

Abstract for NACE Res in Progress, March 2006

Modeling of Crevice Corrosion Stability and Stifling

F. J. Preseul-Moreno, R. G. Kelly
Center for Electrochemical Science and Engineering
Department of Materials Science and Engineering
University of Virginia
Charlottesville, VA 22904

Damage of structural significance from crevice corrosion of corrosion resistant alloys requires that at least a portion of the creviced area remain active. Stifling results when the aggressive chemistry required inside the crevice to keep the material depassivated, i.e. actively corroding, cannot be maintained. This loss of critical chemistry occurs when the rate of mass transport out of the crevice exceeds the rate of dissolution and subsequent hydrolysis of metal ions inside the crevice. For the treatment considered here, the mass transport conditions are constant for a given geometry and potential. What then controls the stability of the internal chemistry is the interaction between the electrochemical kinetics at the interface and the crevice chemistry composition. This work focuses on the parameters that control the stability of crevice corrosion by modeling the evolution of the chemical and electrochemical conditions within a crevice in which the entire crevice is initially filled with the Critical Chemistry Solution (CCS). The crevice mouth is in contact with a near neutral solution that provides the boundary conditions at this side of the crevice. The material selected was 316SS because kinetics at the low pH values of interest are available in the literature. The effects of the presence of a cathodic reaction within the crevice were studied as well as those due to the effects of high ionic strength on pH and conductivity. Stifling was observed for cases in which hydrogen evolution was allowed inside of the crevice. In addition, the importance of the increase in the activity coefficient for hydronium ion with high ionic strengths is shown to be critical for stabilizing crevices of stainless steel.

Acknowledgements

This work was supported by the Office of Science and Technology and International of the United States Department of Energy (DOE) and carried out as part of the DOE Multi-University Corrosion Cooperative under Cooperative Agreement DE-FC28-04RW12252. The funding agency is gratefully acknowledged.