creases in the projected fuel cycle costs. Hence, a need is cited for further optimization of reload operations, fuel type, shutdown, and power scheduling. Since these in turn depend on a better knowledge of materials behavior, burnup limits, and optimum fuel element design which must be established by experimental tests in a fast reactor, the total fuel cycle with recycle of plutonium or U^{233} is discussed at length.

In spite of the present inability to accurately model fuel cycle costs and performance, a three-fold increase to about 35,000 tons annually in uranium mining and milling is predicted for 1980. Future developments with some of the experimentation and manpower required are discussed in relation to fuel production, enrichment, separation of spent fuel, reactor design, safeguards, and regulation. The academic community is given the task of aiding in orienting management, labor, local government, and the public on the role of safeguards, in addition to conducting and evaluating research to keep safeguards technology abreast of a growing and sophisticated industry.

This collection of papers is an excellent review of the state of the industry and should be comprehensible to the average engineer; but for one not acquainted with the field, the acronyms employed without nomenclature listings make tedious reading and searching. The engineering and economic coverage of the problems encountered in the development of nuclear energy is stressed rather than reactor physics. The long lead times cited in the development of reactors and a proven fuel cycle show that advanced, economical breeder reactors are still in the future as an answer to the impending energy crisis. As an in-depth text for studying segments of the nuclear industry, this book would have little value, but it does give a good overall view of the technology which must be developed.

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Turbulence Phenomena, J. T. Davies, Academic Press, New York (1972). 412 pages. $19.50.

As an initial impression, this book is interesting, contains a great deal of valuable information, and makes a different and definite contribution to the popular (and perhaps overworked) field of transport phenomena. In fact, an alternate title might be "Transport Phenomena in Turbulent Systems."

The book has a rather wide range, touching on all the familiar transport topics and including several new ones. The first chapter introduces the basic concepts of turbulent flow such as types of turbulence, velocity distributions, friction factors, Prandtl's eddy mixing length theory, etc. The next several chapters use the Prandtl mixing length approach to develop logically the forms that correlations should take for heat, mass, and momentum transfer. Separate analyses are made of eddy transfer far from and near surfaces. Included are solid-fluid, clean gas-liquid, clean liquid-liquid, and film covered surfaces.

The final chapters in the book cover various special topics which reflect the author's background in surface phenomena. Interesting discussions of drag reduction, movement of individual drops (as influenced by surfactants), spontaneous emulsification, and dispersion of one phase in another are provided.

The single feature that makes this book unique is a complete absence of differential equations. None are presented and none are solved. The entire analysis is built on the eddy mixing length theory of Prandtl. The emphasis is on understanding the physical mechanism of turbulent flow and how this turbulence influences heat, mass, and momentum transfer.

Since many topics are discussed, the pace of the book tends to be rapid. Often the explanations are satisfactory and interesting. At other times they are not. In places the presentation of correlations becomes almost encyclopedic, making reading laborious. Sometimes topics are included without suitable amplification so that the final result is an incomplete and misleading picture of the subject. Unfortunately, the important topic of mass transfer with chemical reaction was a victim of this error.

The author and publisher suggest that the book is a suitable text for a first course in turbulence which is to be presented either at the undergraduate or graduate level. This is only partly true. The book is, for the most part, readable and the level is approximately correct for the upper level undergraduate or beginning graduate student. However, the introduction provided to some of the basic concepts is not satisfactory. The basic topics are covered too briefly and not entirely clearly; therefore, they would not provide an acceptable base for building the remainder of the course. Introduction to turbulence must come from some other source. This reviewer feels that the main value of the book is its alternate method of viewing turbulence phenomena. Hence, it would be satisfactory as a supplementary text and only if it were suitably supplemented would it serve as a primary text.

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Chemical Reaction Engineering, Octave Levenspiel, Wiley, New York (1972). 578 pages. $16.95.

Professor Levenspiel's second edition maintains the lucid style and clear exposition of the first which made it deservedly popular in teaching chemical engineering reaction kinetics. Although the organization of the book remains largely as before, it has been rewritten in a variety of ways, both small and large, and the reader will note considerable changes, especially in the second portion dealing with nonideal reactors and heterogeneous systems.

Texts in the general area of chemical reaction engineering vary greatly in the topics considered and their depth of coverage. The first half of this book provides an excellent detailed treatment of ideal reactors and, as in the first edition, extensively uses graphical means of explaining reactor performance both for clarifying concepts and for quantitatively comparing the performance of reactors under different constraints. The two chapters on nonideal flow and mixing provide a useful and a more extensive treatment of this area than that found in most books. Considerable attention is given to fluidized bed reactors, to fluid-fluid reactions, and to reactions between a solid particle and a fluid. Heterogeneous catalytic reactions are treated rather briefly as is fixed bed reactor design. Slurry reactors appear in passing, and there is no mention of trickle bed reactors.

One might also classify texts in this field in terms of their relative emphasis in approach on (1) clarifying concepts and providing insights, (2) developing rigorous mathematical treatments, and (3) giving guidance to practical applications, including useful correlations, data, and treatment of real situations. Professor Levenspiel's text seems to fall largely in the first category. The practitioner and the advanced student may profit from other texts which give more detailed guidance to the recent literature and more treatment of the complexities encountered in real reactors. However, the author states that he has set out to write an introductory

and teaching book and at this he has succeeded admirably. Bemused readers of the first edition should know that the adventures of the Lavender Hill Philanthropic Society and other suitably outrageous propositions live on in this new edition and the author's analyses again lead him to conclude (for example, page 482) that even in chemical engineering S_{ex} and S_{in} may be encountered in close juxtaposition.

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A Handbook of Unit Operations, D. A. Blackadder and R. M. Nedderman, Academic Press, New York (1971). 284 pages. $15.00.

This American edition of a British textbook presents an analysis of a selected group of unit operations. Graphical or mathematical (noncomputer) techniques are used exclusively. There is almost nothing on sources of experimental data needed in the analyses, and there is little discussion of design factors such as performance correlations, efficiency predictions, economic considerations, or equipment layouts. The authors state that they have addressed themselves to students wishing to become familiar with the methods of analyzing unit operations before proceeding to a detailed equipment or process design. The material covered is indicated by the chapter headings: "Distillation of Binary Systems." "Solvent Extraction," "Gas Absorption," "Multicomponent Systems," "Heat Exchangers," "Drying," "Evaporators," and "Filtration." Notably absent are chapters on fluid flow, heat transfer, and mass transfer. There are many worked examples but no problems for homework or self study except for an occasional suggestion in the text of some proof or variation for the student to work out. SI units are used throughout.

The structure of the book is stated to be that each new topic is first treated in simple terms. Then complications and variations are introduced, frequently as part of a sample problem. Few of these treatments would be easily grasped by a beginning student. Indeed, sometimes the first exposure to a topic is in terms of a rather complicated case, for example, the first drying example is a continuous countercurrent, adiabatic, steady state dryer. At other times, the treatment is done in a way which would be likely to mislead or confuse a student. For example, in the McCabe-Thiele method, the operating line is plotted with no attempt to explain or point out the reasoning for the point of intersection with the $y = x$ line. It is not clearly and promptly stated that the operating line is straight if the McCabe-Thiele assumptions apply. No satisfactory criteria for the applicability of the McCabe-Thiele assumptions and method are given.

Several of the examples given in the book should be of interest to the practicing engineer. The book as a whole may serve, in fact, as a convenient review or reference book of certain useful analytical techniques in unit operations calculations.

This book is unlikely to be attractive as a textbook to the North American student or professor. Nevertheless, it may be recommended to libraries and those individual engineers who want a concise compilation of selected desk methods of analyzing unit operations.

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Industrial Processing with Membranes, Robert E. Lacey and Sydney Loeb, Interscience, New York (1972). 348 pages. $17.50.

This book is comprised of 13 chapters prepared by 15 contributors and edited by outstanding scientists in the membrane field Robert Lacey and Sydney Loeb. The stated purpose is to provide information which will enable consideration of membrane processes for industrial separations and to present basic principles to aid in the design and operation of membrane plants.

The scope of the book is limited to two membrane processes. One-third is devoted to electrically-driven processes. The other two-thirds is devoted to pressure-driven processes including reverse osmosis, ultrafiltration, and gas permeation.

I would characterize the book as being primarily useful to students and industrial workers interested in an introduction to the technology. For this purpose it has sufficient depth and detail of theory and basic principle, and is written in a clearly understandable and concise manner. One of its best attributes is copious referencing which enables further searches on specific topics of interest to the reader.

From an engineering viewpoint, particularly for those with some experience in this area, the title may be misleading. The title implies industrial application, but the book does not really come through with any reality in this regard. For example, there are virtually no photographs in the book. The use of photographs and schematics to illustrate types of available equipment and typical installations could have been used to give the reader confidence that there is reality in the application of this technology. In addition, for clarity and understanding, the use of photographs and schematics is really a necessity, especially in view of the complexity of the apparatus generally available.

I must also comment that the limitations of the present state of the art are not emphasized. Such limitations as the refractivity of membranes to physical, chemical, and biological attack as these pertain to membrane life are barely mentioned. The basic problem of maximizing flux on the face of complex feed components, the formation of gel layers, and the management of flows to optimize flux are not given sufficient attention.

It seems to me that the limitations might very well have been emphasized by description of some of the larger scale industrial applications of the technology in these terms. For example, large demonstration plants are and have been in operation for utilizing reverse osmosis and electrodialysis for desalination. Typical economics and performance could have been tabularized for such installations to give the reader—particularly the engineer—a feel for the reality of the art. Several large commercial applications which were in existence at the time of the writing of the book are either not mentioned or given only slight attention; for example, the use of membrane processes in the treatment of electrophoretic paint, whey, and the production of high purity water.

I share the conviction of the authors that this new technology will find wide application in the process industries. This book goes part of the way toward illuminating the potention of industrial separation processes with membranes. I share the conviction of the authors that this technology will find wide application. This conviction could have been strengthened with more evidence of current industrial utility.

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