An Analytical Modeling Method for Calculating the Current Delivery Capacity of a Thin-Film Cathode and the Stability of Localized Corrosion under Atmospheric Environments

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Corrosion resistant materials under atmospheric conditions can suffer from localized corrosion (*e.g.*, pitting, crevice, stress-corrosion cracking). The stability of such a localized corrosion site requires that the site (anode) must dissolve at a sufficiently high rate to maintain the critical chemistry and that it be coupled to a wetted surrounding area (cathode) that can provide a matching cathodic current. The objectives of this study were to computationally characterize the stability of such a local corrosion system and to explore the effects of physiochemical and electrochemical parameters. The overall goal of the work is to contribute to the establishment of a scientific basis for the prediction of the stabilization of localized attack. An analytical method is presented for evaluating the stability of localized corrosion of corrosion-resistant alloys under thin-layer (or atmospheric) conditions. The method requires input data that are either thermodynamic in nature or easily obtained experimentally. The maximum cathode current available depends on the cathode geometry, temperature, relative humidity, deposition density of salt (*i.e.*, mass of salt per unit area of cathode), and interfacial electrochemical kinetics. The anode demand depends on the crevice geometry, the position of attack within the crevice, and the localized corrosion stability product. The localized corrosion stability product, i*x, is the product of the current density at the localized corrosion site and the depth of that localized corrosion site. By coupling these two approaches for analysis of the current capacity of the cathode and the current demand of the anode, the stability of a crevice can be determined for a given environmental scenario. The method has been applied to the atmospheric localized corrosion of Type 316L stainless steel as well as Alloy C-22. The effects of the key parameters are described and compared.

Acknowledgements
Support by the Science & Technology Program of the Office of the Chief Scientist (OCS), Office of Civilian Radioactive Waste Management (OCRWM), U.S. Department of Energy (DOE), is gratefully acknowledged. The work was performed under the Corrosion and Materials Performance Cooperative, DOE Cooperative Agreement Number: DE-FC28-04RW12252. Samples of corroded Alloy 22 were provided by R. Rebak, Lawrence Livermore National Laboratory.