Overview

The increasing demands being placed on structures and equipment have led to the requirement to use a mix of materials to obtain the desired performance. Galvanic corrosion is the unfortunate result in many cases. The first Special Technical Publication (STP) containing much galvanic corrosion information was published by ASTM in 1976. Since then, significant progress has been made in the field, particularly in computer prediction and testing for galvanic corrosion, but also in describing the latest computer and testing techniques and summarizing how galvanic corrosion affects various industries. This symposium was held on 3-4 Nov. 1986 in Phoenix, AZ. Most of the papers presented there are included in this volume.

The papers are organized into a format typical of a manual on the subject. Many of the papers are tutorial in nature, starting with the basics and proceeding to the level of detail necessary for full understanding of the subject. The first paper on the electrochemical theory of galvanic corrosion, by Oldfield, is designed to start at an introductory level and build to the most recent developments in electrochemical theory. This is a good introduction for any reader, regardless of background. More specialized theory relating to corrosion products and hydrogen embrittlement follow in the papers by Wilhelm et al. and by Pollock and Hinton. The use of semiconductor theory from solid-state physics to describe the interaction of corrosion products with the base alloy is a new and exciting development in the field. Hydrogen embrittlement is often overlooked as a form of galvanic corrosion, since it occurs on the cathode, but increases in importance as the quest for higher strength materials leads to the use of more hydrogen-sensitive alloys in structures.

Typically, galvanic prediction has been based on the use of galvanic series, galvanic compatibility tables, or on short-term polarization curves. The next set of papers describes newer and better techniques for galvanic corrosion prediction based on the use of computers and long-term data. Calculational techniques are discussed first by Astley. These techniques solve the equations of electrical continuity throughout the electrolyte by making assumptions about the geometry and boundary conditions to reduce the problem to a form that is sufficiently simple to be solved directly, or by the use of relatively fast computer routines. This is an extremely valuable technique for specific types of galvanic corrosion problems. For more general analyses, discretization techniques, including finite element analysis, are extremely valuable for making galvanic corrosion predictions. The theory and application of finite element analysis and boundary element analysis are discussed in the papers by Fu and by Adey and Niku. Finally the paper by Scully and Hack ties together the use of finite element analysis and the use of long-term data to show how these techniques work in a real application, that of a heat exchanger configuration.

Testing and preventative techniques make up the next set of papers. Wright and Doyle discuss a standard test technique called the CLIMAT or wire-on-bolt test for galvanic corrosion in the atmosphere. The importance of the interface between designers and corrosion engineers is next detailed by Jenkins, who believes that improved communications at the outset of the design process will prevent a large number of galvanic corrosion problems. Turner discusses a powerful method for prevention of galvanic corrosion called cathodic protection. This technique is widely and successfully utilized, and the paper describes the design process for a cathodic protection installation.

The next group of papers discusses how galvanic corrosion manifests itself in a number of environments of concern. Soil is discussed by Escalante. Here the major concerns are the limited conductivity and variability of the electrolyte. It is interesting to note the effect of minor

pollutants can dramatically change galvanic corrosion behavior, as pointed out for seawater in the paper by Hack, which appeared in the *Journal of Testing and Evaluation* (Vol. 8, No. 2, March 1980, pp. 74–79). The strong influence of minor constituents in the electrolyte on galvanic corrosion has received too little consideration in the literature. More sophisticated interpretation of polarization curves is necessary in some environments, as shown for highly corrosive fluids in the paper by Sridhar and Kolts. Galvanic corrosion in reducing acids is next discussed by Streicher and Yau. The last paper by Corbett et al. is an example of a well-designed test in a less typical environment. Although galvanic corrosion was found to not be a concern, the systematic approach to exploring the possibility is a good example for all to follow.

The last papers are summaries of the galvanic corrosion problems experienced in a variety of industries. They include for each industry problem areas where galvanic corrosion had been found to occur, including examples, and typical preventative measures. The paper by Baboian et al. describes galvanic corrosion in automobiles, where interaction with trim can lead to problems and cladding can lead to solutions to problems. The next paper by Efird is a comprehensive treatment of the subject of galvanic corrosion in the oil and gas production industry. Useful data to aid in making predictions are included in this paper. Galvanic corrosion in the telephone communications industry is discussed by Schick. Shipbuilding is next addressed by Morton, who discusses the areas of ships where problems can occur, and what is typically done to prevent them. Galvanic corrosion on components in power plants is discussed in the papers by Gehring, and also by Redmerski et al. Finally, galvanic corrosion is a significant problem in desalination plants, as noted by Zaharani et al.

The variety and depth of these papers should make this book a valuable reference tool for anyone in any industry who may have concerns about galvanic corrosion. Supplemental material may be found in *Galvanic and Pitting Corrosion—Field and Laboratory Studies (STP 576)* and in several standard guides and test methods concerning galvanic corrosion published in Volume 03.02 of the *Annual Book of ASTM Standards.*

Harvey P. Hack

David Taylor Naval Research Center, Bethesda, MD; symposium chairman and editor.