tr>
<tr>
<td>Component</td>
<td>Concentration</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>10-15 ° (75 g/L)</td>
<td></td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>3 oz/gal. * (22.5a g/L)</td>
<td></td>
</tr>
<tr>
<td>Proprietary brighteners</td>
<td>as required</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>85 °F (30°C) max 85 max</td>
<td></td>
</tr>
<tr>
<td>Purifier</td>
<td>as required</td>
<td></td>
</tr>
</tbody>
</table>

Sodium carbonate increases with bath age. The maximum is about 15 oz/gal. High carbonate decreases cathode efficiency. Carbonates are absorption from 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 less often chosen 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 log 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 for overnight, or other down time when not plating.

**Alkaline non-cyanide zinc solutions, and typical formula**

The need for pollution control and ecology considerations drove the industry into non-cyanide containing plating solutions. No cyanide zinc plating systems provided the answer. It not only eliminated cyanide but there were operational and functional improvements made possible by research into non-cyanide zinc processes. These included no need to remove anodes when the bath is not in use, brighter deposits, acceptance of post treatments, economical, little build up of carbonates improved covering and throwing power, and easy to control. Alkaline Zinc formulations are good for both barrel and rack operation.

**Typical formula**

- Zinc 1 oz/gal. (7.5 g/L)
- Sodium hydroxide 13 oz/gal. (97.5 g/L)
- Brightening agent proprietary addition agents
- Operating temperature 80°F (27°C)

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 chrome control additives contain a complexor.

**Do's High Cyanide**

- Use pure zinc for anode balls. 99.9% Zn in wire baskets. Use high grade chemicals
- Temperature 65 to 85°F (18-29°C)
- Caution: Add sodium hydroxide slowly
- Use high-grade chemicals
- Use purifier (sulfides)
- Maintain the correct ratio of Zinc to total cyanide at 2.7 to one
- Maintain the sodium hydroxide (caustic soda)
- Ratio at 2.3 times the Zinc concentration

**Don'ts High Cyanide**

- Allow the anode to cathode area fall below 1:1
- Above 85°F (29°C)
- Destroys brighteners
- Add to a hot solution
- Allow carbonates to exceed 15 oz/gal (112.5 g/L)
Use the zinc plating solution for additional cleaning

**No cyanide alkaline zinc and typical formula**

Zinc as metal 1oz gal (7.5 gm/L)
Total sodium hydroxide 12 oz gal (90g/L)
Sodium carbonate 2 oz/gal. (15 g/L)
Temperature 70-80F (21-27C)

Brighteners (proprietary)

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

Since there are no cyanide or complexing agents, many of the typical impurities will have limited solubility. Chromium is treated using sodium hydrosulfite. Copper lead or cadmium can be removed by low current density dummy plating. Iron has little effect.

**Do's No Cyanide Plating**

Maintain the correct anode to cathode area ratio
Purify by using zinc dust, low current density dummy plating
Clean the items to be plated very well
Maintain the ratio of sodium hydroxide zinc at 10 to 1
To prevent delayed blistering: use good cleaning,
Keep zinc bath temperature above 70F (21C)
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.

**Don'ts No Cyanide Plating**

Use polysulfides to purify the bath
Use the plating solution to aid cleaning
Try to plate cast iron or high strength steels. (no deposit)
Air agitate