

Ask Dr. Galv

DEAR DR GALV: When someone asks me how galvanized steel performs in salt spray test, what do I tell them?

A. Atmospheric corrosion testing of metals and materials has a long history of use in the evaluation of uncoated and coated metallic products. Salt spray test results are often used to determine the suitability of a material system for a particular application. Salt spray testing to ASTM B-117, Standard Practice for Operating Salt Spray (Fog) Testing Apparatus, remains the standard method to assess a galvanized coating for corrosion control in some applications. This is despite the fact that severe criticism of this method has been observed in literature for many years, particularly regarding the lack of correlation with service experiences and field applications.

The salt spray test is the exposure of the surface coating to a fine mist containing 5 percent of sodium chloride (NaCl), for a give time, at room temperature. For galvanized steel, the salt spray test, ASTM B-117, accelerates the wrong corrosion mechanism. The salt spray attacks the bare zinc. Zinc is well know for its ability to resist corrosion, but what is not so well known is that this resistance depends on the formation of a reaction product barrier on its surface. When galvanized products are exposed to normal use, such as in the marine or road salt environment, the zinc forms a protective layer of mainly zinc carbonate. After the protective film is formed, it resists attack by salt and other elements and ensures long-term corrosion protection.

In prescribed laboratory conditions detailed in the ASTM B-117, the zinc carbonate cannot form its protective film. The constant spray prevents exposure to the atmosphere which is critical in the formation of the zinc carbonate. Since the zinc carbonate is not formed, the salt spray interacts directly with the zinc metal. The part corrodes very quickly when the salt spray attacks the zinc metal.

When these results are observed, they often lead to a false conclusion as to the corrosion resistance and service life of zinc coatings in actual use. More meaningful accelerated atmospheric corrosion must

allow cycling of the metal surface condition through both wet and dry periods. A more realistic salt spray test is ASTM G-85, Standard Practice for Modified Salt Spray, (Fog) Testing. In particular, wet-dry cycles simulate the natural wetting and drying which occurs in the field.

This test uses the wet-dry salt spray test using solution of ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$ and sodium chloride. The test consists of cycles of one hour of fog followed by one hour of dry. The fog is performed at room temperature and the dry is a an elevated temperature, approximately 95 degrees Fahrenheit. The test should be run for at least 16 hours.

Wet-dry testing is recognized as providing a more realistic accelerated test but it must be used with an appropriate salt solution. The use of dilute mixed salt sprays, appropriately tailored to the environment of interest, reproduces the corrosion products and morphologies representative of natural corrosion on zinc and galvanized steel.

The inadequacy of salt spray tests is demonstrated in Table 1.

| TEST METHOD | MASS LOSS OF ZINC COATING (g/m ²) | |
|-------------------------------|---|---------------|
| | AT 600 HOURS | AT 1400 HOURS |
| 3% Salt Spray | 170 | >500 |
| 20% Salt Spray | 300 | >1000 |
| Synthetic Seawater Spray | 15 | 25 |
| Outdoor Weathering | | |
| 25 m from North Sea | 30 | 60 |
| 250 m from North Sea | 8 | 12 |
| Immersed in Stagnant Seawater | 50 | 100 |

This information was taken from *Corrosion Resistance of Zinc and Zinc Alloys*, Frank Porter.

When all the data is examined, all accelerated corrosion tests do not adequately show the corrosion behavior of zinc. If the wrong mechanism is accelerated by the testing method, then the test results cannot be used to predict the life of the part. The part should be compared to existing parts in the field which are in the same or similar environments. There is an abundance of exposure test information on zinc coatings available through the AGA, ASTM and ILZRO. Don't let any salt spray test results be used against you.