Carnegie Mellon
Materials Science and Engineering Seminar Series

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"Prevention of Corrosion and Cracking of Steel Tanks for Liquid High Level Radioactive Waste"

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10AM Seminar in Baker Hall 136A

At the United Sates Department of Energy's Hanford tank reservation, approximately 50 million gallons of liquid radioactive waste from cold war weapons production is stored in 177 underground storage tanks. Prior to permanent disposal in a geologic site, the waste will be vitrified into glass logs. However, the double shelled carbon steel storage tanks now used for storage will continue in operation until the vitrification plant construction is finalized and waste processing operations completed, which could be still several decades. It is essential that tank leak integrity be assured through control of corrosion and cracking. The wastes are generally highly alkaline, from pH 10 to hydroxide concentrations in excess of 6 M. The steel is passive in these environments, but is susceptible to localized corrosion and stress corrosion cracking because of the generally high nitrate concentrations and elevated temperatures. Maintaining the pH above the specification of 13 requires addition of considerable amounts of hydroxide to balance the neutralizing effects of CO_2 from the atmosphere. These additions have deleterious influences on the vitrification process. On the other hand, nitrite ion, which is present to varying extents in the wastes, is known to be a potent inhibitor for corrosion and cracking in nitrate environments.

In this work, an experimental study was performed to investigate the ranges of susceptibility to localized corrosion and stress corrosion cracking as a function of potential and tank chemistry. Potential and nitrite ion concentration were shown to have a dominant influence, with pH in the range of 10-14 being less important. These results have led to the development of new approaches to control corrosion through tank chemistry. Two other issues must be addressed when considering a change in the tank chemistry specifications: atmospheric corrosion of the tank above the liquid and attack at the liquid/air interface (waterline attack). Both phenomena have been observed and result from local differences in chemistry relative to the bulk liquid composition. The liquid/air interface has been probed by Raman spectroscopy, which shows that key compositional differences can develop with time.

Gerald S. Frankel is the DNV Chair, Professor of Materials Science and Engineering, and Director of the Fontana Corrosion Center at the Ohio State University. He earned the Sc.B. degree in Materials Science Engineering from Brown University and the Sc.D. degree in Materials Science and Engineering from MIT. Prior to joining OSU, he was a post doctoral researcher at the Swiss Federal Technical Institute in Zurich and then a Research Staff Member at the IBM Watson Research Center in Yorktown Heights, NY. His primary research interests are in the passivation and localized corrosion of metals and alloys, corrosion inhibition, and protective coatings. He is past chairman of the Corrosion Division of The Electrochemical Society, past chairman of the Research Committee of NACE, and a member of the editorial board of the journals *Corrosion*, *Materials and Corrosion*, and *Corrosion Reviews*. Frankel is a fellow of NACE International, The Electrochemical Society, and ASM International. He received the OSU Distinguished Scholar Award in 2010, the Alexander von Humboldt Foundation Research Award for Senior US Scientists in 2004, the 2010 ECS Corrosion Division H.H. Uhlig Award, the 2007 TP Hoar Prize from the UK Institute of Corrosion, the 2000 Uhlig Award from NACE, and the Harrison Faculty Award from the OSU College of Engineering in 2000. He was on sabbatical at the Max Planck Institute for Iron Research in Dusseldorf in 2005 and a visiting professor at the University of Paris in 2008. In 2009 he was named adjunct professor, Pohang Institute of Science and Technology, Graduate Institute of Ferrous Technology, Pohang, Korea.