ELSEVIER

Chemical Engineering Journal 88 (2002) 263

Chemical Engineering Journal

www.elsevier.com/locate/cej

Book review

Kinetics of Homogeneous Multistep Reactions
F.G. Helfferich (Ed.), Elsevier, Amsterdam/New York, 426 pp., price: US$ 244, ISBN: 0444826968

Penn State's Friedrich Helfferich has addressed the needs of the practicing chemical engineers and chemists in his integration of the classical foundations of chemical kinetics and new material in Kinetics of Homogeneous Multistep Reactions. Indeed, most of the material is directly relevant to catalytic chemistries, whether homogeneous or heterogeneous.

Chemical engineers and chemists involved in extracting useful information from experimental observations will find Helfferich's perspective eminently useful. The material will assist in the design and interpretation of experiments at the level of mechanistic chemistry. But to do so, requires both engineering and chemistry foundations.

Thus, Kinetics of Homogeneous Multistep Reactions provides the basics of both reactor theory (e.g. batch, CSTR, plug flow, etc.) and kinetics (e.g. transition-state theory) along with the useful tools (e.g. rate-determining step, steady-state approximation) that allow the engineering and chemistry to be linked in, generally, analytical equations. Helfferich provides a review of the classical foundations of kinetics articulated by Boudart, Christiansen, Bodenstein and others in the full context of a chemical engineering problem. This is the rigorous mathematical basis for linking mechanistic chemistry to rate laws, and the reverse. This fundamental chemical basis allows for engineering design and scale up, presumably, with greater confidence over a wider range of process conditions than typically afforded by the empirical alternative. This fundamental basis also allows for the inverse operation, namely the transformation of observable data into improvements in catalysts and operating conditions that can ultimately lead to improved selectivities and rates.

To accomplish these goals, Helfferich devotes the first three chapters to: (1) the obligatory conventions and definitions, (2) the chemical fundamentals of kinetics, and (3) the procurement of kinetics data from research reactors. Chapter 4 provides the tools that link Chapters 2 and 3—the concepts, uses and pitfalls of the rate-determining step and steady-state approximations are discussed in full. In a broad sense, much of the rest of Kinetics of Homogeneous Multistep Reactions is devoted toward the use of these tools in the establishment of rate laws from scenarios for chemical mechanisms, i.e. the transformation of a set of elementary steps into a closed form rate law. One of Helfferich's newer contributions is his inclusion of 'network elucidation' (Chapter 7) as a fundamental, stand-alone concept. Helfferich recognizes that the chemical engineering model is more than an abstraction of the reactor and the rate law, but also the combination of reaction sequences or pathways into a reaction network. That is, the network itself is a model, and Helfferich presents some techniques aimed at systematic elucidation of this network. Helfferich provides further depth and category-specific techniques on topics, such as homogeneous catalysis and polymerization, which appropriately sandwich a chapter on the conceptual issue of chain reactions, where the "catalyst" is often a chain carrier supplied by the reactants themselves. The final two chapters cover mathematical modeling strategies and unusual effects of transport, respectively. Kinetics of Homogeneous Multistep Reactions wonderfully motivates, but itself does not venture very far into the modern computational approaches that can complement and extend the closed form analytical approaches. Thus, some companion guide, that will enhance the expression of the classical concepts in numerical terms, will likely be useful.

Kinetics of Homogeneous Multistep Reactions is thus both a useful collection of classical topics and also a contribution with new material. Both aspects will provide helpful and useable guidance to chemical engineers and chemists involved in the linkage of fundamental and process chemistry. The classical topics also provide a tribute to the historical developments that serve as the foundation for the modern mechanistic approach. Readers will enjoy both the practical and scholarly perspectives of this work.

Michael T. Klein
School of Engineering, Rutgers University
98 Brett Road, Piscataway, NY 08854-8058, USA
Tel.: +1-732-445-2214; fax: +1-732-445-7067
E-mail address: mtklein@jove.rutgers.edu (M.T. Klein)

Accepted 26 February 2002

PII: S1385-8947(02)00040-2