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Summary of Electrochemical Methods

An excellent overview of electrochemical methods of monitoring corrosion is presented in the paper written by Dean, which covers topics such as polarization resistance, stress corrosion cracking, localized corrosion, polarization diagrams, hydrogen probes, AC impedance, and occluded cell corrosion. The importance of employing redundancy in corrosion monitoring is emphasized. For example, time average devices such as polarization resistance and electrical resistance devices can be used to supplement instantaneous corrosion rate measuring devices to assure the reliability of these instantaneous measurements.

More specific techniques for monitoring corrosion, such as hydrogen monitoring and electrical resistance methods, are presented in the papers written by Yamakawa and Cooper. Yamakawa claims that his new hydrogen probe, in which a thin nickel layer was deposited at the extraction side, improves the detection limits for hydrogen monitoring. Cooper summarizes the uses of electrical resistance and electrochemical methods of monitoring corrosion. The major advantage of electrical resistance probes over electrochemical probes is that electrical resistance probes can be used to monitor corrosion in fluids having very low conductivity such as refinery process fluids, oil production fluids, and boiler condensate. The major disadvantage in the use of electrical resistance probes is that corrosion rate information is not as easily obtained. The first three papers should be read in detail before proceeding to the next series of papers.

Specific applications of the use of electrochemical techniques (such as linear polarization and potentiodynamic polarization) for monitoring corrosion and corrosion inhibition are presented in the second grouping of technical papers. Cameron discusses the optimization of oil production corrosion inhibitor programs using electrochemical techniques. Monitoring corrosion in pulp and paper applications in Kraft white liquors is discussed by Yeske in his paper. Labine presents methods of monitoring corrosion inhibitor performance in cooling water applications using linear and potentiodynamic polarization techniques. It should be emphasized the potentiodynamic polarization techniques are especially useful in measuring pitting corrosion rates in oil field, pulp and paper, and cooling water applications. Equipment lifetime may be reduced to one-tenth or less of the time predicted by the general or uniform corrosion rate caused by high pitting corrosion rates.

Liening presents several case histories in which simple electrochemical techniques have provided adequate data to suggest options for temporarily solving emergency corrosion problems until more permanent solutions can be implemented.

Although the use of electrochemical techniques in monitoring corrosion in utility boilers is quite limited because of the low conductivity of the water and the high temperatures, Ronchetti discusses electrochemical techniques for monitoring corrosion in steam condensers and circuits in power plants. Gabrieli and Mohn have taken a different approach and discuss the use of metallurgical techniques and visual examinations of tube samples, from the high heat flux areas of the waterwalls of utility boilers, for hydrogen damage and caustic gouging. Piron's paper illustrates that simple coupon techniques can be used to study the corrosion of cast iron and copper pipe in potable water applications.

Laboratory methods used to minimize field problems are discussed in the third series of papers. Kellner discusses the use of computer controlled AC impedance measurements for the determination of water penetration of anti-corrosion coatings. Hoey and coworkers present the use of potentiostatically controlled slow strain rate tension tests to study the potential dependence of stress corrosion cracking of high-strength low-alloy (HSLA) line pipe steel. Vijayan and coworkers studied the influence of lithium hydroxide additions on the corrosion of carbon steel A516 in concentrated sodium hydroxide solutions using potentiodynamic and potentiostatic polarization techniques. Tuovinen and Cragnolino discuss the use of microbiological and electrochemical techniques in the study of corrosion induced by sulfate reducing bacteria. The location of the electrodes may be crucial in detecting microbiologically induced corrosion in the laboratory. Although McKubre and Syrett have used harmonic impedance spectroscopy to monitor the corrosion of cathodically protected cupronickel alloys in the laboratory, further refinements of the techniques are required to optimize the instrument's sensitivity. In addition, the technique of using electrochemical noise in detecting anerobic corrosion, discussed by Iverson, will also require more improvements.

In the future, in-plant monitoring of occluded cell corrosion should be possible based on the paper written by Silverman and Krisher. A conceptual model of this proposed occluded cell corrosion monitor is presented in their paper. The importance of crevice dimensions, cathode to anode ratios and hydrodynamics at the cathode are discussed by the authors. When this monitor becomes commercially available, premature and unexpected equipment failures caused by occluded cell corrosion should be minimized.

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