CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Materials Week '94. International Symposium on Localized Dissolution and Corrosion. Thick Walled Vessels for Radioactive Waste Containment. 20-5704-041

DATE/PLACE: October 3-6, 1994
Rosemont, IL

AUTHOR(S): Darrell S. Dunn

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PERSONS PRESENT: Darrell S. Dunn (CNWRA)
Charles Interrante (NRC)

BACKGROUND AND PURPOSE OF TRIP:

To present paper entitled, "Relationship Between External Potential and Chemistry Inside Crevices of Type 304L Stainless Steel and Alloy 825" at the International Symposium on Localized Dissolution and Corrosion. Attend Thick-Walled Vessels for Radioactive Waste Containment Sessions. Attendance in these two sessions ranged from 20 to 40, and the overall attendance was approximately 2,000.

SUMMARY OF PERTINENT POINTS:

Presentations in the Localized Dissolution and Corrosion symposium covered a wide range of topics and materials. Following a brief nostalgic review of pitting corrosion investigations over the last 30 yr by M.B. Ives from McMaster University, the symposium started Monday afternoon with presentations addressing the chemical and electrochemical etching of solids.

The Tuesday morning session on passivity and its breakdown was compromised by the cancellation of two papers on the repassivation and corrosion resistance of molybdenum containing alloys. A comparison of the High Field Model and the Point Defect Model of passive film growth was made by E. Sikora from Pennsylvania State University. It was shown that the Point Defect Model could predict both the passive film growth and thinning on tungsten. The predictions of the model compared very well with experimental investigations. Without some modifications, the High Field Model was unable to make these predictions.

The Tuesday afternoon session included papers on the stability and growth of localized corrosion. A paper by H.H. Strehblow from the Inst. fur Physikalische Chemie und Electrochemie in Dusseldorf, Germany, addressed mechanistic aspects of localized corrosion on pure metals. The initiation of localized corrosion was shown to be a result of either film breaking, which is possible when there are significant stresses in

the film, or by thinning of the passive film. The efficacy of halides in promoting localized corrosion was stated to be due to the stable complexes of iron or chromium that can be formed with chloride. A paper on pit dissolution kinetics by N.J. Laylock and R.C. Newman from UMIST, Corrosion and Protection Centre, Manchester, U.K., presented the results of research aimed at determining when active pits are covered with a salt film. From experimental data using artificial pits, a transition potential was defined. Verification of the transition potential, which marks the transition between metastable pitting in the absence of a salt film and the growth of stable pits with a salt film, was conducted using a potential step technique with 304 Stainless Steel (SS) in 1 molar chloride. The onset of salt precipitation corresponds to an increase in pit nucleation rate. A paper on passive film properties by B. Baroux presented several possible explanations on the ageing of passive films including film thickening, film modification, chromium enrichment and inclusion passivation.

Several measurement techniques were presented in the Thursday morning session including a paper on the use of electrochemical noise for evaluation the localized corrosion of SS by J.L. Luo and M.B. Ives from McMaster University. The presentation covered the use of the power spectral density method to analyze localized corrosion of SS in sea water.

The Thick-Walled Vessels for Radioactive Waste Containment sessions were held Wednesday. The first session, covering fabrication processes and materials, was opened by D. Stahl of B&W Fuel Company, Las Vegas, NV. His presentation covered some of the design requirements for thick walled corrosion allowance and corrosion resistant materials as well as a partial list of the alloys that are presently being considered. The Multi-Purpose Canister (MPC) was presented as being constructed of 316L SS. For disposal, an overpack having a carbon steel outer barrier approximately 200 mm thick and a clad corrosion resistant inner barrier (possibly alloy 825) approximately 20 mm thick was proposed. An alternate design may be developed for a cold repository. Iron shot may be used as an optional filler material at the repository site. Filler materials are assumed to provide mechanical stability, critically control, and chemical buffering. It is anticipated that remote operations will be required to weld, inspect and, if necessary, repair the closure weld. Currently, there are no plans for internal inspections after closure. The list of materials for the thin walled Site Characterization Plan (SCP) design was stated to be a good starting point but some additional corrosion resistant materials were mentioned in this, as well as other, presentations, including C-4 and Ti Grade 12. Performance prediction with corrosion resistant materials was said to be difficult as the corrosion resistance was itself not predictable. While the exact method of container construction is not fixed at this time, it is anticipated that clad cylinders will be welded using either a narrow gap weld or an electron beam weld.

The effects of water vapor on the corrosion of copper and iron was presented by G.E. Gdowski from Lawrence Livermore National Laboratory (LLNL). The oxidation rate of copper has previously been shown to decrease in moist air at temperatures below 470 °C. However the periodic wetting or spraying resulted in much higher corrosion rates. This was observed in some early tests conducted at LLNL. In addition to presenting results of experimental investigations, some background material and possible candidate materials were listed. Corrosion resistant materials included C-4, C-22, Ti grade 12, Ti grade 16, and 825 hMo (Nicrofer 4221 hMo) a high Mo version of alloy 825. Moderately corrosion resistant materials included alloy 400 and CDA 715 and corrosion allowance materials of interest were A27 cast steel, A516 (1020 steel), and A387 (2.25%Cr-1%Mo).

The following two presentations were focused on casting container components. The centrifugal casting of corrosion allowance and corrosion resistant materials was presented by P. Enders of Wisconsin Centrifugal in Waukesha, WI. One key point of this technique is that the directional solidification of the

casting from the outside diameter to the inside diameter results in most of the casting impurities collecting near the inside diameter. If no inner material is subsequently cast inside the outer material, the bore can be machined which removes the near surface casting impurities. However, for double wall castings this machining step is not performed prior to the casting of the inner material.

The development and the preliminary design of a steel supported titanium shell container for the disposal of fuel from CANDU reactors was presented by B. Teper from Ontario Hydro Technologies in Toronto, Canada. The containers will hold 72 CANDU fuel bundles and are tentatively designed with a 30 to 50 mm steel inner shell and a 6.5 mm titanium outer shell. The temperature repository in the Canadian shield is expected to be less than 100 °C. The author noted that titanium is susceptible to crevice corrosion at temperatures above 100 °C.

The Wednesday afternoon session of the focused on the closure and nondestructive inspection of thick walled vessels. E.S. Robitz Jr. from Babcock and Wilcox Alliance Research Center in Alliance, OH indicated that the closure of the thick-walled vessels could take up to 18 hours for 4 inch thick carbon steel and require as many as 30 passes to complete. Electron beam and laser welding were also addressed in this session. Results from welding investigations conducted at The Welding Institute in Cambridge, U.K. were presented by C. Punshon. Electron beam welding of carbon steel and copper up to 50 mm thick were possible in a reduced pressure chamber. D.G. Atteridge from the Oregon Graduate Institute in Portland, OR presented material on the electroslag welding and electroslag cladding of carbon steel. Electroslag welding can be used to weld sections up to 16 inch thick. Typically, there is up to 50 percent base metal dissolution in the weld region and 8 percent dissolution when cladding. The weld takes many hours to complete and the heat affected zone has large grains.

IMPRESSION/CONCLUSIONS:

The paper presented by the author in the localized dissolution and corrosion symposium was one of only a very few papers directly related to localized corrosion of candidate container materials. Several authors in the Thick-Walled Vessels for Radioactive Waste Containment sessions indicated that corrosion investigations were planned. Most of the presentations were focused at the formation and closure of a variety of candidate materials. The detrimental effects of the closure methods on the container materials went largely unaddressed. Some of the welding processes presented will subject the disposal overpacks and possibly the MPC to high temperatures for many hours. The thermal stability of the material must be investigated under these conditions. Thicker sections may provide additional corrosion allowance but it will also take additional heat input to close by welding. In addition, very little information was presented on the stresses induced by the closure methods, or the nondestructive inspection of the closure weld.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

None

RECOMMENDATIONS:

None

REFERENCES:

The conference program with abstracts is available with the author.

SIGNATURES:

Darrell S. Dunn
Research Engineer

10/19/94
Date

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