

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 15th International Corrosion Congress
20.06002.01.081, AI 01402.571.033

DATE/PLACE: September 21–29, 2002
Granada, Spain

AUTHOR: G.A. Cragolino

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PERSONS PRESENT:

The conference was attended by more than 500 participants from all over the world with a high proportion of European and Latin-American attendees.

BACKGROUND AND PURPOSE OF TRIP:

The purpose of the trip was to attend and present a paper in the 15th International Corrosion Congress. The Congress is the main event organized every 3 years by the International Corrosion Council, an international body composed of corrosion experts representing more than 70 countries.

SUMMARY OF PERTINENT POINTS:

The technical program included 5 plenary lectures in 5 main areas. Two of these lectures included different aspects of passivity. Keynote speakers covered 27 different topics on corrosion science and engineering introducing sessions in which approximately 250 papers were presented orally. A poster session covering the same topics had around 200 posters.

M. Seto (Hokaido University, Japan) discussed in one of the plenary lectures mechanical properties of passive films formed on iron and titanium. He described the tensile and compressive stresses that developed in passive films as a result of changes in potential. Stresses were measured with a laser optical method using a thin piece of glass sputtered with the metal of interest as a bending beam. Tensile stresses developed in the prepassive state on iron surfaces but changed to compressive stresses with increasing potential, presumably associated with the dehydration of the oxide film. In the case of titanium the changes from tensile to compressive stresses were attributed to hydrogen absorption at cathodic potentials followed by removal from the passive film at anodic potentials. The effect of electrostriction in the development of compressive stresses was considered negligible. The development of compressive stresses was attributed mostly to the increase in the specific volume of the oxide film with respect to the metal substrate. Although interesting from the fundamental point of view, no consideration was given to the influence of long-term aging of passive films.

C. D'Alkaine (Sao Carlos Federal University, Brazil). D'Alkaine discussed passivation transients in terms of models to explain active/passive transitions and growth of continuous films. This was a very fundamental presentation, in which basic concepts of electrochemistry and corrosion were discussed. Some ideas based on the theory of dynamic systems may be considered to attain a better understanding of conditions leading to the instability of passive films.

The sessions of particular interest to the NRC high-level waste program included (i) Nuclear Waste Storage and Disposal, as part of the topic of Corrosion and Protection in Power Generating Systems, in which a session on Corrosion in Nuclear Plants was also held; (ii) Localized Corrosion and Passivity; (iii) Stress corrosion Cracking and Fatigue; (iv) Microbial Corrosion and its Prevention; (v) Indoor Atmospheric Corrosion; (vi) Electrochemical Techniques; (vii) New Emerging (nonelectrochemical) Techniques; and (viii) Corrosion and Protection of Cultural Heritage.

The first of the sessions listed above was initiated by a keynote lecture by A. Pourbaix (CEBELCOR, Belgium) titled "Life prediction for nuclear waste storage corrosion issues" in which the main corrosion issues confronted in the various repository designs that are currently being pursued in the world were discussed. Pourbaix paid particular attention to the proposed repository and waste package design for Yucca Mountain and supported the concept of the repassivation potential for localized corrosion as a valid criterion to define the boundary between passivity and accelerated, localized corrosion.

Madina (ISESMAT, Spain) presented a paper on corrosion of carbon steel, Type 316 L stainless steel, copper and Cu-30Ni alloy in saturated bentonite. The main observation was the corrosion of carbon steel specimens with the formation of siderite whereas the other materials did not exhibit signs of corrosion after more than a year of exposure.

The author of this report presented a paper titled "Lifetime prediction of high-level radioactive waste containers affected by corrosion." In this paper the approach adopted in the development of the EBSFAIL module of the TPA code to predict failure as a result of corrosion processes is described. It is shown that for certain environmental conditions localized corrosion of Alloy 22 may occur for a limited number of containers. Data from industrial experience is used in support of the repassivation potential concept. Unfortunately, a paper by R. Rebak and R.D. McCright (Lawrence Livermore National Laboratory, USA) on corrosion of Alloy 22 was cancelled. Nevertheless, the time available in the session due to this cancellation, permitted an interesting discussion of our paper with many questions regarding stability of passive film and modeling, measurements of corrosion rates by electrochemical methods, and validity of long-term (thousand of years) life estimates. In the discussion it was clarified by Pourbaix that for materials in which corrosion is controlled kinetically by a passive film, the protection potential (the term he uses instead of the repassivation potential) is not a thermodynamically defined quantity but depends on the corrosion potential of the crevice environment, and hence, on the balance between anodic and cathodic currents. T. Burnstein (University of Cambridge, United Kingdom) raised interesting questions regarding the measurement of passive current densities. This session was well attended with about 60 people.

The session on Corrosion in Nuclear Plants was initiated with a presentation from D. Feron (France). It was essentially a review of problems of corrosion and the effect of radiolysis in light water reactors. He emphasized the importance of having a solid knowledge on the water chemistry and its variation during the fuel cycle and the whole operation of a plant to control several corrosion phenomena that have affected the output of the plants. Some discussion regarding activation control as related to corrosion and transport of corrosion products was also included in his presentation.

T. Burnstein (University of Cambridge, United Kingdom) was the keynote speaker in the session on Localized Corrosion and Passivity. In his lecture the generation of metastable pits as precursor to stable pit growth was discussed. Potentiostatic instrumentation, as well as ancillary equipment designed to measure current transients in the range of the pico-Amperes, was described to demonstrate that the transients related to passivity breakdown are similar to those produced by particle impingement on passive films formed on stainless steels and titanium. Burnstein's presentation offered certain controversial aspects related to the postulation of chloride as an anion that can penetrate and migrate through a stable passive film, an assumption that has been questioned by many authors, initiating a depassivation event at the metal/film interface based in specific volume considerations. In the same session, R. Oltra (France) presented a paper discussing the effect of residual stresses on the conductivity of passive films on stainless steels. He concluded that the semiconductive properties of passive film formed under tensile stresses, as measured by impedance and analyzed using the Mott-Schottky approach, reveal a higher concentration of vacancies than those films formed in the absence of stress. T. Hakkarainen (Finland) described the effect of heat tinted areas produced by welding on the susceptibility to pitting of stainless steels. The studies were conducted in low concentration chloride solutions with and without the addition of sulfate or thiosulfate. The detrimental effect of heat tinted areas on the pitting of Type 304 stainless steel was well discussed.

The session on stress corrosion cracking was initiated with a keynote lecture by J.R. Galvele (Argentina). Galvele made a incisive presentation, questioning the advances in the mechanistic understanding of stress corrosion cracking of metal as compared to that of glasses. He emphasized the importance of quantitative modeling leading to verification of the assumptions through appropriate measurements of critical parameters such as crack growth rate and its dependence on variables such as temperature, potential, and concentration of specific species, as well as the influence of alloying elements. All this discussion set the stage for the presentation of results, mostly using noble metal alloys as a model systems, in support of his surface mobility model of stress corrosion cracking. A final note was his insistence on the need of developing tools to analyze what happens at the crack tip, not only in the solution but specially in the metal. Several papers were presented in the course of the session on stress corrosion cracking. The role of molybdenum and nitrogen as alloying elements in the stress corrosion cracking of austenitic stainless steels in chloride solution was the subject of a paper by Petterson and Linder (Sweden). Also the effect of lead as aqueous impurity on the stress corrosion cracking of austenitic stainless steel was evaluated by electrochemical noise by the results, regarding the sensitivity, were not conclusive.

M. Stratmann (Germany) gave a very interesting keynote lecture on advanced electrochemical techniques. He discussed the process of miniaturization of electrochemical set-ups by using scanning droplet cells or sealed glass capillaries. The purpose in this case is to gain new insights in processes taking place at grain boundaries or affected by grain orientation or texture.

His presentation also included a review of scanning electrodes techniques which are used to map local electrode potential or local current distributions, such as the scanning vibrating reference electrode. Finally he discussed results obtained under atmospheric corrosion conditions with the scanning Kelvin probe and more recently with the Scanning Kelvin probe Force Microscope (SKPFM). The last instrument is being used to study deadhesion of very thin coatings on aluminum alloys. Stratmann's presentation was followed by several papers in which these techniques were applied to specific problems.

The session on Corrosion and Protection of Cultural Heritage was initiated with a keynote lecture by E. Angelini (Italy). A good review on the preservation of artifacts against corrosion was presented, with particular emphasis in the use of electrochemical and surface analysis techniques to study and detect counterfeit coins and artifacts.

The conference provided an opportunity to interact with other scientists to discuss issues related to life prediction methodologies, new techniques and experimental methods, as well as new theoretical insights on environmentally assisted cracking, localized corrosion and passivity. Unfortunately, since eight sessions were taking place simultaneously, it was impossible to attend the presentation of some interesting papers on advanced techniques for corrosion research. Specific discussions were maintained with investigators working in repository programs of Belgium, Spain, and France.

IMPRESSION/CONCLUSIONS:

The conference was attended mostly by members of the academia and research laboratories from many countries. There were few representatives from the industry and the exhibit included mostly booths of manufacturers and suppliers of instruments and laboratory equipments, as well as publishers.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

It would be useful to examine in detail the conference proceedings because many interesting papers were presented in the poster session, but it was impossible to examine most of them.

REFERENCES:

A program of the conference and a CD-ROM with the papers are available from the author of this report. The proceedings of the conference will be published in a printed edition of several volumes.

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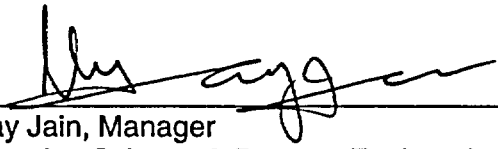
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