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Long term, simulated marine diurnal exposure of Austenitic Stainless Steel at elevated temperatures

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Describe the purpose of this paper. What is the motivating factor for writing it? If the work addresses a new technology, please describe it (max 150 words). Note: This section is not required.

Atmospheric corrosion is a process responsible for over a trillion dollars a year in infrastructure damage and maintenance which impacts many industries. Austenitic stainless steels (SS), such as SS304 and SS316, are commonly known for their enhanced corrosion resistance but are susceptible to pitting and localized corrosion when exposed to atmospheric marine environments for long periods of time. Spent nuclear fuel (SNF) canisters for dry storage are located in independent spent fuel storage installations (ISFSIs). After loading and storage, SNF canisters passively cool with time. During this cooling process, due to dust deposition, concentrated brines can deliquesce when sea salt aerosols in the air adsorb to exposed surfaces. Such environments, especially in marine and near marine locations, may pose a risk for localized corrosion.

Please provide an abstract of your work. The abstract should be approximately 150 words, sufficient to convey what will be included in your work and presented at the conference. Please describe the experimental work, any results and your expected conclusions. Any justification or purpose for this work should be provided in the Background section.

For typical canister heat loads, deliquescent brines on the surface of the canisters are likely to be $MgCl_2$-dominated for the first 300 years of cooling, as conditions for NaCl deliquescence will not be observed. Also, as the surfaces cool, the diurnal conditions of the ambient environment can cause the relative humidity at the canister surface to fluctuate above and below the deliquescence for the deposited sea salts, causing the salts to dry and re-wet daily. During dry out, higher brine concentrations are achieved, and enhanced corrosion rates could occur. The goal of this study is to explore the effects of relevant cyclic diurnal atmospheric conditions on different SS materials and surface finishes.

Please describe how this paper will enhance the existing body of literature and advance the corrosion industry:

In order to evaluate relevant diurnal atmospheric conditions for SNF canisters, austenitic SS coupons of SS 304, 304H, and 316L were prepared with three surface finishes; coupons were mechanically polished to a #4 surface finish (equivalent to 120 grit SiC grind), ground to 600 grit SiC, and finished to a mirror polish. Artificial seawater was deposited on the coupons (300 $\mu g/cm^2$) through salt printing and exposed under cyclic atmospheric conditions, developed to mimic a those on a heated canister at potential marine ISFSI, for 1 week to 1 year. Post exposure analysis of the corroded surfaces and associated pits was performed via optical microscopy, optical profilometry (OP), and scanning electron microscopy (SEM). Additional analysis of the evolution of the surface brine was performed through ion chromatography (IC) measurements of remaining salts and corrosion products. The results of these cyclic conditions at longer exposure times provide insight into the influences of cyclic conditions, surface finish, and material composition on resultant corrosion.

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