Alkaline Noncyanide Zinc Plating

by Edward Budman,
Dipsol-Gumm Ventures, Kearny, N.J.

Scarcely 30 years ago, the first commercially available alkaline noncyanide zinc was introduced. The concept hinged on a very valid determination to eliminate cyanide in the plating room. These first baths reflected the most immature stage of development in the learning curve for this new technology.

These early baths offered some very favorable traits, such as excellent throwing power, low zinc metal content, and no need to add cyanide. They typically had high levels of hard chelates that proved troublesome for waste treatment. The addition agents were numerous, and some even contained small amounts of cyanide as an ingredient.

Just imagine, the platers of the day thought they had eliminated cyanide, only to have phantom traces continue to be found in their effluent. These early baths also gave deposits that were susceptible to delayed blisters, which could appear hours, days, or weeks after plating. Additionally, the efficiency of the alkaline noncyanide zinc baths at 70–86% is lower than that of other types of systems, such as cyanide (75–93%) and chloride (95+%).

Manufacturers and vendors have done a very creditable job in curing

| Table I. Typical Formulations of Alkaline Noncyanide Baths |
|-----------------|----------------|-----------------|
| Zn               | 6–20 g/L       | Addition agents |
| Caustic soda     | 100–200 g/L    | Per supplier recommendations |

Figure 1. Typical circulation system for alkaline zinc—Style A. (When zinc concentration in the zinc plating solution becomes too high or over range, valves V2 and V3 are closed. Valve V6 is opened and V4 is closed after the solution in the dissolving tank is brought out.)

Table II. Effects of Impurities and Method of Removal

<table>
<thead>
<tr>
<th>Impurities</th>
<th>Permitted Limit</th>
<th>Phenomena</th>
<th>Method of Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexavalent chromium</td>
<td>0.1 mg/L</td>
<td>1) Lowering of brightness in whole current density areas.</td>
<td>1) Add 0.2 g/L aqueous solution of sodium hydrosulfite and leave it for a night.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) No brightness in high current density areas.</td>
<td>2) No suitable method other than diluting solution.</td>
</tr>
<tr>
<td>Lead</td>
<td>0.5 mg/L</td>
<td>1) Blackening or nondeposition in low current density areas.</td>
<td>1) Zinc dust treatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Lowering covering power.</td>
<td>2) Add 0.1–0.3 g/L sodium sulfide and then filter the solution.</td>
</tr>
<tr>
<td>Copper</td>
<td>1 mg/L</td>
<td>1) No brightness in low current density areas.</td>
<td>Zinc dust treatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Blackening in nitric acid dipping.</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>1 mg/L</td>
<td>Discoloration in baking treatment</td>
<td>Zinc dust treatment.</td>
</tr>
<tr>
<td></td>
<td>5 mg/L</td>
<td>1) Blackening in low current density areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Lowering of the bending property after plating</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Lowering of adhesion.</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>10 mg/L</td>
<td>1) Lowering of the bending property after plating</td>
<td>Plate out at low current density (0.2–0.5 A/dm²).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Lowering of adhesion.</td>
<td></td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>80 g/L</td>
<td>1) Lowering of the bending property after plating</td>
<td>Carry out bath filtration after cooling.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Lowering of adhesion.</td>
<td></td>
</tr>
<tr>
<td>Organic materials, oils, and floating materials</td>
<td>80 g/L</td>
<td>1) Adhesion of oils to plated components.</td>
<td>1) Filtration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Occurrence of rough surface.</td>
<td>2) Filter through filter aid packed in unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3) Active carbon treatment.</td>
</tr>
</tbody>
</table>
**Mist Eliminator**
*Prolite Plastics Ltd.*
*Port Coquitlam, B.C.*

The Prolite CT-120/2 dual-stage horizontal mist eliminator represents a simple yet ultra-efficient method of removing mist and airborne droplets from gas streams. Unlike mesh eliminators, the CT-120/2 is very compact, does not tend to plug up, can be easily cleaned, has a very wide operating velocity range, and is designed to be simple to maintain. The Prolite CT-120/2 embodies total airflow casing design with both eliminator banks internally separated and independently baffled from each other. Inlet and outlet transitions are streamlined and no baffles extend into the airstream to generate turbulence. The CT-120/2 can also be used as a scrubber. Gas streams and fumes, particularly in the surface finishing industry, consist mainly of ultra-small acid/alkali droplets that can be captured by the CT-120/2. In the case of hard chrome fumes, air management emission levels can easily be met.

Circle 108 on reader information card

**Tank Covers for Hard Chrome Plating**
*Merlin Enterprises*
*Huntington Beach, Calif.*

Merlin tank covers eliminate hexavalent emissions from hard chrome plating operations while eliminating fume exhaust hoods, ducting, scrubbers, fans, poly balls, and fume suppressants. The cost for heating the solution is reduced by 60-70%, depending on usage and location. The tank covers operate with emissions below 0.005 mg/A-hr and turn-around time is reduced to one minute or less.

Circle 109 on reader information card

**Composite Pad Media**
*Kimre Inc.*
*Perine, Fla.*

Kimre Inc.'s composite pad, known as B-Gon, is a unique product in the arsenal of air pollution abatement/phase separation materials. These pads have several layers of differing coarseness from heavy for heavy loads of solid particulates or liquids to less coarse for small liquid droplets. B-Gon is manufactured from polypropylene and for higher temperatures or more aggressive chemicals—Kynar, Teflon, and Tefzel. Support grids are manufactured in fiber-reinforced plastic, stainless steel, or other materials.

Circle 110 on reader information card

---

**UNIT LINER COMPANY**

Established 1957

Innovative Manufacturer of Flexible Lining Systems
to recycle or prolong the life of your tanks.

"High Temp" PVC Drop-In Liners
Easy Installation • Highest Quality • Savings

Write or Call for Information: P.O. Box 3968 • Shawnee, OK 74802-3968
In OK: (405) 275-4600 • FAX (405) 275-4625

1-800-633-4603 Ext. 400

Circle 074 on reader information card
Table III. Table of Best Application and Corrosion Resistance for Chromates

<table>
<thead>
<tr>
<th>Chromate</th>
<th>Cyanide Zinc Bath</th>
<th>Noncyanide Alkaline Zinc Bath</th>
<th>Acid Chloride Zinc Bath</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Application</td>
<td>Color Tone</td>
<td>SST</td>
</tr>
<tr>
<td>Blue bright</td>
<td>Good</td>
<td>Light blue</td>
<td>48/192</td>
</tr>
<tr>
<td>Yellow iridescent</td>
<td>Good</td>
<td>Yellow iridescent</td>
<td>96/360</td>
</tr>
<tr>
<td>Black</td>
<td>Good</td>
<td>Deep black</td>
<td>96/360</td>
</tr>
<tr>
<td>Phosphate type</td>
<td>Good</td>
<td>Deep black</td>
<td>72/288</td>
</tr>
<tr>
<td>Acetic acid type</td>
<td>Good</td>
<td>Deep black</td>
<td>72/288</td>
</tr>
<tr>
<td>Green</td>
<td>Rack formula</td>
<td>Light green</td>
<td>168/552</td>
</tr>
<tr>
<td></td>
<td>Barrel formula</td>
<td>Not recommended</td>
<td></td>
</tr>
</tbody>
</table>

SST, salt spray test hours to corrosion. Thickness: 8 μm.

many of the objectionable deficiencies of these early baths. The newest generation baths offered by many manufacturers today (see Table I) have neither cyanide nor hard chelates in their formulas. This permits the plater to treat the effluent more easily. It also eliminates the delayed blistering problems of the earlier baths.

Domestic thought leans to reduced organics in the brightener as the reason for blister elimination. Many Pacific Rim platers, however, believe that the culprits are the wetting agents that are formulated into the systems. Eliminate the wetters and you can eliminate the blistering.

Quite often, if the zinc content of the bath keeps dropping, you can use a zinc generator tank to place additional zinc metal in contact with the solution. The diagrams in Figures 1–3 indicate three possible zinc generators that work effectively.

CONTAMINANTS

Alkaline noncyanide zins are susceptible to metallic and organic contamination, just as are other baths. Table II shows some typical contaminants, their suggested limits, appearance, and removal techniques.

A SINGLE-SAMPLE METHOD FOR ANALYTICAL CONTROL

Alkaline zinc baths typically see up-and-down movement of the metal content. Good analytical control is a very important responsibility of the plater.

There are many good techniques available for analysis, and the following method should be of interest. With this technique, you can analyze both zinc and caustic soda by using a single pipetted sample.

**Required Analytical Reagents**

- 0.1% Sulfo-Orange indicator
- 1.0 N Hydrochloric acid
- pH 5 Buffer solution (15% anhydrous sodium acetate solution with pH adjusted by acetic acid to pH 5)
- 0.1% X-O (Xylenol-Orange) indicator
- 0.1 M EDTA standard solution

Figure 2. Typical circulation system for alkaline zinc—Style B.

Figure 3. Zinc generator—one tank system.
Zinc and Caustic Soda
Procedure

1. Prepare a 300-ml wide-mouth Erlenmeyer flask.
2. Pipette a 5-ml sample of plating solution into the 300-ml Erlenmeyer flask.
3. Add about 100 ml of deionized water.
4. Add 3–5 drops of 0.1% Sulfo-Orange indicator.
5. Dip the glass electrode of a pH meter into the analyzed solution.
6. Titrate with 1 N hydrochloric acid standard solution until the solution pH becomes 11.5. When the solution pH becomes 11.5, the solution color should appear completely yellow.
7. Read this endpoint as “V1” ml of 1 N hydrochloric acid.
8. Add 1 N hydrochloric acid again until the solution pH becomes 5–6.
9. Pull out the pH glass electrode and wash with deionized water.
10. Add 15 ml of pH 5 buffer solution.
11. Add 1-3 drops of 0.1% X-O (Xylenol-Orange) indicator.
12. Titrate with 0.1 M EDTA standard solution until a pink to yellow color endpoint occurs.
13. Read this endpoint as “V2” ml of 0.1 M EDTA standard solution.

Calculation

\[
\begin{align*}
Zn (g/L) &= V_2 \times 1.31 \times 0.1 \\
NaOH (g/L) &= V_1 \times 8 \times 1
\end{align*}
\]

POSTPLATE TREATMENTS

Chromate conversion coatings are used on alkaline noncyanide zinc deposits, just as with other types of baths. Table III shows the number of hours that typically can be expected, by type of chromate, as applied to the three major types of plated zinc.

Table IV. Main Types of Chromate Coatings for Zinc Plating

<table>
<thead>
<tr>
<th>Coating Type</th>
<th>Color Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin</td>
<td>Colorless (bright dip, blue bright) Polishing type (better appearance)</td>
</tr>
<tr>
<td>Thick</td>
<td>Colored Nonpolishing type (higher corrosion resistance)</td>
</tr>
<tr>
<td></td>
<td>Dark green Yellow or indescent type</td>
</tr>
<tr>
<td></td>
<td>Olive drab</td>
</tr>
<tr>
<td></td>
<td>Black Acetic acid type (better black color)</td>
</tr>
<tr>
<td></td>
<td>Phosphate type (higher corrosion resistance)</td>
</tr>
</tbody>
</table>

It should be noted that some of the results appear higher when applied to alkaline noncyanide zinc deposits. One belief is that the extra protection comes from a very small percentage of iron that codeposits with the zinc. In the cyanide baths, iron complexes with cyanide and is blocked from codeposition. The chloride baths employ either peroxide additions and/or air agitation to oxidize and precipitate the iron, causing it to be removed by filtration.

Table III reflects hours to white/red corrosion, using the ASTM B 117 Salt Fog Test.

A general chart of most generic chromates on zinc is shown in Table IV. The chromate conversion coating is formed by a reaction between the chromating solution and the plated zinc deposit. Table V gives the dimensional change in the zinc and the thickness of the actual chromate film.

When the chromate conversion coat-
ing is applied to the plated part, you must exercise great care in drying the work. One common error is to dry the parts at too high a temperature. This may desiccate the chromate film, thereby reducing the corrosion resistance. The chromate film cannot be rehydrated, and the product quality is sacrificed. Figure 4 shows the effect of drying temperature on the salt fog test to white corrosion products.

CONCLUSION

Alkaline noncyanide zinc is a very important type of plating system in today’s metal-finishing world. Factors such as lower metal content, no cyanide, good chromate receptivity, no hard chelates, and convenient waste treatment should ensure the popularity of this type of system for a long time to come. Deposits plated out of these baths accept all popular chromates offered by vendors in the industry. You can expect this type of zinc plating system to be a viable alternative to cyanide and acid chloride zinc applications.

Printed Circuits Handbook
edited by C.F. Coombs, Jr.
hardcover $74.50

This excellent handbook is a complete reference for all topics in printed circuits manufacturing. It addresses both technical concepts and common everyday problems. Furthermore, the handbook considers all aspects of fabrication processing.

Send Orders to:
METAL FINISHING
Three University Plaza
Hackensack, NJ 07601

For faster service, call (201) 487-3700 or FAX your order to (201) 487-3705

All book orders must be prepaid. NY, NJ, and MA residents add appropriate sales tax. Please include $5.00 shipping and handling for delivery of each book via UPS to addresses in the U.S.: $8.00 for each book for Air Parcel Post shipment to Canada; and $20.00 for each book for Air Parcel Post shipment to all other countries.

End Paint Waste Liability.

The threat of liability from hazardous paint waste can surface years after it has been disposed of legally. The best way to end your risk is to beneficially recycle your waste into new products. Ask how we can help.

EPI: Environmentally sound. Economically efficient.

ENVIROMENTAL PURIFICATION INDUSTRIES
419/727-0495
2111 Champlain Street, Toledo, Ohio 43611 Fax: 419/727-0595

TRY THE RETEC REMEDY For Increased Profits

The increasing cost of toxic heavy metal waste treatment and disposal may be eroding your profits more than you think. Higher waste disposal costs and more stringent effluent standards result in increased operating costs which directly affect profitability.

Operating costs can be reduced and profits increased by recovering metals before they are converted to toxic metal-bearing sludge and liquids. Every dollar of saved waste treatment cost translates directly to an additional dollar of operating profit.

The RETEC® Heavy Metal Recovery System can save you money - and increase your profit - by recovering waste metals such as copper, cadmium, nickel, precious and other metals that otherwise would result in costly sludge disposal expenses.

Prove it to yourself, as have others, and take advantage of the RETEC remedy for increased profits. RETEC is the practical, effective, and economical alternative to chemical waste treatment for minimizing or eliminating the generation of toxic waste.

Now exclusively marketed by:

Wheelabrator
Engineered Systems Inc.

Circle 026 on reader information card

Circle 026 on reader information card
INFORMATION SERVICE

For your convenience, Metal Finishing has introduced a new Information Service to provide our readers with the opportunity to obtain additional product information.

Just circle the corresponding number — from the categories listed below — in the Information Service section of our Reader Service Card, and information will be sent directly to you from manufacturers and suppliers of products and services in these categories who advertise in the pages of Metal Finishing. The categories listed include:

501 Adhesion Testers
502 Analytical Instruments
503 Anodes
504 Anodizing Processes & Equipment
505 Barrel Plating Equipment & Supplies
506 Blackening & Antiquing Compounds
507 Blasting Equipment & Media
508 Brightener & Chemical Feeders
509 Brush Plating Processes & Equipment
510 Buff/Brush/Polishing Equipment & Supplies
511 Centrifugal Dryers
512 Cleaners, Acidic
513 Cleaners, Solvent
514 Cleaning & Pretreatment Equipment
515 Conversion Coating Processes
516 Coatings & Metals
517 Corrosion Testing Equipment
518 Electrophoresis Processes & Equipment
519 Electrolytic Recovery Equipment
520 Electroplating Equipment & Supplies
521 Evaporators & Still
522 Filtration Equipment & Media
523 Heating & Cooling Equipment

524 Hull Cells and Test Panels
525 Ion Exchange Equipment
526 Masking Supplies
527 Mass Finishing Equipment & Supplies
528 Mechanical Plating Processes and Equipment
529 Membrane Separation Processes
530 Nozzles, Spray
531 Ovens
532 Painting & Powder Coating Equipment
533 Paints, Lacquers and Powder Coatings
534 pH Meters & Controls
535 Phosphate Coating Processes
536 Pickling & Bright Dipping Compounds
537 Plating Equipment & Systems
538 Plating Processes, Base Metals
539 Plating Processes, Precious Metals
540 Plating Processes, Printed Circuits
541 Power Supplies
542 Pumps
543 Racks & Baskets
544 Refining Services
545 Rinse Control Systems

546 Sludge Handling Equipment
547 Strippers
548 Tanks & Tank Liners
549 Thickness Testers & Controls
550 Vacuum Coating Equipment & Supplies
551 Ventilation & Air Pollution Control Equipment
552 Waste Disposal & Recycling Services
553 Water Pollution Control Processes & Equipment

Price Pump's ORCA... Solving Difficult Corrosive Chemical Pumping Applications

Discover Price
Pump Co.'s
ORCA Line...
the most corrosion resistant pump in America.

ORCA Line’s sealless vertical pump solves your most difficult chemical handling applications.

- Available in CEVG, natural polypropylene or PTFE
- Unique labyrinth flame barrier design
- Optional motor purge cap
- All nonmetallic wetted parts
- All injected molded construction
- Pump runs dry indefinitely.

#1 Pump Way, P.O. Box 569
Sonoita, CA 95476-0529
600-345-PUMP (7867)
FAX 707-938-0764

Circle 081 on reader information card