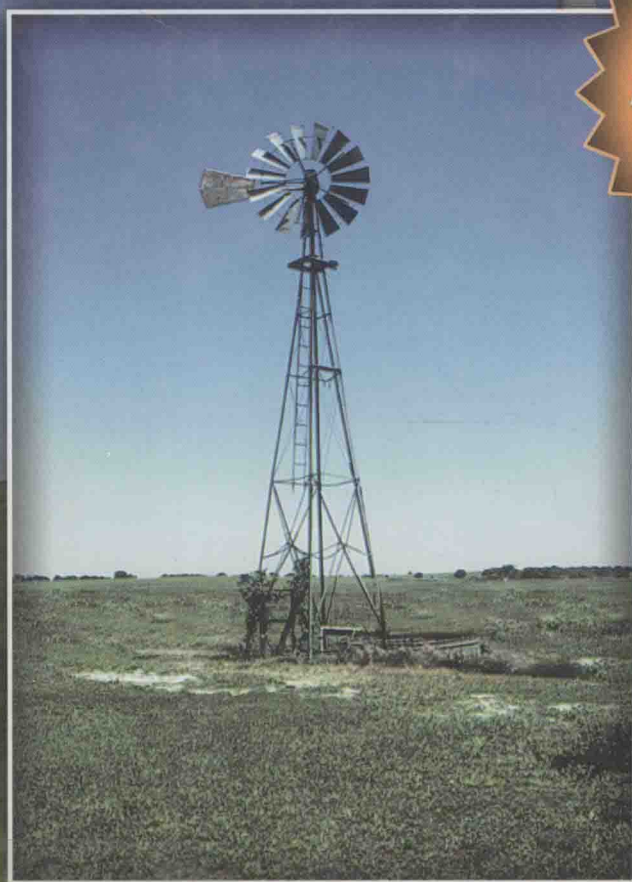


# FUNDAMENTALS OF ENVIRONMENTAL CHEMISTRY

THIRD EDITION

*Fully  
Updated  
Third Edition*



STANLEY E. MANAHAN



CRC Press  
Taylor & Francis Group

F U N D A M E N T A L S   O F

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ENVIRONMENTAL  
CHEMISTRY

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## PREFACE

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*Fundamentals of Environmental Chemistry*, 3rd edition, is designed to build upon the approach successfully employed in the first two editions while also expanding the scope of the book into the strongly emerging area of Sustainability Science and Technology, which includes green chemistry and industrial ecology. The book takes into account the needs of those who have little or no knowledge of chemistry, but who require the basics of chemical science for their trade, profession, or study curriculum, as well as for readers who want to have an understanding of the fundamentals of sustainable chemistry and its crucial role in maintaining a livable planet.

The first ten chapters of the book are a basic course in chemical science that includes the fundamentals of organic chemistry and biochemistry. In presenting the fundamentals, every effort is made to relate them to real-world examples from environmental chemistry, green chemistry, and related areas while still maintaining brevity and simplicity. The following 16 chapters of the book deal with environmental chemistry, broadly defined to include sustainability aspects, green chemistry, industrial ecology, and related areas. These chapters are organized on the basis of five environmental spheres: the hydrosphere, atmosphere, geosphere, and biosphere (water, air, earth, and life), and a fifth sphere called the anthrosphere, which consists of that major part of the environment made, modified, and operated by humans. To serve the large segment of readers for whom chemical analysis is important, the last two chapters deal with analytical chemistry, specifically environmental chemical analysis.

One of the unique features of the book is a “mini-course” in chemistry presented in the first few pages of Chapter 1 and consisting of the most basic concepts and terms needed by the reader to really begin to understand chemistry. To study chemistry, it is necessary to know a few of the essentials, i.e., what an atom is and what is meant by elements, chemical formulas, chemical bonds, molecular mass, and chemical reactions. With these terms defined in very basic ways, it is then possible to go into greater detail concerning chemical concepts without having to assume—as many introductory chemistry books do somewhat awkwardly—that the reader knows the meaning of these terms.

Chapter 2 discusses matter largely on the basis of its physical nature and behavior, and introduces physical and chemical properties, states of matter, the mole as a quantity of matter, and other ideas required to visualize chemical substances as physical entities. Chapters 3–5 cover the core of chemical knowledge constructed as a language in which the elements and the atoms that form them (Chapter 3) are presented as letters of an alphabet, the compounds made up from the elements (Chapter 4) are analogous to words, the reactions by which compounds are synthesized and changed (Chapter 5) are like sentences in the chemical language, and the mathematical aspects hold it all together quantitatively. Chapters 6–8 constitute the remainder of the material that is usually regarded as essential in general chemistry. A basic coverage of organic chemistry is presented in Chapter 9. Although this topic is often omitted at the beginning chemistry level, those who deal with the real world of environmental pollution, hazardous wastes, agricultural science, and other applied areas

quickly realize that a rudimentary understanding of organic chemistry is required. Chapter 10 covers biological chemistry, an area essential to understanding material presented in later chapters that deal with environmental and toxicological chemistry.

Chapter 11 is the first of three chapters centered on the environmental chemistry of the hydrosphere, and deals with water as a unique substance, how its properties affect its role in the environment and as a green, sustainable resource. Chapter 12 discusses the role played by water in the environment as a whole, how the hydrosphere interacts with the other environmental spheres, and water pollution. Chapter 13 emphasizes the importance of water resource sustainability, and discusses water treatment and uses for water.

Chapter 14, the first of three chapters pertaining to the atmosphere, emphasizes the nature and composition of the atmosphere together with the vital protective function that it fulfills. Chapter 15 deals with atmospheric chemistry, including chemical processes, which lead to air pollution. Chapter 16 concentrates on the sustainability of the atmosphere along with ways to remove and to prevent air pollutants.

The geosphere is introduced as a distinct environmental sphere in Chapter 17 along with the basics of geochemistry. Chapter 18 deals with the most important segment of the geosphere, namely soil and its role in food production. Chapter 19 pertains to the preservation and enhancement of the geosphere, and discusses the geosphere as a resource of essential minerals.

Along with Chapter 10 (Biochemistry), Chapters 20 and 21 cover the biosphere as one of the distinct spheres of the environment. Chapter 20 is an overview of the biosphere and its resources. Chapter 21 deals specifically with toxic substances and their importance in environmental chemistry and green chemistry within the framework of toxicological chemistry.

The section on the anthrosphere begins with Chapter 22, which explains what the anthrosphere is, why it is a distinct sphere of the environment, and how it relates to the other environmental spheres. The related areas of green chemistry and industrial ecology, both key aspects of the anthrosphere, are covered in Chapter 23. Chapter 24 discusses the potential of the anthrosphere to generate wastes, including hazardous wastes, and the various classifications of waste. Chapter 25 discusses the sustainability of the anthrosphere and how to deal with its wastes (including hazardous wastes). As its title "Sustainable Energy: The Key to Everything" implies, Chapter 26 is to do with the unique importance of energy in sustainability. It discusses various energy sources and how the development of sustainable energy is the single most important aspect of achieving sustainability.

The last two chapters cover the basics of analytical chemistry and its relevance to environmental chemistry. Chapter 27 is an overview of analytical chemistry and the major categories of chemical analysis. Chapter 28 deals specifically with the analysis of materials in water, air, wastes, and biological samples.

The author welcomes input from readers. Comments and questions may be sent to the author at the following e-mail address: [manahans@missouri.edu](mailto:manahans@missouri.edu)

## AUTHOR

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**Stanley E. Manahan** is a professor of chemistry at the University of Missouri (Columbia) where he has been on the faculty since 1965. He received his A.B. in chemistry from the Emporia State University in 1960 and his PhD in analytical chemistry from the University of Kansas in 1965. Since 1968, his primary research and professional activities have been in environmental chemistry, toxicological chemistry, waste gasification, and gasification of biomass for energy production. His classic textbook, *Environmental Chemistry*, 8th edition (CRC Press, Boca Raton, Florida, 2004), has been in print continuously in various editions since 1972 and is the longest standing title on this subject in the world. Other books that he has written are *Green Chemistry and the Ten Commandments of Sustainability*, 2nd edition (ChemChar Research, Inc., 2006), *Green Science and Technology: The Path to a Sustainable Future*, 2nd edition (CRC Press/Taylor & Francis, 2006), *Toxicological Chemistry and Biochemistry*, 3rd edition (CRC Press/Lewis Publishers, 2001), *Industrial Ecology: Environmental Chemistry and Hazardous Waste* (CRC Press/Lewis Publishers, 1999), *Environmental Science and Technology* (CRC Press/Lewis Publishers, 1997), *Hazardous Waste Chemistry, Toxicology and Treatment* (Lewis Publishers, 1992), *Quantitative Chemical Analysis*, (Brooks/Cole, 1986), and *General Applied Chemistry*, 2nd edition (Willard Grant Press, 1982).

Dr. Manahan has lectured on the topics of environmental chemistry, toxicological chemistry, waste treatment, and green chemistry throughout the U.S. as an American Chemical Society Local Section Tour Speaker. He has also presented plenary lectures on these topics at international meetings in Puerto Rico, the University of the Andes in Mérida in Venezuela, Hokkaido University in Japan, the National Autonomous University in Mexico City, and in Italy and France. Since 1998, he has taught a short course annually at the National Autonomous University of Mexico. He was the recipient of the Year 2000 Award of the Environmental Chemistry Division of the Italian Chemical Society.



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