Finally, the possibility of adding controllers to cause optimal oscillation of stable steady state processes is examined.

The author has provided problems with an indication of their level of difficulty. However, so few of them are designated as undergraduate that this book must be considered as a graduate text. The two volumes should be used in sequence with Volume 1 at either the undergraduate or graduate level.

ROBERT L. NICKELSON
CHEMICAL ENGINEERING DEPARTMENT
MONTANA STATE UNIVERSITY
BOZEMAN, MONTANA

Dynamic Behavior of Processes, John C. Friedly, Prentice-Hall, Englewood Cliffs, N. J. (1972). 590 + xv pages. $18.95.

This text by John C. Friedly is a surprisingly complete discussion of the principles of unsteady state behavior of chemical and related processes. Friedly has given a very complete and detailed exposition of the dynamics of chemical processes. This book is especially noteworthy for its many detailed examples of models for reactors, both continuous for stirred tank and batch tank, and distributed (packed bed and tubular) and for its major emphasis on distributed systems and their partial differential equation models. Likewise, a very thorough treatment is given of the methods of solution of the resulting sets of equations where they fit any of the systems which have analytical solutions or where approximations are possible. Also extensively treated are lumped and distributed models for distillation and the related separation processes.

This text uses fully the mathematical techniques of vector analysis and matrix notation to facilitate the development and the solution of complex models of ordinary and partial differential equations. Chapter 3, along with two appendices of the book, gives a 37-page review and tabulation of matrix, vector, and linear algebra techniques, as well as Laplace transform methods. This material is enough for reference or review but requires that the reader have experience with these techniques prior to attempting a thorough study of process dynamics as presented here.

While the book is somewhat larger than average, it is still relatively small for the large number of topics covered. Consequently, the material is covered at a quite high level in order to be thorough but brief. The result is a text which is really suited only for students with a high level of preparation. The author in his Preface recommends his book for a typical graduate course in process dynamics, or for advanced and specialized courses in this area. As just mentioned, this reviewer would certainly support the use of this book for a second or advanced level graduate course in the area of process dynamics.

In view of the specialized nature and very high level of this text, this reviewer would not endorse it even with extensive supplementary material for a course in process control (presumably at the graduate level) or for a senior course in process dynamics and control. There are too many excellent process control tests available today which cover both dynamics and control at a lower technical level and in a much more detailed fashion. Certainly, one or the other of these should be used for such purposes.

In summary, this is a very valuable reference book for those with the background to use it and an excellent text for the advanced student.

THEODORE J. WILLIAMS
102 MICHAEL GOLDEN LABS
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

Gas Chromatography, L. Szepesy, Chemical Rubber Co., Cleveland, Ohio (1972). 384 pages, $26.50.

The gas chromatograph is probably the analytical instrument with which a chemical engineer is most likely to become involved. This book by L. Szepesy, a chemical engineer himself, is well designed to acquaint those having little or no experience in gas chromatography with the fundamentals, equipment, and techniques of this constantly expanding field. It is a well organized and very readable book, although the translation is occasionally awkward.

In the first sections of the book dealing with the theory and fundamentals of gas chromatography, many of the familiar equations of mass transfer, fluid flow, and phase equilibria are in evidence. Refraining from including derivations, the author has simply presented the more important equations and correlations accompanied by discussions of their relative value and applicability.

The chapter on equipment is quite complete with descriptions of the major types of the various components which make up gas chromatographic systems. The advantages and uses of each type of equipment are presented clearly and concisely.

The varieties of columns, packings, operating techniques, and the treatment of data are adequately discussed. Information about conditions for specific analyses are not given in the book. Instead, the author has chosen to present tables containing references on the analyses of the more important groups of compounds, both liquids and gases. Most of these references are to English language journals, and there are several given for each group of compounds.

Two short chapters on preparative and process gas chromatography are also included. There is an extensive bibliography of over 1100 references, and the index is very complete.

While there is nothing new or unique in this book, those inexperienced in the field of gas chromatography will find it a very useful and informative text. The price, however, may limit its attractiveness for many.

R. G. WETHEROLD
MOBIL CHEMICAL COMPANY
RESEARCH AND DEVELOPMENT LABORATORY
EDISON, N. J. 08840

Chemical Reaction Engineering, Advances in Chemistry Series 109, American Chemical Society, Washington, D. C. (1972) $16.50.

This book represents the proceedings of the First International Symposium on Chemical Reaction Engineering held in Washington, D.C. in June, 1970. Although titled "First International", the Symposium was an outgrowth of the previous four European symposia; the first held in 1957. Many feel that these symposia defined, in essence, the broad field of chemical reaction engineering. A wide range of topics is represented and both fundamental and applied papers are included. There are papers dealing with fixed bed reactors, polymerization kinetics and reactor design, fluidized bed reactors, optimization of reactor performance, physical phenomena and catalysis in gas-solid surface reactions, two-phase and slurry reactors, catalyst deactivation, industrial process kinetics and parameter estimation, stability, control and transient operations, and biochemical reactions.

In each subject area (10) is an authoritative review of the state of the art by an international expert, followed by extended summaries of the research papers. This structure provides the reader with a current, general survey of each area, as well as details of the latest research. Care was taken to ensure that session chairman and authors represented both the United States and

(Continued on page 416)

press some doubt about the theory concerns the estimates of the rates of leakage of tracer gas from bubbles into the particulate phase around them and, particularly, the conclusion in the theory that gas flows into the bases of bubbles at the same rate at which it leaks out. Garcia et al. believe that our observations of rapid accumulation of tracer gas in the wake region behind a bubble can be accounted for by the shedding of tracer from the outer edge of our thin tracer clouds in the particulate phase above our bubbles; we believe that it can be accounted for by the continual release of solid particles from the unstable roof of a bubble, leading to addition of interstitial gas to the bubble at the top and entrapment of bubble-cavity gas at the floor.

Thus, there are alternative explanations of bubble behavior, each acceptable, we think, on the basis of presently available evidence.

Garcia, Grace, and Clift (1973) refer to their own observations of upward gas velocities inside bubbles using very light solid particles inside a fluid bed composed mainly of coal particles four to six times larger than our glass beads. Their observations are contrary to our own conclusion that, for our smaller glass beads, the direction of net gas flow probably was downward, with a rather large uncertainty which we reported. Our calculated downward flow rate came from a material balance which we believe is valid. We suggested that one way to account for the rapid growth of tracerfilled gas volume below each bubble, exceeding the flow rate down the bubble's sides, is to assume that there was entrapment of gas at the floor between solid particles that land there. Garcia et al. believe instead that the observed accumulation rates come entirely from diffusive shedding of tracer from the theoretical cylindrical cloud of gas outside each bubble. As we pointed out, our numerical results agreed approximately with the theoretical expectation. We think that either point of view about the rate of loss can be taken on the basis of the available data. The unsettled question seems to us to be whether tracer gas returns to a bubble or not.

Garcia et al. criticize our conclusions about solid volumetric flow rates which we derived from a similar material balance. They are correct in their assertion that we did not evaluate the contribution in this balance from solid particles which cross the tracer-gas streamline enclosing the wake region. The potential flow theory is clearly invalid for the base region below the flat floor of a bubble and there are no particle velocities available for making such estimates. Their direction is known, however. Because of the vertical pressure gradient in our bed, the gas tends to flow upward about 1.3 in/s faster than the solid. If such a downward flux of solid had been included in the balance for our wake regions, the derived value of the downward flow of solids onto the floor of our typical bubble would have been even greater than the value we reported.

We believe, finally, that the potential flow theory is supported by much of the available evidence but we continue to believe, as we stated, that conclusions from it about the mechanism by which tracer gas is lost from bubbles and whether tracer gas returns may be wrong.

LITERATURE CITED

1. Garcia, A., J. R. Grace, and R. Clift, "Behavior of Gas Bubbles in Fluidized Beds," *AIChE J.*, **19**, 369 (1973).
2. Rieke, R. D., and R. L. Pigford, "Behavior of Gas Bubbles in Fluidized Beds," *AIChE J.*, **17**, 1096 (1971).

R. L. Pigford and R. D. Rieke
University of California
Berkeley, California

TO THE EDITOR

In a recent issue of this Journal, Angus, Edwards and Dunning (1) presented a helpful discussion of signal broadening in laser doppler velocimeters. In the Appendix to that paper they add an analysis of the beam in the region of the geometrical focus.

Additional diagrams of intensity for truncated gaussian beams that may be helpful to the reader are contained in the following article:

"Design of Optical Systems for use With Laser Beams" by Daphne J. Innes and Arnold L. Bloom published as the Spectra-Physics Laser Technical Bulletin Number 5, Mountain View, California.

LITERATURE CITED

Angus, John C., Robert V. Edwards, and John W. Dunning, Jr., "Signal Broadening in the Laser Doppler Velocimeter," *AIChE J.*, **17**, 1509 (1971).

Jack L. Gaston
School of Engineering
California State University
Northridge, California 91324

BOOKS (continued from page 414)

Europe and, likewise, industrial and academic professionals. Future International Symposia (such as that held in Amsterdam in May, 1972, and that to be held in Chicago in 1974) will also have state-of-the-art reviews. In summary, the book contains "chemical reaction engineering 1970" as it is seen by a wide range of experts in the field.

Thus, this book should be a very useful consolidation of the recent progress in chemical reaction engineering. The research contributions indicate the current directions of research and serve to alert both investigators and users to the next problems that will be attached and hopefully be solved.

Kenneth B. Bischoff
School of Chemical Engineering
Cornell University
Ithaca, New York

Editor's Note: Professor Bischoff was the chairman for this First International Symposium and, since the subject area was so broad, it was felt that he could best present a summary of the objectives of the symposium as well as to review its contents.

Guide for Safety in the Chemical Laboratory, Manufacturing Chemists Association, Van Nostrand Reinhold, New York (1972). $17.50.

This book provides the chemical laboratory supervisor with a practical guide for controlling laboratory safety problems.

Information on safety storing, handling, and disposing of chemicals in a laboratory is given. You might say that the coverage is weak because all details are not given. On the other hand, the coverage is strong in that the most frequently occurring accidents are treated and up-to-date references are given for follow-up details. This is as it should be so that the reader can personalize his own action for his particular circumstances.

The book provides safety guidelines for scale-up from the laboratory bench to the pilot plant that are not readily available elsewhere.

This book should be a welcome addition on safety designs and practices for all personnel involved in chemical laboratory operation.

E. James Gratz
Senior Safety Engineer
Chevron Research Company
Richmond, California