Advice & Counsel

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Working With Salt Spray Tests

Dear Advice and Counsel,

Our company rack-zinc-plates for a customer per ASTM B633 Type III Class FeZn8. According to their lab we are having some problems passing the 12 hour salt sprav test performed per ASTM B117. Our outside lab doesn't agree. Are there written guidelines for determining whether a white spot is corrosion or a stain? Another concern that we have is that these parts are too long for the salt spray cabinet. Our customer is cutting a section of the part off and using tape to cover the un-plated area for the salt spray test. Can the un-plated edge cause problems for the zinc plated areas?

Signed, I. C. White

Dear Ms. White,

Your question came in a timely manner, as AESF has just completed a successful workshop (in Rockford, IL) on Salt Spray Testing and Evaluation, with 28 students attending. You may wish to sign up for the next class.

There are no written guidelines as to what is a white corrosion spot versus a stain. As chromate conversion coatings are exposed to the corrosive environment of a salt spray chamber, it is not unusual for the chromate film to initially discolor, producing variations in coloration that may be interpreted as "stains." Stains typically are not considered corrosion.

Let's first discuss the mechanism for corrosion in a salt spray chamber (you may also wish to read an article I wrote titled "Critical Aspects of the Salt Spray Test," September issue of *P&SF*, 1985).

The salt spray test takes advantage of a phenomenon known as "Oxygen Concentration Cell Corrosion." If a drop of water rests on a metal surface (see figure) there is a difference in the concentration of oxygen available to the specimen rela-



tive to the position within the drop. At the center of the drop, the metal is in contact with the dissolved oxygen in the droplet and with the oxygen in the hydroxide ions due to water dissociation. At the edge of the drop, additional oxygen from the air is available; thus, an oxygen concentration gradient is produced from the edge of the drop to the center.

Since oxygen may diffuse from the air outside the drop into the water at the edge of the drop, the difference in oxygen contact is greatest at the area furthest from the edge of the drop, which is the center. According to Dr. Harold Read, a well known expert in corrosion, this difference in oxygen content creates an oxidation potential that can be measured and is approximately 0.3 volts. The metal at the center of the drop dissolves, producing a pit and electrons which flow to the edge of the drop where corrosion products are precipitated (producing the white zinc oxide/hydroxide that you see when you examine the parts which yields salt spray failure).

In the salt spray test, the above corrosion mechanism is accelerated in four ways. First, the use of salt (sodium chloride) results in a higher solubility for metal ions in the water droplet, extending the life of each cell. Second, electrochemical reactions are accelerated by elevating the temperature of the corrosion cell. Third, by inclining the test specimen, the corrosion cell is continuously formed and replenished with fresh electrolyte; therefore, the reaction is never slowed by the accumulation of metal ions and hydroxides within the corrosion droplet. Fourth, the fine mist that is sprayed results in the formation of thousands of corrosion cells which are set up and continuously replenished during the exposure period.

In summary, when the chromate conversion coating fails, the zinc under the chromate film reacts with the alkalinity within the salt water drop to produce zinc hydroxide/oxide. If this zinc hydroxide/ oxide is not present on the surface of the test sample, there is no failure, even if the chromate is discolored.

If you need to prove the absence of corrosion products, wipe the stained area with a cotton swab soaked with deionized water. Transfer the deionized water to a small glass dish and acidify with a drop of any reagent grade acid. Next, test the acidified water for the presence of zinc using an atomic absorption spectrophotometer. (Be sure to run a blank for comparison purposes. Do this by wiping and testing a chromated sample that has not been subjected to the salt spray test.) The absence of zinc or the presence of zinc in the same concentration compared to the blank will confirm the absence of corrosion product.

As for exposure of parts that are too large for the chamber, the first rule is to never use a chamber that is less than 15 cubic feet. Assuming your chamber is larger than that, and you still need to cut the specimen, there is nothing in the ASTM specification that prevents you from cutting it. Parts may be cut to fit the cabinet, as long as what is left after cutting truly represents the sample. The cut edge must be protected from corrosion and it needs to be facing the bottom of the cabinet. Plastic tape (no paper) may be used, but wax is a far better mask for the cut edge. Any corrosion that appears within 1/4" from the cut edge is ignored. *P&SF*