REVIEW: Chemical Reactor Theory

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index at the end.

The book is produced by photostat of the typed manuscripts; this has kept both the price within bounds, and the production relatively error-free.

Finally, the editors are to be congratulated on performing the herculean task of carrying this work through to print. It is tragic that Leon Lapidus met his untimely death just before the volume actually appeared in print—this is a work he would be rightly very proud of. □

THEORETICAL RHEOLOGY THERMOCHEMICAL KINETICS, 2nd EDITION

By Sidney W. Benson, John Wiley, New York, 1976 ($22.50).

Reviewed by Robert D. Tanner,
Vanderbilt University

The rate constants for 7 out of the 19 most important reactions proposed to model the destruction of ozone in the stratosphere were not accurately known in 1976. [1] The first direct measurement of the reaction rate of nitric oxide with the hydroperoxyl radical, a critical reaction in the chemistry of ozone in the upper atmosphere, was not reported until the next year. [2] That report, of a rate 10 to 40 times faster than had been estimated, led to the conclusion that chloroflurocarbon aerosols may by 35% more destructive of the earth's ozone layer than had been previously predicted, while supersonic aircraft may be only half as destructive. [2] Since understanding the estimation techniques for such important gas-phase reactions are timely, it is appropriate to examine the general status of estimating rate constants in Benson's revised book on *Thermochemical Kinetics*. How accurate for example, are the most recent developments of the classical transition-state theory and collision theory in predicting rate constants, a priori, from thermochemical data? Can we tell beforehand, as Levenspiel [3] states, whether the predicted rate will "match the experiment by a factor of two" or will be off by a factor of 10^6? Unhappily, as the hydroperoxyl radical example illustrates, the most recent estimation methods still deviate by more than a factor of two, and Benson's text doesn't help us deal with this problem.

What seems to be needed, after recognizing that the collision theory may generally be used to estimate the upper reaction rate bound, [3] is a lower bound estimate. When information is available to apply the transition state theory, the predicted rates are generally closer to experimental rates than that predicted by the collision theory. [3] Nevertheless, the transition state predicted rate does not provide the desired lower bound. We therefore need to simultaneously develop definite upper and lower bounds for predicting rates of specified reactions, and sharpen the predicting tools for each bound, thereby reducing the predicted maximum errors.

A recent review by Rossini [4] aptly covers the topics in the five chapters of Benson's book and, thus, will not be repeated here. What seems to be important in Benson's book, from an engineering point of view, is its potential to help us predict the behavior of such reactions as pyrolysis, cracking, hydrogenation, oxidation, and polymerization in new processes, such as those being developed for coal gasification. Extensions of the predictive methods covered by Benson to the condensed phases (liquids) are beyond the scope of his text, but are presently under development. It is hoped that Benson's book will be the inspiration for one which will eventually cover methods, for not only predicting liquid phase reaction rates, but for those of reactions governed by both homogeneous and heterogeneous catalysts. □

REFERENCES

1. Maugh, T. H., II, **Science**, (October 8, 1976), 170.
2. **C & EN**, (June 13, 1977), 16.
3. Levenspiel, O., **Chemical Reaction Engineering**, 2nd ed., Wiley, New York (1972), 23-29.
4. Rossini, F. D., **Chem. Engin.**, (May 9, 1977), 12.

PATTERNS OF PROBLEM SOLVING

By Moshe F. Rubenstein, Englewood Cliffs, N. J. Prentice Hall, Inc., 1975

Reviewed by Richard M. Cyert,
Carnegie-Mellon University

This book is, in one sense, misnamed. I looked forward to reading it because I thought from the title that it would be an application of some of the recent research in psychology. In fact, only the first chapter attempts that type of approach. The rest of the book could best be described as an introduction to operations research. Nevertheless, the book is an interesting one for the person who wants a quick introduction to such diverse topics as Boolean algebra, Bayesian analysis, the central limit theorem, random walk, utility theory, linear programming and sequential analysis. The book is a potpourri of techniques.

Rubenstein is a professor of engineering at UCLA and developed the book from a course on problem solving. The course was apparently a campus wide course and those techniques were selected that had the highest probability of attaining immortality.

On balance, I liked the book and believe that it can be a useful book for self-study. It would not be as useful as a text book because the author attempts to cover too much ground. He also demonstrates a lack of real understanding of many of the areas. He obviously did some reading and then attempted to teach the particular technique he had just "learned." The elements are not getting put together to facilitate understanding of any process.

I will illustrate my point with the subject of decision making under uncertainty. In a real sense the most important case in the study decision making, if not the only one, is decision making uncertainty. Rubenstein does several things to confuse that point and in doing so makes it clear that he understands his material as a student not as a practicing professional.

In discussing decision making in Chapter 7, he accepts the distinction between risk and uncertainty that Frank Knight first made in 1920 in his book, *Risk, Uncertainty and Profit.* Risk was used by Knight to define situations where it is possible to compute an objective probability and uncertainty refers to those situations in which an objective probability cannot be computed. This distinction was useful historically in thinking about certain decision-making problems, but it is a distinction that is not meaningful since L. J. Savage's, *Foundations of Statistics.* (This book is not listed in the extensive bibliography of books listed on pages 522 to 528. Since the list is not alphabetical, I might have missed it). Savage resuscitated Bayes and demonstrated that a Bayesian always has a probability for an event. Rubenstein does show that he is aware of the existence of subjective probabilities but never ties together their existence with Bayesian analysis. Rather he reduces the subjective probability case to the case of risk since probabilities exist. This reduction is wrong since a Bayesian would behave differently and, in fact, Rubenstein has shown such behavior, 158 pages earlier, in his development of decision tries.

In addition Rubenstein discusses sequential analysis in isolation from decision making under uncertainty. Yet for those who understand decision making behavior from either a positive or a normative point of view, sequential analysis is acknowledged to be the most effective approach to decision making under uncertainty. It is also the most commonly used approach.

In other words, I am warning the reader that the author is a talented amateur. Thus much can be gained from the book, but it should be recognized that one is jumping from the tip of one iceberg to another. It is important for real understanding to stay on one iceberg (properly defined) and get to the part that is submerged.

Nevertheless the book is interesting as an introduction to a large number of techniques as well as to the jargon used in many disciplines. One has to admire the aplomb which Rubenstein demonstrates in Chapter 5 in discussing models. He has one section on "Models of History." In that section Freud is handled in one short paragraph while Spengler and Toynbee take one long and two short paragraphs. In this chapter he describes not models in history but also models of the universe, the atom, the brains and others. That chapter alone is worth the price of the book.

The book is well written. It has problems at the end of chapters and answers at the end of the book. Professor Rubenstein's knowledge is so vast that any reader will learn something. To go more deeply into any of the subjects he mentions more work is necessary. □

ChE conferences

EMULSION POLYMERIZATION

A short course on Emulsion Polymerization and Latex Technology will be offered August 27-31, 1979, in Davos, Switzerland. Additional information can be obtained from: Dr. Gary W. Poehlein, ChE Department, Georgia Institute of Technology, Atlanta, GA 30332.

SHORT COURSE ON PRINTING INKS

The first annual one-week short course, "Physics and Chemistry of Printing Inks," will be offered at Lehigh University during the week of October 29 - November 2, 1979. This course is designed for engineers, chemists, other scientists, and managers who wish to acquire background in this subject. Further information can be obtained from: Dr. Mohamed S. Al-Aasser, ChE Department, Whitaker Lab. No. 5, Lehigh University, Bethlehem, PA 18015.