Do’s and Don’ts of Bright Zinc Plating

Part II Acid Zinc and Zinc Alloys

The development of acid chloride zinc plating solutions was pursued to provide plating solutions that would meet the demand for new zinc deposits to meet many applications for the automotive and aerospace industries. Items that were previously plated with cadmium now required something else to substitute for highly toxic cadmium. Fasteners had to meet torque/tension requirements coupled with higher demands for better corrosion resistance.

There are numerous formulas for the acid zinc group. Some of the typical plating solution make up formulas are listed below. Among them are acid chloride formulas with full ammonium chloride, low ammonia, and no ammonia. Others use potassium chloride or sodium chloride. Some contain boric acid. There are a number of alloys that can be plated from these formulas, such as zinc-cobalt, zinc-iron, Zinc-manganese.

From the acid chloride group of plating solutions, also came zinc solutions that are based on sulfate and sulfamate instead of chlorides. The sulfamate formulations produce very hard deposits due to the inclusion of zinc hydroxide in the deposit.

**Typical plating solutions make up formulas**

<table>
<thead>
<tr>
<th>Acid chloride</th>
<th>Zinc-Nickel</th>
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<tbody>
<tr>
<td><strong>Zinc chloride</strong></td>
<td><strong>Zinc (metal) 5.3 oz/gal. (39.75g/L)</strong></td>
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<tr>
<td>Zinc (metal) 2.6 oz/gal. (19.5 g/L)</td>
<td>Nickel 3.3 oz/gal. (24.75g/L)</td>
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<tr>
<td>Potassium chloride 25 oz/gal. (187.5 g/L)</td>
<td>Ammonium chloride 37 oz/gal. (277.5 g/L)</td>
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<tr>
<td>Boric acid 4 oz/gal. (30 g/L)</td>
<td>PH 5.7</td>
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<tr>
<td>pH 5</td>
<td>Temperature 100F (38C)</td>
</tr>
<tr>
<td>Brighteners as required. (Proprietary)</td>
<td>Brighteners as required</td>
</tr>
<tr>
<td>Temperature 90F (32C)</td>
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</tr>
<tr>
<td><strong>Zinc-cobalt</strong></td>
<td><strong>Zinc-iron</strong></td>
</tr>
<tr>
<td>Zinc (metal) 6 oz/gal (45 G/L)</td>
<td>Zinc sulfate.7 H2O 1.2 oz/gal. (9 g/L)</td>
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<tr>
<td>Cobalt 1.3 &quot; (9.75 g/L)</td>
<td>Iron sulfate.7H2O 33.3 oz/gal. (250g/L)</td>
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<tr>
<td>Boric acid 3 oz/gal (22.5 g/L)</td>
<td>Sodium sulfate 4 oz/gal. (30g/L)</td>
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<tr>
<td>Potassium chloride 25oz/gal. (287.5 g/L)</td>
<td>Sodium citrate.3H2O 2.7 oz/gal. (20g/L)</td>
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<tr>
<td>PH 5</td>
<td>Potassium chloride 1.33 oz/gal. (10 g/L)</td>
</tr>
<tr>
<td>Temperature 100F (38C)</td>
<td>pH 1.7</td>
</tr>
<tr>
<td>Brighteners as required (proprietary)</td>
<td>Brighteners as required</td>
</tr>
</tbody>
</table>

Zinc-Magnesium
Zinc sulfate 9.33 oz/gal. (70 g/L)
Magnesium sulfate 6.7 oz/gal. (50 g/L)
Trisodium citrate 26.7 oz/gal 200 g/L)
pH 3
Temperature 104°F (40°C)

- Potassium chloride can be substituted for ammonium chloride and visa versa in most formulations. Ammonium chloride presents additional waste treatment.
- There are many variations of each formula above.

Note: Zinc chloride (ZnCl₂) contains 48% zinc and 52% chloride by wt. To raise the zinc content by 1 oz/gal. (7.5 g/L) add 2.08 oz/gal (15.6 g/L) of dry zinc chloride. The total chloride will be raised by 1.08 oz/gal. (8.1 g/L)

ADVANTAGES AND DISADVANTAGES OF SOME OF THE ZINC PLATING SOLUTIONS

Cyanide Zinc Advantages
- Tolerant to impurities
- Good throwing power
- Good covering power
- Requires less cleaning Minimal equipment solution

Disadvantages of Cyanide Zinc
- High cost of waste treatment
- Minimal leveling
- Difficult to plate cast iron and high carbon steels
- Highly toxic solution

Zinc Chloride and Alloys Advantages
- Reduced waste costs
- High cathode efficiency
- Very bright deposits
- Plates cast iron, malleable iron, and Carbonitrided steels
- Leveling
- Reduced cooling
- Wide range of current density

Disadvantages of Zinc Chloride
- Poor throwing power
- Acid resistant equipment
- Limited thickness
- Requires better cleaning
- Solution is corrosive to surroundings

Alkali Non-Cyanide Zinc Advantages
- Good throwing power
- Good covering power
- Ease of waste-treatment Low cost
- Good corrosion resistance
- Solution not corrosive to tanks and equipment

Disadvantages of Non-Cyanide Zinc
- Lower cathode efficiency
- Requires good cleaning
- Potential for delayed blistering
- Less bright
- Cannot plate cast iron or high carbon steels
**Do's and Don'ts of Acid Zinc Plating**

**Do's**

Clean thoroughly prior to plating  
Add brightener by amp-hour meter  
Rinse thoroughly  
Requires periodic peroxide treatment to remove iron contamination  
Cover copper buss bars.  
Mild air agitation OK  
Filter through a carbon pack continuously  
Maintain the correct temperature.  
Limits are narrow  
Anode current density should be about 20 A/sq ft. (2.15 A/sq Decimeter)  
Bag anodes Zinc balls in titanium baskets or bagged slab anodes. Use 99.9% zinc

**Don'ts**

Allow high chloride. More than 20 oz/gal. (150 g/L) will cause surfactant oil out.  
Short cut final rinsing. Loss of brightness and poor chromate reception.  
Allow copper contamination to prevent dark deposit  
Allow pH to rise above limit, dull deposits result.  
Use iron or lead heating and cooling coils.