BOOKS

The Mathematical Theory of Diffusion and Reaction in Permeable Catalysts, Vol. I, Rutherford Aris, Oxford University Press, New York, 1975. $39.50.

A psychologist friend of ours says that reviewers can be divided into those who must have, and those who couldn't have gone to charm-school; and that every normal reviewer begins his task by looking at the bibliography. This reviewer's qualifications: No charm-school, otherwise normal.

The handling of the bibliography forecasts it, the book confirms it: Rutherford Aris has succeeded in giving us a highly comprehensive treatise of the subject without being encyclopedic; he manages critical selectivity, yet without undue omissions. He covers principal developments and references in the text and adds brief Additional Bibliographical Comments after each chapter—a good method. It is refreshing to have the references accompanied by their own titles to lay "the sinews, if not the flesh and skin, on what otherwise are but dry bones".

We were frankly surprised at the magnitude of analysis that has by now accumulated, and greatly impressed by the way Rutherford Aris has taken these many pieces and placed them into a consistent and functional scaffold using his own extensive analysis as the flux and the binder. Even the short historical sketches are meticulously developed and instructive.

The title is wordy, but could hardly be shortened. For, while the catalysts (of the title) may be the most familiar examples, other—such as liquid/gas and (immiscible) liquid/liquid—systems in which molecular transformations proceed could be rightfully included. The author makes some valiant attempts to point to the interdisciplinary applicability by including occasional mention of such systems as cells, fluids, and membranes.

No one can ever avoid "errata", but just one comment on "phi's", φ and ϕ and Φ. The Thiele modulus has been all sorts of things including φ for many authors. In the main, it's ϕ in this book; but φ's appear on some figures, and they should be ϕ. And then there are Φ's which are ϕ's modified or generalized in certain ways. Unfortunately, we and others have used the "big phi" Φ to represent the characteristic modulus which contains the observables only (observed rates, not rate constants), and equals $\phi^2\eta$ in Aris' notation. This formulation which is most important to the experimentalist is little used by Aris.

The book is an indispensable bible for every institution, library, department, etc. involved in pushing the horizons of knowledge, and for any individual doing theoretical analysis in the field. It is generally instructive for the applied mathematician. The experimentalist will gain some orientation in the introduction portion of the text, and learn where to go for help; it does not attempt any serious bridging to the world of experimental encounter. As the author says "It is important not to be limited to realistic values as the locus of reality is actually moving with the tides of science and technology and to sell the freedom of theory for the temporary relevance of experiment would be unconscionable".

It covers the real and it covers the conceivable. It is an impressive record of a systematic and adventurous journey of mathematical analysis into the behavioral consequences of a vast spectrum of conditions—well organized, classified and developed.

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Biochemical Reactors, B. Atkinson, Pion Limited, London (1974). 267 pages. £5.00.

In this book Professor Atkinson develops and presents models for the behavior of idealized fermentation reactors. Following a brief historical introduction to this ancient art and its nomenclature, he deals with kinetics both as isolated reactions and coupled reaction-diffusion problems. The models are based primarily on flat-plate and spherical geometries (microbial films and flocs), and might be of value in fields relatively unrelated to fermenter design. Next comes a useful chapter on parameter measurement before two chapters on the design of reactors. The chemical engineer will find these to be a satisfying link between his prior knowledge of reactor design and considerations unique to microbial processing. Also included is an interesting design problem involving a trickle-flow fermenter. The only disappointing part of the text is a pair of chapters on reactors containing soluble or immobilized enzymes. A good deal of recent literature, particularly on immobilized enzyme kinetics and reactors, has not been tapped, and the overall treatment is fairly qualitative.

With its emphasis on idealized models, this book should be an especially valuable reference for biochemical engineers involved in the design or analysis of fermentations. Their chief reservation probably would be that many of Professor Atkinson's ideas appear not to have been tested by comparison with real data. The critics could be more at fault for this problem than the author, however, because of the traditional secrecy which has surrounded much microbial processing. Even if several specific models are found to be inadequate, *Biochemical Reactors* will be a great success if it stimulates a more active interchange of data and ideas between the process bioengineer and the theoretician.

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"Fundamentals and Modeling of Separation Processes," C. D. Holland, Prentice-Hall. 430 pages. $24.95

For the chemical engineer who was trained in the "old school", this book will introduce him to the new world of chemical engineering calculations. As he reads the first chapter, at first he wonders why the book was written at all. The author starts out describing the simple heat and mass balances of evaporator systems, solving an example by the conventional trial-and-error method. "So what's new?", you think. "I learned this stuff back in 1939."

In the middle of the chapter, the author reveals his reasons for this easy approach, and you suddenly find yourself knee-deep in matrix algebra. As you compare the new method with the old, the transition becomes easier, and the new methods begin to make sense.

I doubt if you could start cold and learn the matrix approach from this book, but if you know a little about matrix algebra, the book is very helpful in making the application to chemical engineering calculations.

The same technique is repeated over and over in section 1 for equilibrium stage processes: distillation, absorption, leaching, and extraction. In each case, the book sets forth the basic principles, works a problem by the conventional method, then sets up the Newton-Raphson matrix for solution by computer. An excellent learning technique.

Obviously an equation-solving computer program is a necessity. The book skips over the step of solving the matrix, once it is set up. Not until chapter 4 is there an example simple enough to be solved by hand. It would be helpful if this example were earlier in the book, to give the novice a feel for the method and confidence that it works. Unfortunately there is a typographical error in the answer to this example, which will be somewhat confusing to the nonexpert.

Section 2 fails to inspire such enthusiasm. It deals with rate processes, and is limited almost entirely to the derivation of rate expressions for various models by the integral or integral-differential forms of material and energy balances. No aid to application is offered, and only once is it suggested that the Newton-Raphson method might be used to advantage. The problems in this section are all derivation exercises.

The last three chapters describe the results of field tests on several kinds of equipment. An optimization procedure is used to choose models which give the best fit to the product distribution which was obtained. The models are shown to give good agreement with data, but the procedures are not sufficiently well described to be useful to the inexperienced reader.

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Oxidation of Petrochemicals: Chemistry and Technology, Theodore Dumas and Walter Bulani, Halstead Press. 186 pages. $18.75

This small book is a carefully and critically written summary of most industrially important hydrocarbon oxidation processes used to produce petrochemicals. These processes are arranged into four chapters: (1) catalytic oxidations in homogeneous liquid phase, dealing with twenty catalytic and noncatalytic reactions; (2) heterogeneous catalytic oxidations dealing primarily with the production of phthalic anhydride, ethylene oxide, and acrylic acid; (3) catalytic dehydrogenations for production of styrene, butadiene, and related compounds; and (4) amoxidation of olefins, dealing primarily with acrylonitrile and methacrylonitrile production. Each process is described in detail including data on thermodynamics, kinetics, reaction conditions, processing and purification techniques, catalyst compositions and properties, comparison of processing differences as practiced by different companies, and other special problems.

The text is rich in quantitative detail. While the authors bring out the important points relevant to each process, they avoid being trapped by the mountainous array of oxidation technology details described in the literature. Although the authors have done an excellent job of selecting and summarizing the material, they have allowed an unusually large number of typographical errors to remain in the book. The authors' occasional (mis) use of organic names will certainly cause the organic chemist to look over the top of his eyeglasses (for example, use of *alkyl alkanes* as a general term for butane, butylene, isopentane, and isopentylene.) The description of catalyst function and mechanism is somewhat superficial and economic aspects are often too briefly covered. In spite of these minor shortcomings, however, the book is well worth reading by chemical engineers and industrial chemists concerned with this basic source of chemicals production.

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Thermodynamics (2nd Edition), J. P. Holman, McGraw-Hill Book Company, New York (1975). 590 pages. Prices not specified.

The field of thermodynamics is so broad that no single book can encompass all possible topics. Therefore, the value of a book is likely to be judged by the reader on the use to which he might put it. Holman's Thermodynamics is such a text. Many potential users will find it of importance because it develops the science from both the classical and the statistical points of view. On the other hand, since many chemical engineering students receive their introduction to statistical thermodynamics in courses in physical chemistry, other users might prefer that this coverage be eliminated in favor of the inclusion of such topics as phase equilibria which are omitted. Similarly, chemical engineering curricula normally contain full-year courses on kinetic theory and transport phenomena, so Chapter 9 will not be of major use to chemical engineering instructors in thermodynamics courses. They would prefer more extensive coverage of nonideal gas behavior.

It is, perhaps, unfair to judge a book on other than its own terms, and on this basis, the book under discussion can be considered very successful. It is so designed that the essential principles of thermodynamics can be covered in a single term by the appropriate selection of chapters. It is, therefore, ideally suited for such a single-semester course in any discipline. Further, the author is a mechanical engineer, and he undoubtedly envisions the application of his text more to that field than to chemical engineering. As such, it could be used for a two-semester course quite satisfactorily. Chemical engineering students would also benefit from the broader applications than are normally included in a text designed specifically for their use. However, while all chemical engineering instructors will find this book a useful addition to their library, they will need to supplement it considerably in those areas of their special interest. Since one hesitates to ask students to buy two texts, one for a general introduction and one for special applications, there are other texts better suited for chemical engineering courses of more than one term.

The book is well written and illustrated, and contains many examples worked out to show the applications. In addition there are numerous problems, and a solutions manual is available.

Professor Holman has also provided an unusual adjunct to his book, although this reviewer has not had the opportunity to examine it. One can purchase for $65 a series of self-study cassettes (nine hours running time) and a self-study guide ($2.95). While this material is not intended to replace class instruction, it should be useful not only to the beginning student but to those who have been away from formal instruction for some time and would like to brush up on their thermodynamics background. It will be interesting to see how this idea works out, but even without this self-study auxiliary material, this book can be used with profit by anyone wishing to compare the classical and statistical approach to thermodynamics theory and to see how theory can be applied in many areas, many of which are of interest to chemical engineers.

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