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Predicting Localized Pitting Corrosion on Austenitic Stainless Steels Utilized in Spent Nuclear Fuel Storage

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Austenitic stainless steels (SS), utilized extensively in the storage and transportation of spent nuclear fuel (SNF) in the United States, are potentially susceptible to localized corrosion and stress corrosion cracking (SCC) when exposed to chloride environments. The environment can result from the deposition of chloride-rich salts, which deliquesce over time as the canister cools. SNF installations at marine or near marine sites likely have a higher potential for localized corrosion and SCC to occur due to sea-salt aerosols, though inland SNF installations may still have chloride present through different sources. Assessing the current damage state on the surface of these canisters is difficult as high radiation levels dictate confinement within a limited access overpack. Hence, prediction of the surface pitting corrosion damage is beneficial to determining localized corrosion and SCC susceptibility. Recent work evaluating the maximum attainable localized corrosion pit size that can form could be the basis for those predictions.

Deliquescent brine compositions are constantly changing due to varying ambient relative humidity, ambient temperature, and surface temperature (due to the cooling of the SNF). This creates a wide parameter space to evaluate potential localized corrosion damage to the canisters. In order to inform upon localized corrosion damage, information regarding the anodic kinetics and parameters affecting the potential cathodic current supply (*i.e.* conductivity, brine layer thickness, cathodic reduction rates) are necessary. We have parametrized the maximum pit model to predict corrosion pit sizes as a function of surface relative humidity (from ~ 35 to 98 % RH) and temperature (20 – 75 ˚C), thus spanning electrolytes that vary from $MgCl_2$ rich to NaCl rich. In addition to the effects of varying environmental conditions, corrosion processes increase cathodic pH, potentially resulting in the precipitation of various hydroxide-containing Mg phases. The influence of these precipitates will be incorporated into modeling efforts. The results of this model are discussed in terms of potential canister degradation and pit to crack transitions.

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