Overview

The measurement of any electrode potential includes an error caused by a voltage drop through the electrolyte. This error is caused by the inherent resistance (IR) of the solution and is proportional to the cell current. It has therefore been referred to as IR drop, ohmic overpotential, IR voltage error, or potential error caused by solution resistance. As the current or solution resistivity increase, or both, the error in electrode potential measurements can become quite large, thus distorting current-potential data and preventing accurate interpretation. Due to the ubiquitous nature of ohmic electrolyte resistance throughout the electrochemical sciences, an understanding of the phenomenon, methods to measure it, and means to correct for its presence are required to obtain precise data.

The purpose of this book is to present, review, and critique new and existing methods for the correction of ohmic electrolyte resistance. Although the 13 papers have been segregated into the areas of Theory, Critical Comparisons, Mathematical Approaches, and Applications, many of the papers are more broadly based, covering more than one of the above areas.

The reader is introduced to the theoretical considerations of ohmic electrolyte resistance measurements by Hack, Scully, and Moran in their review of the impact and methods for correcting IR in electrochemical measurements. This is complemented by Ehrhardt's paper, which includes consideration of cell geometry, current distribution, and the type of experiment on the IR voltage drop.

The next section critically compares several of the commonly available methods for correcting the error associated with IR voltage drop. Nisancioglu compares the current interruption, potential pulse, and electrochemical impedance techniques, and discusses error correction using electrode design, measurement technique, and data analysis. Mansfeld, Chen, and Shih compare correction methods present in commercially available systems and discuss the practical advantages and limitations of the respective techniques and equipment. Ehrhardt also reviews existing correction methods, but compares them experimentally to a new system introduced by the author, which is capable of combining different methods.

Esteban, Lowry, and Orazem introduce a numerical method to adjust current-potential data for the electrolyte resistance. This has provided better agreement between experimental data and mathematical models for the rotating disc electrode. Farozic and Prentice utilize numerical simulation of the potential distribution in more complex systems (for example, multiple electrode, irregular electrode shape) to provide insight into data interpretation and optimization of electrode arrangement.

The last section examines engineering applications of IR voltage drop measurement and correction. Thompson discusses the issues related to potential measurements of buried pipelines under cathodic protection. Abraham, Jones, Whitbeck, and Case use a modified Wheatstone bridge to assess ohmic interference associated with corrosion measurements of nuclear waste containers in desert soil. Another important area in which high-resistivity media complicate electrode potential measurements is that of rebar corrosion in concrete. The paper by Escalante describes the use of current interruption as a means to eliminate the IR error that arises in the measurement of the potential of steel in concrete under galvanostatic conditions. Berke, Shen, and Sundberg look at the same rebar/concrete system, but compare two correction methods, current interruption and electrochemical impedance measurements. Streinz et al. present a number of methods for determining the sources of ohmic resistance in lithium/iodine batteries. The final paper by Shaw focuses on the importance of ohmic potential drop in crevice corrosion measurements, an area of extreme importance when one realizes its relevance to other areas such as environmentally assisted fracture.

The universal nature of the ohmic electrolyte resistance and its bearing on subsequent electrode potential measurements must be recognized and corrected for by those in the electrochemical sciences. We feel that the depth, range, and relevance of the topics presented here will make this STP an excellent reference and source for the electrochemical scientist and engineer.

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