less than the boiling point at one atmosphere.

In general, the book will be quite useful in process design calculations and will unquestionally reduce the time consuming step of searching the original literature for vapor pressures.

ROBERT C. REID
EDITOR
AICHE JOURNAL

Turbulence in Liquids, J. L. Zakin and G. K. Patterson, (Eds.), Department of Chemical Engineering, University of Missouri—Rolla (1972). 203 pages. $10.00.

This volume contains the papers presented at the 1971 biennial conference of the Rolla series devoted to turbulence in liquids. These symposia provide an excellent opportunity for researchers in this somewhat specialized area to discuss their work.

In 1971, sessions were labeled Measurement Techniques, Turbulent Burst Signatures, Pressure Fluctuations, Measurement and Analysis of Turbulence, Visual and Light Transmission Measurements, and Needed Data. Most sessions included an invited lecturer. Many papers emphasize experimental techniques, data analysis, and the supporting theory rather than a theoretical description of the turbulence observed. Since the experimental basis for liquid studies has generally been lacking until recent years, this emphasis is justified. Particular attention is given to hot film anemometry and visual techniques such as laser-Doppler velocimetry. Lacking from the collection of measurement technique papers, however, is a critical review of the state-of-the-art pinpointing the questions about liquid turbulence measurements that remain and suggesting work to be done. Discussions of individual papers are concerned with details and generally do not provide perspective.

A noteworthy paper by G. R. Offen, S. J. Kline, and W. C. Reynolds does review current investigations of turbulent shear with particular attention to turbulent bursts. This paper and several others raise concern about the interpretation of conditioned-sampling results.

As is often true for specialized symposia, some authors present only one phase of their work here with their major contribution published in the journal literature. However, incentive is provided by a collection such as this to refer elsewhere to related work.

The book is attractively bound in hardcover. However, the type size is too small to be read comfortably.

In balance, the volume provides a very useful discussion of some recent developments in the study of turbulence in liquids and will be welcomed by the large body of researchers having an interest in that area.

ALEXANDER SESONSKE
DEPARTMENT OF NUCLEAR ENGINEERING
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

Industrial Source Sampling, David L. Brenchley, C. David Turley, and Raymond F. Yarmac, Ann Arbor Science Publishers, Michigan (1973). 481 pages. $18.00.

Each audience and reader sees a book differently. I wonder if the authors of this book agree upon the audience at which they have aimed. The preface says that Chapters 1 through 5 are aimed at administrators and that these chapters will be useful to engineers who plan and perform source tests. I doubt that. Those chapters will be most useful in a classroom. Specifically, Chapters 1 to 3 are too introductory. Some of the information may well be useful to administrators and engineers, but I doubt that they will read all of it.

Probably every reviewer sometimes wishes he could have had a hand in the writing. I would have organized this particular book another way certainly, with the very useful Chapter 8 titled "Errors in Source Sampling" located nearer "Computational Methods" which is in Chapter 15.

The list of symbols could have been a little tighter. It would have made reading easier if the authors had selected just one of P_b, P_{atm}, P_{bar} to represent atmospheric pressure.

All books, it seems, suffer from typographical errors. Most in this one are simply letter errors which cause no trouble for the reader, but here and there a sign is dropped as on page 42, or a word is changed, as when impacted particles become compacted particles. One wonders upon discovering one such error if meaning is changed somewhere with another error.

In spite of these negative comments, this book deserves space on the desk of anyone concerned with the subject of source sampling.

Chapters 9 through 14 effectively lead one through preparation for, and performance of, tests. Chapter 8 tells one what could be wrong with the results, and Chapter 15 is a very clear treatment of the necessary calculations associated with those tests. Chapters 16 to 18 assemble in one location a wealth of up-to-date information on equipment and methods for source testing and monitoring. Covered are both commercial instruments and some methods which, although still in development stage, appear especially promising.

My major complaint with the book is its unevenness. The chapters on industrial process information are necessarily quite superficial, while the chapter on error analyses is quite theoretical. That is not a fatal flaw, however, and the book can definitely be recommended.

HOWARD REIQUAM
BATTELLE
COLUMBUS LABORATORIES
COLUMBUS, OHIO

Applied Statistical Mechanics, Thomas M. Reed and Keith E. Gubbins, McGraw-Hill, New York (1973). 506 + xx pages. $18.50.

The authors have presented a current, accurate collection of methods of predicting properties employing the principles of statistical mechanics. The best available statistical mechanical models are presented along with comparisons of calculated and experimental values. The style is uniformly easy to read and the text is well interspersed with examples and figures.

We used this book as a base for discussion in a doctoral colloquium in the chemical engineering department at Texas Tech. Each participant reviewed one chapter at our weekly meetings. We formed the impression that many concepts which could be grasped fairly easily were thoroughly explained, while some of the more difficult were merely stated. We concluded that fruitful use of the book would require more than an elementary background in quantum mechanics and statistical mechanics. However, the calculational methods presented should prove to be excellent for the prediction of both thermodynamic and transport properties in the hands of an experienced statistical mechanician.

We found the book to be very broad in its coverage, both of systems considered (from ideal gases to liquid mix-

(*Continued on page 1087*)

LETTERS TO THE EDITOR

LETTER TO THE EDITOR: HANDLING OF EQUALITY CONSTRAINTS IN OPTIMIZATION

In a recent paper Westerberg and Debrosse (1973) presented an optimization algorithm which appears to suffer from the difficulty of being unable to handle nonlinear equality constraints without introducing significant errors. The optimization of an alkylation plant as described by Sauer et al. (1964) illustrates the problem at hand.

The model of alkylation plant as presented by Sauer et al. is described by 10 variables subjected to 7 equality constraints and 20 inequality constraints. In the optimization of this plant Westerberg and Debrosse have replaced 4 of the equality constraints by 8 inequality constraints so that the problem would fit into their proposed optimization algorithm. In so doing, they have allowed in essence these 4 equality constraints to be violated, and have thus increased the yield, the motor octane number, and the performance number and decreased the acid dilution factor. Although 1% change in these variables may not appear to be much, such a change is very significant. Since the estimate of the daily profit is calculated from the excess of returns over costs and these are of the same order of magnitude, such constraint violations have the effect of increasing the expected daily profit from the optimal value of $1162 to $1715, an increase of 47%. Although Sauer et al. (1964) used approximations to solve this problem by linear programming, their approximations were very reasonable, yielding an expected optimal daily profit of $1163. Also, their results were very close to the optimum values: x_1 = 1728.37, x_2 = 16000, x_3 = 98.184, x_4 = 3056.05, x_5 = 2000, x_6 = 90.626, x_7 = 94.19, x_8 = 10.41, x_9 = 2.614, x_{10} = 149.58.

With a simple modification, the procedure of Westerberg and Debrosse (1973) can be used to obtain the answer without undue approximations simply by running the problem twice. The first time the problem can be run with the approximations. Then after identifying the tight inequalities which approximate equalities, the problem can be rerun with the removal of the 1% approximations.

LITERATURE CITED

Sauer, R. N., A. R. Colville, and C. W. Burwick, "Computer Points in the Way to More Profits," *Hydrocarbon Processing Petrol. Refiner*, 43, No. 2, 84 (1964).

Westerberg, A. W., and C. J. Debrosse, "An Optimization Algorithm for Structured Design Systems," *AIChE J.*, 19, 335 (1973).

Rein Luus
Dept. of Chemical Engineering
University of Toronto
Toronto, Canada

REPLY TO LUUS' LETTER

It is unfortunate that Dr. Luus has misunderstood our use of the Sauer example. Dr. Luus attributes our replacing of the nonlinear equality constraints in the original Sauer formulation to our inability to handle them directly. This is incorrect.

To counter his interpretation, we have re-solved the original Sauer problem directly, getting essentially Sauer's answer. It required only 9 function evaluations starting from the equivalent first feasible point (that is, defined by the equivalent set of tight constraints) as used in the paper. 15 function evaluations were required in the paper.

The source of our formulation, which we stated in the paper, was Bracken and McCormick's book of solved problems (1968), a convenient source of problems on which to test the suggested algorithm. They, not us, replaced the equality constraints in contention by the perturbed inequality constraints. It is unfortunate that these changes have made the problem physically unrealistic, as shown above by Dr. Luus. We certainly would not replace equality constraints by perturbed inequality constraints as a general policy. That action should almost certainly produce a problem requiring more work.

Since the algorithm requires tight inequality constraints to be used as equality constraints while moving toward a solution, deliberately using perturbed inequality constraints to replace equality constraints and solving a problem in two passes as suggested by Dr. Luus is of no value for this approach.

LITERATURE CITED

Bracken, J., and G. P. McCormick, *Selected Applications of Nonlinear Programming*, Wiley, New York (1968).

Arthur W. Westerberg
Dept. of Chemical Engineering
University of Florida
Gainesville, Florida 32601

BOOKS *(Continued from page 1086)*

tures) and molecular models. Depth of coverage was lacking, in that none of the methods was exhaustively treated, nor were constraints and limitations completely presented.

This work is outstanding in being up-to-date with the literature at the time of its printing and for its comprehensive bibliography. We were particularly impressed with its user-oriented, engineering viewpoint. Appropriately, little space was devoted to development of theory which is adequately developed elsewhere. Each chapter summarizes the assumptions made in using the molecular models of that chapter.

In the experience of the reviewers, some of the computational procedures recommended are fraught with pitfalls for those inexperienced in the use of statistical mechanics. The shortcomings of some of the calculational methods presented should be more fully discussed. In places, the nomenclature is confusing because so many different symbols are used. However, it must be conceded that the result is uniformity, even though some of the symbols used in the text do not appear in the Table of Symbols at the beginning of the book. The obsolete Greek *digamma* used for degrees of freedom would be more easily found by the reader in the English alphabet under F.

Remarkably, we found only two specific errors. First, Equation 4-39, page 125, is dimensionally inconsistent. The difficulty lies in the given definition of $P^{(N)}$, which Reed and Gubbins define as an Nth order polynomial in r, a, and b. DeRocco and Hoover, from whom Equation 4-39 is taken, define $P^{(N)}$ as an Nth order polynomial in $1/[r \pm (a + b)]$. Secondly, Figure 8-6 is upside down. Hutchinson plotted $-\phi(r)/kT$ vs. r, whereas Reed and Gubbins consistently plot $+\phi(r)/kT$ yet the figure was reproduced directly from Hutchinson.

The problems at the end of each chapter are well thought out and are reasonably representative of the material in each chapter. Also, the appendices are extremely valuable to the reader seeking more detailed discussion, and this greater detail is quite appropriately located, since the main text is a conceptual outline leading to final equations.

In general, we were well impressed with this fine effort to accomplish a Herculean task.

H. R. Heichelheim
and D. C. Bonner
Department of
Chemical Engineering
Texas Tech University
Lubbock, Texas