ELECTROANALYTICAL METHODS
in Chemical and Environmental Analysis

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Edited by
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"The natural resources of the earth including the air, water, land, flora, and fauna and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate."

(From the DECLARATION on the HUMAN ENVIRONMENT – The United Nations Conference on the Human Environment, Stockholm, June 1972.)

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PREFACE

Electroanalytical methods play an important role in chemical analysis in view of their sensitivity, simplicity, broad application, adaptability to field applications, and relatively low investment outlay. They find applications in all branches of science and technology where chemical analyses are required. These qualities are of particular value in environmental protection, which involves mass application of instrumental techniques and large numbers of monitoring stations and networks around the world. The methods are applicable to an enormous number of chemical substances encountered not only in environmental monitoring but in many other fields.

This volume presents the current state of the art of electrochemical analytical methods, such as polarography, voltammetry, potentiometry with ion-selective electrodes, etc. It summarizes the potential offered by these techniques for monitoring various substances affecting health and the environment and for chemical analysis in general.

R. Kalvoda

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CHAPTER 1

INTRODUCTION

Robert Kalvoda

One of the most pressing tasks for mankind during the scientific and technical revolution, in addition to efforts to preserve peace, is the protection of the environment. This topic has been discussed so thoroughly in general that it is unnecessary to do so here.

A great variety of branches of science participate actively in the solution of environmental problems, including medicine, biology, physics, chemistry, and also electrochemistry. The latter has played an important role here in several respects. In addition to the analytical aspects treated in this book, electrochemistry is used in the removal of toxic substances or other products and wastes polluting the environment as a result of industrial activity (metallurgy, chemical and food industries, energy production, etc.), from the point of view of agriculture or of communal hygiene. Electrochemistry can also help in decreasing or eliminating the occurrence of some substances, e.g., by wasteless technologies, especially in the chemical industry and related fields. Moreover, electrochemistry can, and most probably will, affect energy production and all kinds of transport, which are among the major polluters of the environment. These questions and others are discussed in greater detail in other books [1–4].

This book summarizes the potentialities offered by electrochemistry from an analytical point of view, in monitoring various substances polluting or affecting the environment, as a result of human activities brought about by technical progress. Electroanalysis is characterized by unusually broad applicability, from analyses for traces of heavy metals in waters or atmospheric aerosols to determinations of organic compounds with which we are in continuous contact in our surroundings. Especially polarography enables the detection of many high-priority pollutants that are listed, e.g., in Ref. 5. It is certainly interesting that more than two-thirds of the substances given in the Fourth Annual Report on Carcinogens [6] are polarographically determinable. One of the advantages of electroanalysis is the relatively simple, cheap instrumentation that can often be applied to field work and operated by technicians. This is extremely useful in the present

trend to build various analytical laboratories for monitoring pollutants in the framework of national, regional, or global programs of environmental protection.

The following chapters discuss the use of selected electrochemical methods in solving the problems of environmental protection, with emphasis on tested and successful applications. At the end of the book are also discussed some possibilities of using electroanalysis in tackling ecological problems.

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CHAPTER 2

ANALYTICAL CHEMISTRY AND ENVIRONMENTAL PROTECTION

Jaroslav Zýka

One of the most important problems to be solved at present by mankind, in addition to securing food and providing necessary sources of energy, is the protection of the environment and creation of conditions for modification of the environment in an ecologically optimal way for the further development of the human race.

Human intellect has led to the attainment of such a high level of science and technology that, in accordance with the law of equilibrium, which is valid not only in chemistry and other natural sciences but also in human life in general, the equilibrium in the relationship between man and nature has been disturbed and technical progress is beginning to turn against those who created it, i.e., people, mankind.

Most people feel, and to a certain extent objective experience has confirmed, that chemistry has contributed to this disturbance of the equilibrium; on the other hand, chemistry has yielded many favorable effects. It is paradoxical that progress in chemistry, inseparable from the development of human society and the present high standard of living, has often led to pollution of the atmosphere, water, and soil and thus also indirectly of plant and animal food with unfavorable consequences for people, plants, and the whole environment of living organisms. However, man is capable of restoring this equilibrium.

Hence, chemistry plays one of the most important roles in environmental protection and ecology, analytical chemistry being the most important field, because it points out the problems to be tackled, even though it cannot solve them itself. The results of recent medical research indicate that some inorganic and organic compounds have harmful effects in amounts substantially lower than those assumed a few decades ago, and thus it is necessary to develop analytical procedures capable of detecting and determining these substances with better precision, reliability, sensitivity, and selectivity which would simultaneously be cheap in operation to permit their use not only for research purposes, but also for wide-scale