BOOKS

Stability of Reaction and Transport Processes, Morton M. Denn. Prentice-Hall, Inc., Englewood Cliffs, N.J., 243 pages, $

This book deals with stability (Liapunov, linear and nonlinear) theory applied to chemical reactor and fluid systems (shear flow, buoyancy and Marangoni convection, and Couette flow), including extrusion and spinning instabilities of polymers.

In each case the author attractively presents the material by examining in detail a very simple mathematical model and then using an annotated bibliography to lead the reader into the literature. The leverage so obtained greatly expands the scope of the work. The detailed presentation does not give much in the way of physical insight into the problems but concentrates on the obtaining of a stability statement given the differential system of the model. The choices of references in the bibliographies are rather parochial, giving the reader the impression that all major contributions to stability theory have been made by chemical engineers. Perhaps the most glaring such case is the brief discussion in the good introductory chapter of the instability of a Newtonian fluid in the Couette flow between rotating cylinders. Here a figure is presented for the change in slope of the torque vs. shear rate curve due to the onset of Taylor vortices. The caption indicates an unpublished master's thesis from the University of Delaware!

There are several discussions that would be puzzling to the uninitiated reader. The (inviscid) Rayleigh criteria for centrifugal and shear flow instabilities are introduced by the statement that the limit of vanishing viscosity is a singular one, but the reader is given no guidance as to why the results should ever be useful.

Inexplicably, the discussion of Couette flow continually refers to the square of the azimuthal velocity divided by the radial position as the Coriolis acceleration. Perhaps those popular devices used in industrial separation should be called *ultracoriolifuges*.

"The student who has read the entire book should be prepared to solve problems and read the literature in linear and nonlinear stability for lumped and distributed parameters systems." I believe that this stated goal has not been fully accomplished. The subtleties of choosing appropriate idealizations for study, of scaling, and of relating these idealized results to practical problems have not been confronted. However, I do not think that these could be done justice in such a slim volume. The present book is a good one; a chemical engineer familiar with elementary differential equations, matrices, and Fourier series should come away from this book with an appreciation of why stability analyses are done and when in practical situations stability is an issue. He will also feel comfortable in reading the literature. He will probably need further help, though, if he wishes to be able to read the literature critically or to be a practitioner of stability theory or its applications.

STEPHEN H. DAVIS
Department of Mechanics & Materials Science
The Johns Hopkins University

Turbulent Mixing in Nonreactive and Reactive Flows, S. N. B. Murthy, editor. Plenum Press, New York, 1975, 464 pages, $37.50

In 1974 Project Squid (U.S. Navy) and the Air Force Office of Scientific Research sponsored a workshop bearing the same title as this book. The workshop was attended by some eighty specialists from Europe and the United States. This volume contains the twenty-three papers presented there as well as the discussions following the papers. An unusual feature of the collection is a helpful subject index.

For a chemical reaction to proceed, the reacting species must be mixed at the molecular level, and for fast reactions the turbulent mixing rate rather than chemical kinetics controls the reaction rate. Turbulent mixing and its effect on reaction rate is the subject of this book. The papers, which are all by specialists in turbulence, emphasize modern turbulence theory and measurements. The book contains much food for thought both for "eddy chasers," who concern themselves with measurements of coherent structure in turbulence, and for the modelers of turbulence, who need an understanding of structure to proceed with mathematical modeling.

The first paper, by S.N.B. Murthy, is a comprehensive but concise (84 pages) review of turbulent mixing, and it is followed by a review paper on turbulence modeling (D.B. Spalding). Both are critical reviews, and both discuss unsolved as well as solved problems. Another paper (P.O.A.L. Davies) reviews an earlier conference on coherent structures in turbulence. The remainder of the papers are on specialized topics. Of greatest interest to chemical engineers are (1) a paper by C. duP. Donaldson in which the reaction $A + B \rightarrow C$ is studied for a variety of "eddy structures" and the results are compared to classical chemistry; (2) a computational study of the same reaction by R. Borghi; (3) a paper by E. E. O'Brien which is largely a review paper on the probability density function formulation of diffusion controlled reactions; and (4) a paper by P. A. Libby which contains a stimulating discussion and some experimental results on turbulent flows with fast reactions.

The book is an invaluable status report on a wide variety of topics included under turbulent mixing. The target audience, however, consists of turbulence buffs, and some prior knowledge of turbulence is required to take advantage of the wealth of ideas in the book.

C. A. SLEICHER
University of Washington at Seattle

Equilibrium Properties of Fluid Mixtures (A Bibliography of Data on Fluids of Cryogenic Interest), M. J. Hiza, A. J. Kidnay, and R. C. Miller, Plenum Publishing Corporation, New York (1975), 160 pages, $29.50.

This volume is a part of the National Standard Reference Data System (NSRDS) Bibliographic Series. The authors are associated with the Cryogenics Division, Institute for Basic Standards, National Bureau of Standards. Approximately 1 000 reference citations (through 1974) are given for experimental phase equilibria and thermodynamic properties of the major fluid mixtures of cryogenic interest. The materials considered are hydrogen, hydrogen deuteride, helium, helium 3, (helium 4), deuterium, neon, carbon monoxide, nitrogen, oxygen, hydrogen sulfide, fluorine, argon, carbon dioxide, krypton, xenon, and the saturated and unsaturated hydrocarbons through the C_4's. A table of selected physical properties for the pure fluids is also included.

The bibliography is organized into ten sections each of which is independent of the other. Six sections are devoted to various types of phase equilibria. The remaining four sections are concerned with sources of original experimental data for liquid mixture densities, gas or vapor mixture densities, Joule-Thomson coefficients (including pure component data sources), and calorimetric measurements. The format for each of the sections is the same: 1) a brief introduction, 2) a figure showing the availability of the data for binary systems, 3) a table describing the available data for binary systems, 4) a table describing the available data for ternary and higher systems, and 5) an alphabetic list of references. The tables describing the available data also include the temperature and pressure range and any pertinent remarks. No critical evaluation is made by the authors concerning the reliability of any reference. In some sections of the bibliography additional species are included in the survey that are not listed on the availability chart. Outside sources have been used in some cases to cross-check the references.

One point should be made concerning the accessibility of the data sources noted in this bibliography. Some recent bibliographies have, in the absence of reviewing the original data source, relied upon published abstracts for information and in doing so give no reasonable guarantee that the data are accessible by normal means. My experience with previous NBS bibliographies on cryogenic systems has been that the NBS Cryogenic Data Center is helpful in obtaining those data sources that are otherwise difficult to obtain. In addition the utility of the bibliography would be greatly enhanced if supplements were published periodically as new experimental data become available.

Research workers, design engineers, and others interested in the separation, purification, and liquefaction of cryogenic materials should welcome this book as a valuable addition to their reference collection.

MONTFORD S. BENSON
Scientific Systems Section
Management Information Department
Air Products and Chemicals, Inc.

Thermodynamics of Fluids, K. C. Chao and R. A. Greenkorn, Marcel Dekker Inc., New York (1975). $29.75.

For those involved in teaching and learning chemical engineering thermodynamics on a graduate level, the need for new, modern and comprehensive text books is evident. Consequently, it is no surprise that several books were published in the last three years.

In the book considered here the authors present many of the key concepts and equations that a graduate student must learn in order to solve problems of equilibrium systems containing at least one fluid. In the five chapters the book presents basic physical and mathematical principles and some applications of them to gases, to liquid solutions, and to phase and chemical equilibria.

In the approach to equilibrium situations the book covers a wider range of situations than some of the recently published texts, although several important aspects, for instance the area of ionic systems, are not included.

The mathematics are well developed and presented. However, the presentation of specific subjects is not deep enough to always permit the student to recognize limits of applicability or to select one equation rather than another in a real design case. Moreover, if the book were to be considered as a text, it would have been desirable—even mandatory from this reader's point of view—for the relationship of empirical equations to the fundamental laws to appear in detail. Also, definitions of basic thermodynamic concepts should have been more precise. Accurate statements on developmental background, such as the Van der Waals theorem of the corresponding states, are instrumental to education.

The authors should have emphasized and reemphasized, especially in the first chapter, that thermodynamic processes are changes and that process thermodynamics deals with defining final conditions and exchanges of energy that result from these changes. Perhaps the biggest flaw, common also to some of the other books in the field, is the desire to present in book form an attempt to cover this diversified subject in a one-semester course. Thermodynamics is too fundamental to many aspects of chemical engineering to be adequately taught in one semester, as, unfortunately, is the case in most schools. In this reviewer's opinion books are not guided by administrative considerations and should present wider scope.

DAVID ZUDKEVITCH
Corporate Engineering
Allied Chemical Corporation

Turbulence in Mixing Operations, Robert S. Brodkey, editor, Academic Press, Inc., New York, 1975, 339 pages.

This book presents a review of the advances in mixing operations involving laminar and turbulent flows with and without chemical reaction. An initial response to the book is that a discussion of the entire field of mixing is intractable. The papers are taken for the most part from the June 1974 AIChE symposium "The Application of Turbulence Theory to Mixing Operations." Although there is some redundancy, the authors do a remarkable review of the field.

Following an introduction, six major chapters are presented by separate authors. The first four cover the more theoretical aspects of turbulent mixing of reactants in a variety of apparati. Chapter V discusses simulation of turbulent field mixers and reactors and applications toward design. Chapter VI presents a helpful summary of turbulent mixing in industrial applications and outlines the major procedures for design in representative industrial systems.

For the chemical engineer concerned with industrial applications and design, a comprehensive reading of Chapter VI and the various references listed is essential. Thereafter, a review of Chapter V, which presents the major results obtained with the hydrodynamic mixing model, is recommended. This material includes suggestions for additional research in turbulent mixing in order to improve the credibility of the mixing process simulations. Readers who wish to examine the theory of mixing should study the remaining four chapters. Chapter II presents a comprehensive review of some aspects of the theory and supports that material with experimental comparisons for pipe flows, mixing vessels, and the multijet reactor. The review given in Chapter III on the nonpremixed reaction should be examined, with attention given to the experimental results.

As R. Clausius once said, "Es gibt nichts mehr praktisches als eine gute Theorie" ("there is nothing as practical as a good theory"). In the case of turbulent mixing, the delicate balance between experiment and theory with application to design is being effected. The use of the theory presented can aid the designer for mixer comparisons or scale up of equipment. It can provide an indication to the designer of what he does not know, whether experiment is justified, or whether a commercial unit should be purchased.

This is not a textbook but a review. It could be used as a resource for a special topics course at the graduate level. In general it is necessary for a reader to study many of the references cited to obtain a basic understanding of the material presented. In many respects the book is of paramount interest to chemical engineers engaged in chemical reaction analysis and engineering.

KERMIT L. HOLMAN
Department of Chemical Engineering
New Mexico State University

ERRATA

In "Axial Distribution of Reactivity Inside a Fluid-Bed Contactor" by Shintaro Furusaki, Tatsuji Kikuchi and Terukatsu Miyauchi [*AIChE J.* **22**, 354-361 (1976)]:

1. The sentence following Equation (2) on page 355 should begin as follows. "e is expressed by . . . . . ".

2. On page 358, in the bracket, m should be m_c.

3. Caption for Table 1 on page 359 should be as follows: "Table 1. Effect of Fine Particles on Conversion, Catalyst 600 cm^3, $U_f = 30.5$ cm/s".