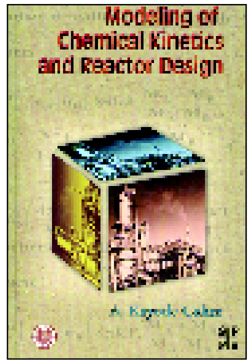
Modeling of Chemical Kinetics and Reactor Design

A. Kayode Coker, Gulf Professional Publishing, Butterworth-Heinemann, Boston, MA, 1136 pp., $195, 2001



Dr. Coker, as a lecturer and consultant in the industry, spends great effort to cover a variety of topics. In addition to essential subjects, such as mechanisms of chemical reactions, ideal and nonideal reactor design, the text includes sections on biological reactor design, scaleup, hazard analysis, and safety in chemical reaction engineering. It offers a balanced approach to the understanding of both industrial and laboratory reactor designs. The text also provides the reader with a case study (ammonia synthesis) that is discussed in several chapters. Completion of the text will give a good introduction to the fundamentals of chemical reaction engineering and biological systems. Coker's lecture-note style lengthens the text, but it also allows the reader to easily follow the intermediate steps in solving the problems. This book can be used in an introductory course; however, it does not outperform other textbooks available. It is surprising that a contemporary text would still define the reaction rate using a mass balance rather than defining it as a function of temperature and composition of the system. The definition of the reaction rate using mass balance in a batch reactor misleads the students enormously in writing mass balances for different reactor systems. The book may find its target audience in the chemical industry. It will be especially useful to process engineers for safety and scaleup applications.

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Wave Motion

J. Billingham and A. C. King, Cambridge Texts in Applied Mathematics, Cambridge University Press, New York, NY, 475 pp., Hardcover $115 and Paperback $40.00, 2000

Wave motion is the predominant form of motion in the physical world. Not only does it describe how electromagnetic radiation passes through space, but it explains sound propagation. Earthquakes are described as wave motion occurring on the surface of a solid. Wave motion transmitting energy through a solid is called "seismic" and is used for oil exploration and for geologic research into tectonic events occurring deep within the earth. It also explains the features observed on the free surface of large liquid expanses, such as lakes and oceans, as well as the energy transmitted through the body of such liquid expanses.

Because wave phenomena are so varied and so pervasive, the authors of this book prefer not to present a single definition for wave motion. Rather, they view waves "as a generic set of phenomena with many similarities."

The book's contents are divided into three sections entitled "Linear Waves," "Non-linear Waves," and "Advanced Topics." It also contains five appendices. In Chapter 1, "Basic Ideas," the authors discuss the importance of the superposition principle. Chapter 2, "Waves on a Stretched String," covers the derivation of the differential equation describing wave motion and solves it via separation of variables. Also presented is d'Alembert's solution for a string of infinite length. Chapter 3, "Sound Waves," discusses compression waves and longitudinal waves. Also, wave-guides are introduced in this chapter. Chapter 4 is an overview of "Linear Water Waves." The authors first derive the differential equation describing such motion, then they solve it for various initial and boundary conditions. For example, they discuss edge waves, ship waves, shallow water waves, sea swell reflection by a ship, wave amplification by a sloping beach, and wave refraction. Chapter 5 outlines "Waves in Elastic Solids." Waves in flat plates and rods are discussed, as well as point sources causing such motion. Chapter 6, "Electromagnetic Waves," contains a good introduction to wave-guides.

The section about non-linear waves contains three chapters. The first, Chapter 7, discusses "The Formation and Propagation of Shock Waves." Two physical phenomena are presented — traffic waves and compressible-gas dynamics. The governing differential equations modeling these physical phenomena are solved via the use of characteristics. Chapter 8, "Non-linear Water Waves," expands the use of the method of characteristics. Chapter 9 presents "Chemical and Electrochemical Waves."

The third section, "Advanced Topics," also contains three chapters. Chapter 10 discusses Burgers' equation. Chapter 11 shows how to develop and solve diffraction and scattering problems. Chapter 12 outlines the solutions for the Korteweg-de Vries equation and for the non-linear Schrodinger equation.

The formation of shock waves in piping at chemical plants is more common than generally recognized. Thus, the discussion of shock waves and chemical reaction kinetics in this text is of use to chemical engineers. This text discusses how a shock wave forms, develops with time, and propagates. It is for advanced undergraduates in applied mathematics. However, the authors present the physics and chemistry of each discussed phenomenon thoroughly, thereby making it an acceptable text for use in a classical wave-motion physics course.

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