HAVALLOY Z-C provides a bright, ductile electro-deposited zinc-cobalt alloy containing from 0.1% to 0.5% cobalt that is evenly distributed at low, mid and high current densities.

HAVALLOY Z-C alloy deposits provide greatly enhanced corrosion resistance compared to traditional zinc plate when properly chromated.

HAVALLOY Z-C is low foaming and therefore can utilize high agitation to maximize current densities.

HAVALLOY Z-C process does not require separate rectifiers or anodes for replenishment of cobalt in the bath.

HAVALLOY Z-C deposits accept a non-silver black chromate as well as conventional yellow, clear, and silver-based black chromates.

**OPERATING PARAMETERS:**

<table>
<thead>
<tr>
<th></th>
<th>RANGE</th>
<th>RACK</th>
<th>BARREL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Metal</td>
<td>5-6 oz./gal.</td>
<td>5.6 oz./gal.</td>
<td>5.5 oz./gal.</td>
</tr>
<tr>
<td></td>
<td>37-45 g/l</td>
<td>43 g/l</td>
<td>41 g/l</td>
</tr>
<tr>
<td>Zinc Chloride</td>
<td>11-13 oz./gal.</td>
<td>12 oz./gal.</td>
<td>11.5 oz./gal.</td>
</tr>
<tr>
<td></td>
<td>82-98 g/l</td>
<td>91 g/l</td>
<td>86 g/l</td>
</tr>
<tr>
<td>Cobalt Metal</td>
<td>.1-.5 oz./gal.</td>
<td>.45 oz./gal.</td>
<td>.35 oz./gal.</td>
</tr>
<tr>
<td></td>
<td>.8-4 g/l</td>
<td>.3.5 g/l</td>
<td>2.8 g/l</td>
</tr>
<tr>
<td>Potassium Chloride</td>
<td>26-32 oz./gal.</td>
<td>30 oz./gal.</td>
<td>27 oz./gal.</td>
</tr>
<tr>
<td></td>
<td>200-250 g/l</td>
<td>225 g/l</td>
<td>200 g/l</td>
</tr>
<tr>
<td>Boric Acid</td>
<td>3-5 oz./gal.</td>
<td>3.4 oz./gal.</td>
<td>3.5 oz./gal.</td>
</tr>
<tr>
<td></td>
<td>22-35 g/l</td>
<td>30 g/l</td>
<td>26 g/l</td>
</tr>
<tr>
<td><strong>HAVALLOY Z-C MAKE UP</strong></td>
<td>5-6 % By Volume</td>
<td>5.5 % by volume</td>
<td>5.5% by volume</td>
</tr>
<tr>
<td><strong>HAVALLOY Z-C MAINT</strong></td>
<td>.05-.1% by Vol.</td>
<td>.075 % by Vol.</td>
<td>.075% by Vol.</td>
</tr>
<tr>
<td><strong>HAVALLOY Z-C REPLENISHER</strong></td>
<td>1-2% by vol.</td>
<td>1.8% by vol.</td>
<td>1.5% by vol.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>RANGE</th>
<th>RACK</th>
<th>BARREL</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5-6.2</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Temperature</td>
<td>65-95°F (20-35°C)</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td>Cathode Current Density</td>
<td>.05-40 ASF</td>
<td>3-40 ASF</td>
<td>0.5-15 ASF</td>
</tr>
<tr>
<td></td>
<td>.05-4 ASD</td>
<td>0.3-4 ASD</td>
<td>0.05-1.5 ASD</td>
</tr>
<tr>
<td>Anode Current Density</td>
<td>15-35 ASF</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>1.5-3.5 ASD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>2-15 Volts</td>
<td>2-6 Volts</td>
<td>6-15 Volts</td>
</tr>
<tr>
<td>Agitation</td>
<td>Mild Air</td>
<td>Mild Air</td>
<td>Mild Air</td>
</tr>
<tr>
<td>Anode Bags</td>
<td>Dynel or polypro</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td>Filtration</td>
<td>Continuous</td>
<td>Continuous</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
**SOLUTION MAKE-UP:**

1. Leach Plating tank with 2-3% by volume Hydrochloric Acid for 2-4 hours before charging.

2. Fill the tank to approximately 75% of final operating volume with water (hot if possible)

3. Add the appropriate amount of Zinc Chloride with good agitation.

4. Add the appropriate amount of Potassium Chloride with good agitation.

5. Add the appropriate amount of **HAVALLOY Z-C REPLENISHER** cobalt additive to the bath.

6. Add the appropriate amount of boric acid to the bath with good agitation.

7. Adjust the volume of water to desired operating level.

8. Adjust pH to the operating range. (Use dilute 25% Hydrochloric Acid to adjust pH down and 10% Potassium Hydroxide to adjust pH up.

9. Filter the solution for approximately 6-8 hours before use.

10. Add the appropriate amount of Make Up and Maintenance Brighteners to the solution before plating.

**EFFECT OF BATH CONSTITUANTS ON PERFORMANCE:**

**Zinc Metal:**

The zinc metal concentration must be kept within range so that burn-free plating can be achieved. Higher concentrations permit higher current density operation, and also improve covering power, but detract from throwing power. High zinc concentrations will also help improve cobalt distribution in the deposit. Generally higher metal concentrations are utilized in rack operations. Low zinc metal concentrations increase bath sensitivity to excess organic buildup and may also cause levels of cobalt plated in high current density areas to increase, thus creating chromating problems.

The metal concentration of the bath is maintained by electrochemical dissolution of the anodes. Anode dissolution will not take place while the bath is idle.

**Chloride Concentration:**

Chloride ion provides the conductivity of the bath and aids in anode corrosion. Higher concentrations increase conductivity, and are usually required if plating is done at higher current densities. Low concentration will cause anode polarization and a subsequent decrease in operating pH as well as burning in the high current densities. However unusually high concentrations should be avoided so as not to interfere with the solubility of the addition agents.
Cobalt Metal:

Cobalt levels must be kept within range so that the composition and uniformity of the alloy is maintained. In general, the higher the cobalt level in the bath the greater the cobalt content of the alloy.

Boric Acid:

Boric acid is utilized to buffer the effects of pH changes. Boric acid levels above the recommended range will salt out but generally has no detrimental effect. Low concentrations of boric will cause the bath pH to raise quickly. High pH levels will enhance the amount of cobalt in the deposit leading to chromating problems.

Current Density:

Current density is the most important factors that affects the alloy that is deposited. All other factors being constant, the amount of cobalt in the coating will increase proportionately with the increase in current density. Keep in mind that a high cobalt content will lead to chromating problems. Cathode current densities should be maintained at 2-40 amps per square foot. Also too high a current density will lead to burned and granular deposits in the higher current densities and therefore should be avoided.

Maintaining both anode and cathode current densities within their proper operating ranges will insure high quality operation. Too high an anode current density (usually results from too low an anode area) will cause anode polarization, and a decrease in zinc metal concentration. It will also lead to localized lowering of the pH. Too low an anode current density will lead to the metal content increasing.

Operating Temperature:

If the operating temperature is too low, poor conductivity will result, leading to sub optimum performance of the solution. In general however temperature affects both the amount of cobalt in the deposit and the consumption of the addition agents. In general, the higher the operating temperature, the greater the amount of cobalt occluded in deposits at any given current density.

Also, at higher than recommended operating temperatures, the consumption of the maintenance additives will increase.

Operating pH:

In general the amount of cobalt in the deposit will increase as the pH is increased. More importantly however, the operating pH has a major effect on how frequently the solution must be treated to remove dissolved iron. Performance is best at a pH of 5.5 and 5.7. This pH will also minimize the treatment for iron. During the normal operating of the bath, the pH will rise. The pH should be checked periodically and adjusted with 25% to 50% cp hydrochloric acid. Concentrated acid should never be used in that precipitation of some brightener components will occur. Vigorous agitation is recommended with all additions of acid.
Addition Agents:

**HAVALLOY Z-C MAKE UP** is added initially to the bath to aid in burn free plating, even metal distribution and alloy uniformity. It establishes basic grain refinement and sets up the initial balance of addition agent components. **HAVALLOY Z-C MAINT** is added to control the plate brilliance. Together with the make up additives, it provides alloy consistency.

**MAINTENANCE ADDITIONS:**

Replenishment additions of Make Up Additive are replaced as a result of drag out losses. Additions are normally made in accordance with additions of potassium chloride. A good rule of thumb is the addition of 2 to 2.5 gallons of **Make Up** Additive for every 100 pounds of Potassium Chloride added back to the bath. This addition will normally maintain the **Make Up** additive at approximately 5%.

Maintenance Additions are made on an ampere-hour basis. One (1) gallon of **HAVALLOY Z-C MAINTENANCE** is added for every 18,000 to 25,000 ampere hours.

The following table can be utilized to maintain the proper amount of cobalt in solution:

<table>
<thead>
<tr>
<th>Cobalt content desired in bath</th>
<th>Addition of <strong>Z-C REPLENISHER</strong> per 1000 ampere hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10 opg (0.75 g/l)</td>
<td>10 mls</td>
</tr>
<tr>
<td>0.20 opg (1.5 g/l)</td>
<td>15 mls</td>
</tr>
<tr>
<td>0.30 opg (2.25 g/l)</td>
<td>20 mls</td>
</tr>
<tr>
<td>0.40 opg (3.00 g/l)</td>
<td>25 mls</td>
</tr>
</tbody>
</table>

**CONVERSION FROM NON-ALLOY SYSTEMS:**

The **HAVALLOY Z-C** system is compatible with all **HAVASHINE NA** plating systems. Simply stop the **HAVASHINE NA** additive additions and begin to add the **HAVALLOY Z-C** additives.

**CONVERSION FROM COMPETITIVE SYSTEMS:**

Most competitive systems can be converted with simple slide in additions of the **HAVALLOY Z-C** system but a sample should be sent to **Haviland Products Company** for evaluation and conversion.
HANDLING AND STORAGE:

Use normal precautions when handling HAVALLOY Z-C addition agents - wear protective clothing, rubber gloves, and adequate eye protection. As with most chemicals, use in well ventilated areas.

HAVALLOY Z-C plating baths are acidic and all the customary precautions associated with the use of Hydrochloric Acid solutions should be observed.

HAVALLOY Z-C addition agents are stable on standing, with a shelf live in excess of 2 years.

Basic Analysis for HAVALLOY Z-C Acid Chloride plating baths:

Analysis for Zinc Metal:

1. Pipette 5 ml bath sample into a 250 ml Erlenmeyer flask and add 100 ml DI Water.
3. Add approximately 0.2 grams Eriochrome Black T indicator mix.
4. Add 10 ml 8% Formaldehyde solution.
5. Titrate immediately with 0.1M EDTA solution to a blue endpoint.

Calculation = (ml of 0.1M EDTA) x 0.17 = oz/gal Zinc Metal

Analysis for Total Chloride:

1. Pipette 1 ml bath sample into a beaker and 50 ml DI Water and mix well.
2. Add 2 - 5 ml of 2% Sodium Dichromate.
3. Titrate with 0.1N Silver Nitrate Solution to a red endpoint.

Calculation = (ml of 0.1N AgNO₃) x 0.473 = oz/gal Total Chloride

Analysis for Boric Acid:

1. Pipette 2 ml bath sample into a 250 ml Erlenmeyer flask.
2. Add 100 ml of DI Water.
3. Add 15 ml saturated Potassium Ferrocyanide.
4. Add 5 grams Mannitol.
5. Add 8 - 10 drops Phenolphthalein indicator.
6. Titrate with 0.1N Sodium Hydroxide solution to a pink endpoint.

Calculation = (ml of 0.1N NaOH) x 0.479 = oz/gal Boric Acid
Analysis for Cobalt Metal in the Bath Solution:

Reagents Used:

Concentrated Nitric Acid

Titration Procedure:

1. Pipette 10 ml bath solution into a 100 ml volumetric flask.
2. Add 50 mls distilled water and 2-3 mls concentrated nitric acid to the flask.
3. Dilute to volume with distilled water. Mix well.
4. Determine Cobalt content through Atomic Absorption Spectroscopy.

FACTOR: (AA Conc.) x 10 = ppm Cobalt metal (ppm = mgs. per liter)

Analysis for % Cobalt in Deposit of Plated Parts (Best results are obtained when using brass parts):

Reagents Used:

Concentrated Hydrochloric Acid
HP Descaler FEX

Procedure:

1. Weigh sample part or parts and record the weight as “Weight #1”
   Add approx. 1% HP Descaler FEX to enough conc. hydrochloric acid to cover the sample part(s). If total volume to immerse the parts is 500 mls solution then you would use 5mls. of HP Descaler FEX and 495 mls conc. hydrochloric acid.
2. Immerse the parts in the acid solution and strip the electroplate off the base metal. The stripping is complete when the blackish color is totally removed from the substrate.
3. Remove the parts from the solution and rinse with additional water. Record total volume of water used.
4. Add the acid stripping solution to the rinse water. Record the total volume as “Acid Volume”.
5. Completely dry the part(s) that were stripped and weigh. Record this as "Weight #2".
6. Determine Cobalt content of the acid solution by Atomic Absorption Spectroscopy.

Calculations:

1. “Weight #1” - “Weight #2” = “Weight of electroplate” (in grams)

2. \[ \frac{\text{"Weight of electroplate" (grams)}}{\text{"Acid Volume" (mls)}} \times 1,000,000 = \text{ppm electroplate} \]

3. \[ \text{ppm Cobalt (from AA)} \times 100 = \% \text{Cobalt in deposit} \]
SAFETY PRECAUTIONS:

Always read the Material Safety Data Sheet for any chemical product to ensure familiarity with the methods of safe handling and the health hazards associated with the product.

NON-WARRANTY:

The data contained in this bulletin is believed by Haviland Products Company to be true, accurate and complete. However, since final methods of use for this product are in the hands of the customer and beyond our control, we cannot guarantee that the customer will obtain the results described in this bulletin, nor can we assume any responsibility for the use of this product by the customer in any process, which may infringe the patents of third parties.