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CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 1998 Gordon Research Conference on Localized Corrosion
Charge No. 20-1402-158

DATE/PLACE: July 5-10, 1998
Colby-Sawyer College, New London, NH

AUTHORS: Narasi Sridhar and Sean Brossia

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AUTHORS: Narasi Sridhar and Sean Brossia

PERSONS PRESENT: Attendance list attached

BACKGROUND AND PURPOSE OF TRIP:

The conference was attended as part of a staff professional development course/meeting. The objective of the Gordon Research conferences are to promote free exchange of the latest knowledge in chosen areas of specialization. The aqueous corrosion conference is held every two years. In the last two conferences, in addition to invited presentations on fundamental advances in corrosion, a large number of posters have been presented adding to the breadth of knowledge presented at these meetings.

SUMMARY OF PERTINENT POINTS:

The conference program is attached. Gordon conference rules do not permit publication of formal proceedings. For the second time, there were as many as 60 posters presented throughout the five days of the conference which enhanced the technical content of the conference considerably. The presentations provided a good balance between application and mechanism oriented topics.

The conference started with two presentations related to nuclear power generation. The first by Peter Andresen of General Electric (GE) attempted to give a comprehensive summary of studies conducted by GE on stress corrosion cracking of steels and stainless steels in high temperature water. The presenter emphasized two points: (i) the crack growth rate data showed large scatter that challenged analysis and (ii) the crack tip potential and crack tip chemistry played important roles in determining crack growth rate. The effect of noble metal additions which increase the cathodic kinetics in the crack tip region and introduction of oxygen into the crack tip on reducing crack growth rate were cited as evidence for the importance of crack tip chemistry. Dr. Andresen also indicated that threshold stress intensities were not observed in their testing and that this is a function of the resolution limit of crack growth measurement. The models for waste package performance assessment were reviewed by David Shoesmith, formerly of Atomic Energy Canada Limited (AECL) and presently at the University of Western Ontario. He focused mainly on the waste package models relevant to the Canadian program with secondary discussion of the U.S. (only DOE results), Swedish, and Swiss programs. In the limited time available, he chose to devote most of his presentation to an overview of the different approaches in the various programs, thus leaving the impression that the models lacked sound mechanistic bases.

The differences in the electrochemical characteristics of different metallurgical phases were examined by Gerry Frankel (Ohio State University) using the Atomic Force Microscope (AFM) in a non-contact mode. This technique essentially measures the difference in volta potential in different phases in dry air and may be useful in identifying intermetallic particles at the surface of an alloy (e.g., Al alloys used in aircraft applications). The resolution limit is about 5 to 10 μm .

Ivan Cole [Central Scientific and Industrial Research Organization (CSIRO), Australia] discussed the long-term atmospheric corrosion test results and their relationship to world-wide climatic changes. He noted the highly complex role of pollutants on corrosion in marine environments. The effect of aluminum hydroxy carbonate gel formation on increasing the corrosion rate was noted. Reliability of electronic components in military systems was discussed by Jeff Braithwaite (Sandia National Laboratory). While the models he proposed were not particularly sophisticated, of interest was the availability of a web site where failure models can be incorporated in a reliability analysis framework. The reliability tool, called Cassandra eXoskeleton (CRAX) is a CORBA compliant interface that provides various probabilistic drivers which can interface with any deterministic model supplied by the user. The tool is available at <http://reliability.sandia.gov/crax>.

The investigations of passive film on iron using X-ray Absorption Near Edge Spectroscopy (XANES) was presented by Sanna Virtanen. Among a variety of interesting results, she showed that the passive film composition in borate behaves differently from that in phosphate buffer. Her presentation elicited numerous comments and criticism. The main criticism was that her presentation focused on one line of investigation and failed to provide sufficient background information on results of other previous studies. Other comments included lack of mention of other film properties including the degree of crystallinity, semiconductive nature, and the potential distribution inside the film as well as the blocking effect of phosphate and the incorporation of borate or phosphate in the film. An interesting presentation of microsensors using porous silicon as a method to capture species to be analyzed was presented by Walter Schulze (Heinrich Heine University).

A new electrochemical spectroscopy technique called electrohydrodynamic impedance was discussed by Mark Orazem (University of Florida). The technique involves modulation of rotation speed of an electrode while maintaining constant current or constant potential. The changes in potential (at constant current) or current (at constant potential) due to changes in velocity are then measured. The technique can separate out the various transport controlled reactions from surface blocking reactions, whereas the conventional stationary impedance technique cannot distinguish between various transport processes. However, the technique is new and has not been completely analyzed. The various flow regimes in a three-phase mixture of gas, water, and oil were described by Paul Jepson (Ohio University). He made the point that slug flow conditions are extremely detrimental to pipelines because of the impingement effect of gas bubbles and the resultant ineffectiveness of corrosion inhibitors.

The fundamental bases for electrochemical noise measurements were described very thoroughly by Francois Huet (University of Paris). His discussion provided a sound background of the technique for both the novice and moderately experienced users. Rob Kelly (University of Virginia) discussed various mechanistic models of crevice corrosion and presented the results generated by his laboratory over the last several years on the role of ohmic potential drop and chemistry change in initiating crevice corrosion. He emphasized the role of cathodic reactions inside the crevice in mitigating crevice acidification. Martin Straatman (Friedrich-Alexander University) presented a wide ranging discussion of the mechanism of corrosion of coated metal and the development of ordered monolayers for corrosion protection. However, it appears that despite considerable scientific understanding of the processes leading to the formation of

organized monolayers and corrosion of metals under these coatings, economically viable coating systems are far from commercialization at present. Nevertheless, these types of coatings may potentially help replace environmentally sensitive chromate coatings.

Christofer Leygraf (Royal Institute of Technology, Sweden) presented a new avenue of study in Sweden related to the environmental pollution due to dissolved metals from architectural components. Specifically, the Swedish government is concerned about copper, lead, and zinc corrosion from centuries old buildings in Sweden and the resultant toxic side effects. Leygraf presented some preliminary bounding calculations of the release and associated health risks of these cations suggesting that these may not be significant.

The last session was composed of a panel discussion of the flavor and nature of corrosion research in the next century involving Koji Hashimoto (Tohoku University), Jerry Kruger (Johns Hopkins University), Alison Davenport (University of Manchester), Martin Kendig (Rockwell International Science Center) and Roger Newman (University of Manchester Institute of Technology). The panel members each gave a short presentation of the issues that they see facing corrosion science and technology. Nearly all of the panelists viewed the application of new analytical techniques and electrochemical tools to corrosion issues as critical to the future of this area. The panelists also felt that reliability assessment, life prediction, and computer modeling were going to play an even more important role in corrosion research in the future for the application of corrosion science to corrosion engineering problems.

IMPRESSIONS AND CONCLUSIONS:

The question that was asked at the beginning of the conference was whether important new developments are taking place in aqueous corrosion to warrant holding Gordon Research conferences. The presentations indicated that important developments are taking place, although they are incremental in nature. The discussions among conference attendees reinforced the need to apply fundamental, mechanistically-oriented research towards predictive modeling, an area of much interest to CNWRA and the NRC. The conference provided a venue for formal and informal exchange of information and many of the chosen topics were of interest to the CNWRA staff for NRC related work. In addition to the oral sessions, the posters shed further light on the various research directions throughout the world in corrosion. For the first time in Gordon Conference history, there were representatives from Russia, India, and the Peoples Republic of China enhancing the breadth of experience represented at the conference.

PROBLEMS ENCOUNTERED:

None.


PENDING ACTIONS:

A number of areas for internal research and development focused towards NRC HLW program and work for others were identified. These will be discussed with other members of CNWRA for future proposals.

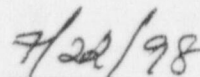
RECOMMENDATIONS:

The NRC and CNWRA should continue attending the Gordon Research conference on this subject.

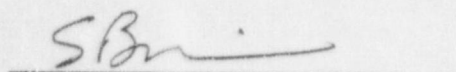
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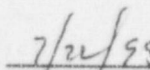
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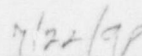


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