

# Salt Spray Testing and Corrosion Protection

## *Alkaline Cyanide-Free Zinc Versus Acid Chloride Zinc*

**A**lthough somewhat of a mystery, it has long been observed in many instances that acid chloride zinc provides better corrosion protection than alkaline cyanide-free zinc when passivated with any of the new high-performance trivalent chromates. What may not be as widely recognized, however, is that the corrosion characteristics of COLZINC<sup>®</sup> ACF-II Alkaline Cyanide-Free Brightener replicate those of acid chloride zinc, due to its unique zinc deposit structure.

### The History

The difference in corrosion protection was most evident in the early and mid-2000's, when the End-of-Life Vehicle (ELV) started ramping up and zinc platers transitioned toward trivalent (hex-free) chromates and away from hazardous hexavalent chromates. With the onslaught of new automotive specifications and the requirement for trivalent chromated parts to be Production Part Approval Process (PPAP) tested, salt spray testing results and all the subsequent data became highly scrutinized.

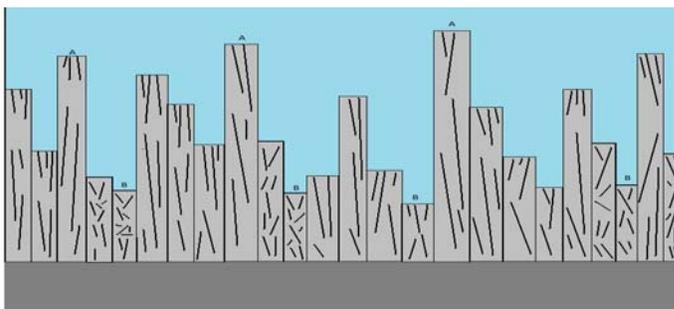
Zinc platers clearly saw a significant drop in salt spray hours between parts plated in alkaline cyanide-free baths vs. acid chloride zinc baths processed in one of the new high-performance trivalent chromates. To make matters worse, platers not only had to stop using hexavalent chromates, but the bar was raised and corrosion protection requirements were increased. The old ASTM-B633 standard of 72-96 hours to first white rust (FWR) quickly became obsolete by the new hex-free standards, such as GMW-3044, which required a minimum of 120 hours to FWR.

In many cases, parts that were plated in optimal alkaline cyanide-free plating baths and then passivated in one of the new high-performance trivalent chromates provided less than half the corrosion protection of identical parts processed in an acid chloride plating bath. During head-to-head salt spray testing (ASTM B117 or ISO 9229), alkaline cyanide zinc nearly always underperformed, typically with 48-72 FWR hours, as compared to acid chloride zinc of 120+ FWR hours.

### Zinc Deposit Structure Defines Corrosion Protection

The differences in corrosion protection between these two zinc plating processes directly relate to the differences in zinc deposit structure.

The typical alkaline cyanide-free zinc deposit is columnar in nature. Figure 1 shows the vertical orientation of this deposit with well-defined peaks and valleys. The SEM image further shows the vertical grain structure and the uneven nature of the alkaline cyanide-free zinc deposit.



**Figure 1**

Columnar zinc deposit structure from alkaline cyanide-free plating.

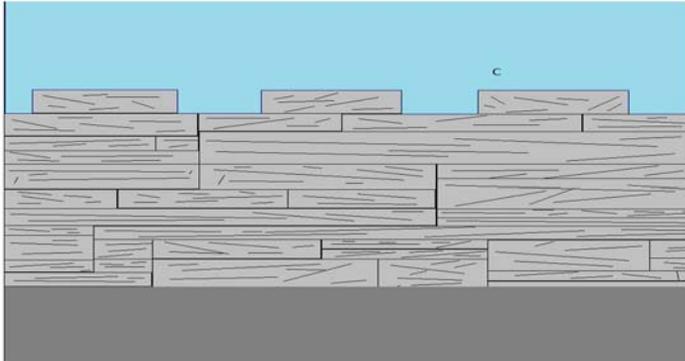


The chromate film thickness at point “A” is much thinner relative to point B.” When corrosion failure occurs, it will start at “A” prior to corroding at “B”. For example, the chromate film thickness may only be 25 nm at “A,” compared to >175 nm at “B.” These peaks are the sites for initial corrosion of zinc since the chromate film barrier is extremely thin.

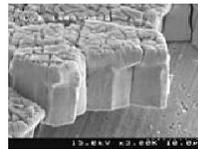
Now compare the acid chloride zinc deposit in Figure 2 with the alkaline cyanide-free zinc deposit in Figure 1. The acid chloride zinc deposit is laminar in structure, with level grain refinement and nice, smooth horizontal layering of zinc. The SEM image further shows the horizontal and even nature of acid chloride zinc.

While the trivalent chromate film deposited over alkaline cyanide-free zinc fills in the columnar gaps and remains thinner at the peaks, the trivalent chromate film deposited over acid chloride zinc adheres in a thick and uniform layer.

Since the chromate is uniform in nature and void of the peaks and valleys of the alkaline cyanide-free zinc deposit, this laminar deposit provides a thicker chromate film across the entire part. The chromate film layer at point “C,” for example, would be 150 nm with an overall range of 150-175 nm. Obviously, these parts would corrode much later and in a more uniform timeframe than typical alkaline cyanide-free plated parts.

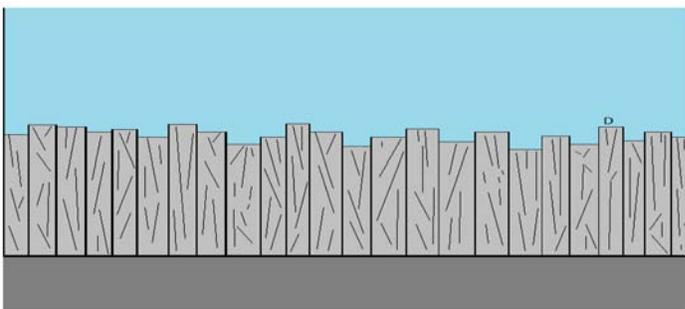


**Figure 2**  
Laminar zinc deposit structure from acid chloride plating.

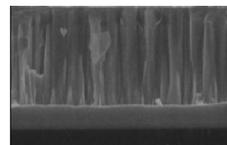


### COLZINC ACF-II Deposit Structure

Finally, compare the deposit structure in Figure 3 from a part plated in Columbia COLZINC<sup>®</sup> ACF-II Alkaline Cyanide-Free Brightener. It is columnar in nature but has a very tight grain structure that is uniform and extremely level. The level deposit of COLZINC ACF-II better reflects light, providing a deep brightness similar to acid chloride zinc. COLZINC ACF-II also produces a zinc deposit that is void of the valleys and peaks of conventional alkaline cyanide-free zinc. Point “D” is more in line with the acid chloride zinc process in Point “C,” demonstrating more uniform chromate film thickness. The corrosion characteristics of COLZINC ACF-II replicate those of acid chloride zinc.



**Figure 3**  
COLZINC<sup>®</sup> ACF-II zinc deposit.



The superior corrosion protection of COLZINC ACF-II is attributable to the exclusively designed structure of the deposit. Use of COLZINC ACF-II also results in superb plate distribution, extreme tolerance to bath impurities, a wide operating range, the ability to plate at high temperatures and excellent brightness.