Books

Kinetics of Homogeneous Multistep Reactions

Friedrich G. Helfferich, Elsevier Science, Amsterdam, Netherlands, 410 pp., $244, 2001 (Vol. 38 of "Comprehensive Chemical Kinetics," R. G. Compton and G. Hancock, eds.)

Chemical reaction kinetics studies the rates of chemical reactions, and more importantly, their dependence on operating conditions such as reactant and catalyst concentrations, reaction temperature, etc. It provides the fundamental knowledge for reactor design, scaleup, optimization, operation and control, which are typically the key tasks of building and operating a chemical plant or petroleum refinery. However, most reaction engineering books, while devoting their major portions to reactor behavior, usually limit their scope to simple reactions with idealized kinetics. Most reactions in industrial processes are much more complicated. A real-world reaction often involves many serial and/or parallel steps.

Helfferich's book deals with the kinetics of complicated multistep reactions, a subject he has taught in an AIChE course for years. The mechanisms of many important multistep reactions have been established by pioneers in the field of fundamental kinetics. However, the difficulty of deriving rate equations from such a complex mechanism has also been recognized, and very few robust rate laws have been published. Up to these days, reaction engineers still have to rely on grossly simplified and limited empirical rate laws, whose parameters need to be revised step-by-step from costly pilot-plant data during design or scaleup. On the other hand, a set of theoretical rate equations written directly for the elementary steps of a complex mechanism is usually too large to be practical. Moreover, there are often many potential mechanisms proposed for a specific reaction in its early stage of investigation. The screening of mechanisms, validation of a complex rate law, and determination of a large number of rate parameters usually call for tremendous experimental resources, or may even be impracticable. To be practical, a complicated reaction network along with its large set of rate equations needs to be reduced. This book provides a systematic methodology with a sound theoretical basis for reducing a complicated reaction network to a practical kinetic model, while preserving its essential kinetic characteristics.

Helfferich's book uniquely demonstrates the methodology with many examples of its successful application to industrial processes; these examples are rarely found in other books and should be of great value to engineers and chemists in industry. Although the book limits its discussion to homogeneous reactions, the methodology is also useful to heterogeneous reactions provided that the additional complications in such a system are properly treated. Recently, I have applied this methodology to fixed-bed catalytic reactors and successfully developed practical models to optimize production and catalyst management.

This is one of the very few books, if not the only one, extensively covering the kinetics of real-world reactions. Focusing on such reactor-independent behavior, it offers a good complement to common reaction engineering textbooks, which focus on reactor behavior with limited discussion of kinetics. Although the book is intended as an aide and guide for industrial practitioners, it should also be an excellent reference for graduate students. In summary, this well written book presents the cumulated wisdom on practical reaction kinetics from the author's exceptional experience in both industry and academia.

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After the Quality Audit—Closing the Loop on the Audit Process, 2nd Edition

J. P. Russell and Terry L. Regel, American Society for Quality, Milwaukee, WI, 256 pp., indexed, $44, 2000

This book is written in easy-to-read, "friendly language" without much technical jargon, and is really meant more for general management and those related to the audit process than for auditors. Every now and then, the authors give examples to make their point. Some important concepts that are succinctly illustrated are the Reason Pain matrix (Chapter 2); PDCA: Plan, Do , Check, Act (Chapter 3); and corrective and preventive action (Chapter. 4).

The first six chapters basically talk about ways to report problems and non-conformities, convey the problem to management and management interests, decide on action to eliminate the problem, take action and finally check if it worked. The book gives more than just a superficial overview of the problem identification and solving process. The final three chapters focus on effective management programs, making the audit programs more effective, and finally the importance of timely action.

The authors have tried to emphasize the importance of followup audits. ISO 9000-based quality systems have made audit procedures more important than before. As the authors correctly point out, this book is not about the audit process, but "... describes closing the loop on the audit process and the relationship between auditors, stakeholders and management for getting results …" The book is recommended as a useful reference tool for auditors. It is also useful for general management, supervisors, audit program managers, examiners and anyone else who seeks improvements from audits.

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