Corrosion Testing in Natural Waters

Second Volume

Robert M. Kain and Walter T. Young
editors

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Foreword

This publication, *Corrosion Testing in Natural Waters: Second Volume,* contains papers presented at the Second Symposium on Corrosion Testing in Natural Waters held 7 November 1995 in Norfolk, VA. This symposium was held in conjunction with the standards development meetings of Committee G1 on Corrosion of Metals, the symposium sponsor. Robert M. Kain, LaQue Center for Corrosion Technology, Inc., and Walter T. Young, Corrpro Companies, Inc., served as co-chairmen of the symposium and editors of the resulting publication.

Contents

Overview

This is the second STP of the same title. The first volume, STP 1086, was published in 1990 and contained papers on seawater corrosivity, crevice corrosion resistance of stainless steels, corrosion fatigue testing, and corrosion in potable water. Since then, final results have become available from the worldwide study on corrosion behavior of metals in seawater, and additional studies have been performed that should be brought to the attention of the corrosion engineering community. The eight papers presented in this volume were presented at the ASTM symposium in Norfolk, Virginia on 7 November 1995. A brief description of each paper follows.

Monitoring Biofilm Formation in Power Plant Environments

Power plants experience severe general corrosion, pitting, underdeposit corrosion, and microbiologically influenced corrosion in cooling water systems. Corrosion results in significant reductions in plant operating efficiency and high costs of operation and maintenance. Microbiological corrosion (MIC) is a particularly difficult problem since alloys that should be corrosion resistant in the general environment often fail in a short period of time when microbiological mechanisms are also active.

This paper discusses a test procedure that can be used to monitor biological activity. The procedure is based on an electrochemical probe that can be placed on-line to provide early warning of biological activity so that early action can be taken.

Modeling of Marine Corrosion of Steel Specimens

A mathematical model would prove to be quite useful in predicting the corrosion performance of steel and other metals in seawater where detailed exposure data are not available. This paper considers the variables of temperature, marine growth, wave action, pollutants, dissolved oxygen, and salinity on the long-term general corrosion rate of steel. A conceptual mathematical model dealing with immersion corrosion, tidal corrosion, and atmospheric corrosion is presented in the first part of the paper. The model is applied to data in the literature for longer-term corrosion. The model is found to be incompatible with the standard nonlinear model for atmospheric corrosion. The paper discusses the uncertainties of dealing with literature data.

Seawater Corrosivity Around the World: Results from Five Years of Testing

In 1980, ASTM Task Group G1.09.02.03 established a test program aimed at assessing seawater corrosivity worldwide. Fourteen locations in eight countries, where capabilities were available for testing in general compliance with ASTM Standard G52, "Recommended Practice of Conducting Surface Seawater Exposure Tests on Metals and Alloys," were selected. The task group also selected three baseline test materials to assess corrosivities at the designated test sites. The materials were aluminum alloys A95036, copper-nickel alloy C71500, and carbon steel alloy K01501.

The present report summarizes the five-year corrosivity results. It was concluded that experiments that rank or characterize test sites can be significantly affected by many variables. The paper reviews the variables that influenced the test results.

Twenty-Year Field Study of the Performance of Coatings in Seawater

The primary means of corrosion protection for steel immersed in seawater is the use of barrier coatings with or without cathodic protection. This paper presents the results of a study by the U.S. Army Construction Engineering Research Laboratories where steel H-piles were coated with various coatings and exposed to natural seawater in Cape Cod and LaCosta Island, Florida. The pilings were coated with epoxy, glass flake polyester, polyurethane, flame-sprayed zinc, and flame-sprayed aluminum coatings. Cathodic protection using sacrificial anodes was used on some of the uncoated and coated pilings. Evaluation was performed using electrochemical polarization and polarization decay techniques. Some of the piles were removed for measurement of corrosion.

Crevice Corrosion Testing of Austenitic, Superaustenitic, Superferritic, and Superduplex Stainless Steel Type Alloys in Seawater

In industry, many problems from corrosion occurring in crevices have been experienced and reported. These include the refining industry, offshore drilling platforms, nuclear power plants, chemical plants, and public utilities. The services are highly variable. Corrosion mechanisms and the results experienced are influenced by severe environments that can not always be avoided.

This paper provides the results of a series of crevice corrosion tests on a number of ferritic, austenitic, super austenitic, and duplex alloys in seawater. The test results are considered useful not in comparing materials, but also in selecting materials for design. The ultimate goal is to use materials that are superior to those currently in use. This will result in fewer outages, reduce repairs, and significantly lower costs.

Statistical Analysis of Pitting Corrosion in Condenser Tubes

Condenser tube failure by means of wall penetration allows cooling water to contaminate the working fluid (steam). Contamination, especially from brackish or seawater, lowers steam quality, and thus lowers overall plant efficiency. Because of the importance of minimizing leaks, power plant engineers are primarily concerned with the maximum localized corrosion in a unit rather than average corrosion values or rates. Extreme value statistical analysis is a useful tool for evaluating the chances of maximum corrosion rates based on relatively small data sizes. Extreme value statistical techniques allow the prediction of the most probable deepest pit in a given surface area based on data acquired from a smaller surface area. This paper describes the use of extreme value statistical methods as applied to pit depth analysis and presents examples of how it can be used.

Corrosion Coupon Testing in Natural Waters: A Case History Dealing with Reverse Osmosis Desalination of Seawater

Corrosion testing is generally intended to assess either the corrosion resistance of a material in a given environment and/or characterizing environmental corrosivity. This paper describes the tests conducted to evaluate the corrosivity of the environment and possible materials for use in a reverse osmosis plant to convert natural seawater to fresh water. The

tests were conducted according to ASTM Standard G4, "Standard Guide for Conducting Corrosion Coupon Tests in Field Applications," and ASTM Standard G78, "Standard Guide for Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride-Containing Waters." The paper focuses heavily on the experimental design of the program as it related to ASTM Standards G4 and G78.

Comparison of Current Reversal Chronopotentiometry (CRC) and Small Amplitude Cyclic Voltammetry (SACV) Method to Determine the Long-Term Corrosion Tendency of Copper-Nickel Alloys in Polluted and Unpolluted Seawater Under Jet-Impingement Conditions

This paper reports on tests using the technique of cyclic current reversal chronopotentiometry to measure the corrosion tendency of two copper-nickel alloys in sulfide polluted seawater. The results are compared to the polarization resistance method.

The symposium committee gratefully acknowledges the efforts of the authors and ASTM personnel that have made this publication possible.

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