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Introduction

A long-term-testing facility, the Integrated Corrosion Facility (I.C.F.), is being developed to investigate the corrosion behavior of candidate construction materials for high-level-radioactive waste packages for the potential repository at Yucca Mountain, Nevada. Corrosion phenomena will be characterized in environments considered possible under various scenarios of water contact with the waste packages. The testing of the materials will be conducted both in the liquid and high humidity vapor phases at 60 and 90°C. Three classes of materials with different degrees of corrosion resistance will be investigated in order to encompass the various design configurations of waste packages. The facility is expected to be in operation for a minimum of five years, and operation could be extended to longer times if warranted. A sufficient number of specimens will be emplaced in the test environments so that some can be removed and characterized periodically. The corrosion phenomena to be characterized are general, localized, galvanic, and stress corrosion cracking. The long-term data obtained from this study will be used in corrosion mechanism modeling, performance assessment, and waste package design.

Materials

A range of construction materials are being considered for the waste packages. The final design and materials of construction will be dependent on the performance of materials under repository-relevant conditions. A range of materials with varying degrees of corrosion resistance will be tested in order to consider materials that may be applicable to various waste package designs. Three classes of materials are under consideration [McCright, 1994]. The corrosion resistant materials are high-nickel alloys and titanium alloys; the corrosion allowance materials are low-alloy and carbon steels; and the intermediate corrosion resistant materials are copper-nickel alloys.

Alloy	UNS Number	Approximate Composition
Corrosion resistant:		
Alloy 825	N08825	42Ni-21Cr-3Mo-Fe(bal)
Alloy 825 hMo	N08221	42Ni-21Cr-6Mo-Fe(bal)
Alloy C-22	N06022	Ni-21Cr-13Mo-4Fe-3W
Alloy C-4	N06455	Ni-16Cr-14-17Mo-3Fe
Ti-Gr12	R53400	Ti-0.7Ni-0.3Mo
Ti-Gr16	none to date	Ti-0.05Pd-0.1Ru
Corrosion allowance:		
1020 Carbon Steel	G10200	Fe-0.2C-0.30-0.60Mn
Cast Steel	J02501	Fe-0.2C-1.2 max Mn
2.25Cr-1Mo	K21590	Fe-0.15C-0.4Mn-2.25Cr-1Mo
Intermediate resistant:		
Alloy 400	N04400	Ni-30Cu
CDA 715	C71500	Cu-30Ni

Materials will be tested in more than one metallurgical condition. In addition to the base material, welded specimens will be included in the testing matrix. When an examination of more than one welding technique is appropriate, specimens with different welding techniques will be included.

Test Environments

The test environments include four solutions and the vapor phases above these solutions. All testing will be performed at atmospheric pressure. The solutions are chosen to simulate the range of environments to which the materials may potentially be exposed. These are as follows: 1) simulated Well J-13 water, a low chloride, low sulfate well water that is thought to be typical of the vadose water in the repository horizon; 2) simulated concentrated Well J-13 water, with which solution concentrating effects such as evaporation and boiling are simulated; 3) low pH (pH 2 to pH 3) water to simulate the effect of possible microbial metabolic products; and 4) high pH (pH 11 to pH 12) water to simulate the effect of contact with cementitious materials used for constructing the repository.

Testing in the high relative humidity vapor phases will be performed in order to characterize the corrosion that is expected to occur on materials which are covered with thin water layers. Previous studies have shown that thin water layers can cause accelerated corrosion of materials under the appropriate conditions [Graedel, 1986].

Testing will be performed at 60 and 90°C to be representative of the range of temperatures where flowing liquid water or condensation water may come into contact with the waste packages.

Test Facility

The test facility will consist of a set of test vessels that will maintain specific values of the test parameters (environment and temperature). Individual test cells will contain specimens grouped by corrosion resistance classification. Parameters to be monitored and controlled are temperature, oxygen concentration, pH, solution composition, and relative humidity.

The test vessels are designed to allow periodic removal of sets of specimens with minimal disturbance of the remaining specimens in the vessel. After removal, the specimens will be characterized with respect to the corrosion which has occurred and the pattern of corrosion attack. A decision will be made after characterization whether to reintroduce the specimens into the test vessel.

Test Specimens

Specimens will be tested in order to obtain information on general corrosion, localized corrosion (e.g. intergranular, pitting, and crevice corrosion), galvanic corrosion, and stress corrosion cracking. Flat coupons will be used for general and pitting corrosion characterization. Crevice corrosion specimens will be made of "same material" metal plates and or metal and teflon plates bolted together. The galvanic couple specimens will be constructed to mimic the waste package design.

To study the stress corrosion cracking susceptibility of the materials, C-ring specimens have been chosen as the most appropriate for this study.
The C -ring specimen can be stressed to a level relevant to the package design and is of the appropriate size for sampling the plate thickness of interest. The relatively compact size of the C-ring specimen makes it well suited for sampling in different areas of a welded plate where significant metallurgical changes can occur.

References

R.D. McCright, "Updated Candidate List for Engineered Barrier Materials," to be published as a UCID report [in press] .

T.E. Graedel, R.McGill, "Degradation of Materials in the Atmosphere," Environmental Science and Technology, 20 (1986), pp 1093-1100.

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