EFFECT OF ATMOSPHERIC ENVIRONMENTS ON THE ENVIRONMENT-ASSISTED CRACKING BEHAVIOR OF 5XXX-SERIES ALUMINUM ALLOYS

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Aluminum-magnesium (Al-Mg; 5xxx-series) alloys have been widely implemented in marine service environments due to their excellent combination of specific strength, weldability, and general corrosion resistance. The environmentally assisted cracking (EAC) behavior of these alloys have been extensively studied in saline environments utilizing an electrochemical potentiostat that allows for the direct potential control of a specimen exposed in full immersion. However, full immersion and potentiostat controlled conditions are not realistic for some in service applications which lack a potential controlling apparatus and complete (full) exposure to an electrolyte. For example, service environments will often experience intermittent salt spray, rain, and/or deliquescence caused by salt deposition and diurnal cycling of temperature/humidity. This study aimed to understand the environmentally assisted cracking (EAC) susceptibility of AA5083-H131 in atmospheric environments compared to the traditionally tested full immersion environment.

There are three primary ways that the atmospheric environments will differ from controlled laboratory environments: electrolyte geometry, electrolyte composition, and potential evolution. The effect of electrolyte geometry was explored by executing fracture mechanics experiments under (1) full immersion, (2) continuous misting, (3) controlled thin films, and (4) wicking of solution directly into the crack mouth. All conditions had a constant solution composition. The results illustrated a clear reduction in EAC susceptibility with decreasing solution volume. This was attributed to cathodic limitation of the dissolution process and subsequent retarding of the H-generation process. These findings were confirmed via monitoring of the OCP of the cathodic sites during the EAC testing using a novel Ag/AgCl electrode configuration. The impact of solution chemistry for a constant electrolyte geometry was explored in a similar manner and demonstrated the expected role of bulk chemistry on the EAC behavior, specifically, an enhanced susceptibility.

This work employs novel testing approaches to evaluate EAC of Al-Mg alloys in atmospheric environments and demonstrates how the governing anodic dissolution-enabled H-embrittlement mechanism is impacted to result in the distinct EAC behaviors for atmospheric environments. This work has important implications to informing simplified testing approaches to ensure proper laboratory characterization of the EAC behavior to enable rigorous extension to in-service performance.