Comparison of Atmospheric Parameters on the Corrosion of Epoxy Coated 2024-T3 Al Alloy.

Leanne Petry[1], Douglas C. Hansen[1], Scott A. Hayes[1], Yuhchae Yoon[1] and Jeremy Angel[2]

[1]*University of Dayton Research Institute*
300 College Park
Dayton, OH 45469
[2]*Air Force Research Laboratories*
Wright-Patterson Air Force Base, Ohio 45433

Introduction

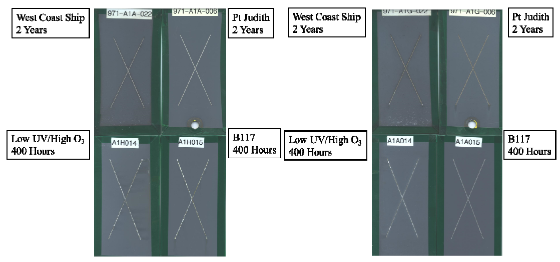
Modification of a standard cyclic corrosion test chamber by the incorporation of both ultraviolet (UVA) light and ozone (O_3) in addition to traditional ASTM B117 accelerated exposures were compared with field exposures of coated 2024-T3 test panels. These accelerated indoor (2000 hours) and long-term outdoor (2 years) exposures were compared to determine the atmospheric corrosion effects[1-4] of temperature, relative humidity (RH), ultraviolet light (UV), ozone (O_3), and salt on 2024-T3 aluminum alloy (AA) in different coating system configurations as a function of sample geometry.

Materials and Methods

There were six land-based exposure sites: Daytona Beach (FL), Pt. Judith (RI), Kirtland AFB (NM), Hickam AFB (HI), Tyndall AFB (FL) and Wright-Patterson AFB (OH). Additionally, there were two exposure sites situated on University-National Oceanographic Laboratory System (UNOLS) ships: the R/V Hugh R. Sharp that traversed the Atlantic Ocean based in Lewes, DE. (East Coast Ship) and the R/V Thomas G. Thompson that traversed the Pacific Ocean based in Seattle, WA (West Coast Ship). The flat 3" x 6" coated 2024-T3 AA panels and lap joint assemblies were installed on exposure racks at each exposure location and retrieved annually over a two year period for a total of eight sets of triplicate panels per exposure site (except for shipboard exposures). There were five separate coating systems for the flat panel configuration and only one coating system for the lap joint assembly deployed at each field location. The coated panels were scribed while the lab joints remained fully intact. For accelerated chamber exposures, the coating systems were down-selected and consisted of a fully chromated coating system, a magnesium rich primer, or a rare earth conversion coating. The modified chamber exposures and outdoor weather conditions at six exposure sites were monitored for temperature, RH, UV, and O_3. Weather monitoring stations containing temperature, RH, UV, and O_3 sensors were deployed at Pt. Judith (RI), Kirtland AFB (NM), Tyndall AFB (FL), Wright-Patterson AFB (OH) and both UNOLS ships. Upon receipt from the field sites, the surface of the scribed panels and interior faying surface of the lap joints were analyzed for chemical composition and morphology using a Zeiss EVO-50XVP environmental scanning electron microscope (ESEM) equipped with an EDAX Genesis 2000 energy dispersive spectroscopy (EDS) system.

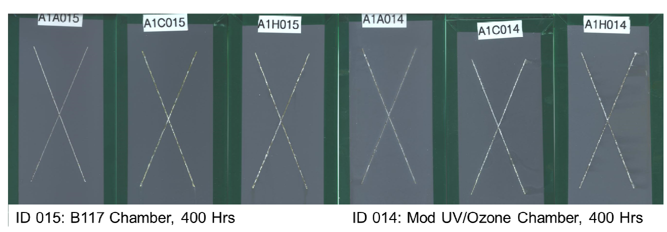
Results and Discussion

Despite daily weather patterns, positive correlations were found regarding temperature, UV, and O_3 concentration to each other while RH exhibited a negative trend with temperature, UV, and O_3 concentration. Locations under the fasteners and at mouth of the lap joints were comparable in not only elemental constituents found but also in their relative weight percent for both ship and land exposures, even in the presence of staining at the mouth of the lap. The corrosion protection properties of the coating systems based on the extent of corrosion of 2024-T3 AA was obtained by long duration outdoor field exposures and is presented in addition to the coated panel results from the modified accelerated lab test protocol (UV and O_3 incorporation) and a traditional ASTM B117 exposure (Figures 1 and 2). The modified exposure method was successful in accelerating the degradation of Department of Defense (DoD) coatings when subjected to the variable parameters noted in this study and can be used to predict performance in the most severe service environments in which the coating is used.

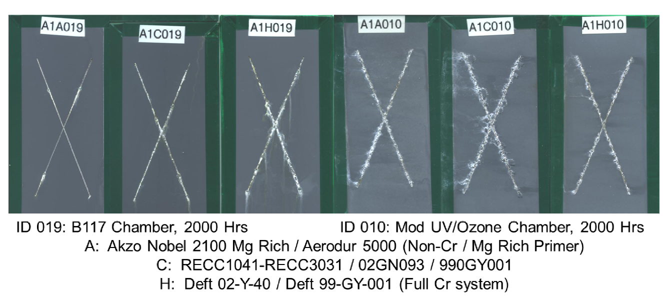


(a) **(b)**

Figure 1. **(a)** Fully loaded chromated system in either chamber is worse when compared to 2 year outdoor exposures even at shortest time intervals when scribe corrosion is compared to Pt Judith and West Coast Ship which were the most aggressive outdoor sites. **(b)** Mg rich system performed better in the outdoor exposure, except for short term accelerated exposures in chambers. After ~1200 hours everything in chambers is worse than 2 Year outdoor exposure.



(a)



(b)

Figure 2. Side-by-side chamber exposure comparison of coated AA2024-T3 panels at (a) 400 and (b) 2000 hours.

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