where is there to be found a treatment of slug or intermittent flow, which occurs widely in industrial equipment; of the problem of flooding in gas liquid flow, which is central to the design of nuclear reactor core cooling systems; pressure drop and holdup in large diameter pipes, in which the energy industry has so much concern; or drop sizes and interchange processes in annular flow, which determines the design of gas-liquid reactors in the chemical industry. Modern computational methods for calculating gas-liquid flow using large integrated codes, and the special problems this entails, find no mention either.

On the other hand there is plenty of redundancy. As examples, bubble rise velocity is treated in some detail in four chapters, the equations of motion for dispersed two phase flow in three, design and operation of bubble columns in three, along with innumerable development of flow pattern maps. In a volume dedicated to gas-liquid flows it is strange to find two chapters dealing with liquid-liquid flow and one with visualizations methods for single phase flow. It's as if these chapters were added to fill out the preplanned page requirement.

Volume 3 consists of three sections; 1. "Properties of dispersed and atomized flows," 15 chapters., 2. "Flow regimes, hold-up and pressure drop" 16 chapters and 3. "Reactors and Industrial applications" 18 chapters. In each section the quality and relevance of each contribution varies enormously. An excellent, encyclopedic presentation of contacting and hydrodynamics of trickle bed reactors by Dudukovic and Mills in Section three is counterbalanced by a cookbook type chapter on the Hydraulics of Distillation column piping in the same section. Some few chapters deal with a subject broadly but most concern themselves with a very narrow aspect of the field. This book is hardly an encyclopedia and will be of only limited use to the researcher or designer concerned with gas-liquid flow.

A. E. Dukler
Dept. of Chemical Engineering
University of Houston
Houston, TX 77004

Encyclopedia of Fluid Mechanics *Volume IV: Solids and Gas-Solids Flows,* 1,391 pp.

Though described as an encyclopedia, this volume is actually a collection of papers in the area delineated by the title. These are grouped into four sections, namely: properties of particulates and powders, particle-gas flows, fluidization and industrial applications, and particulate capture and classification. Of the forty-four articles printed, eight are written by the editor himself, and the remainder by authors from a wide variety of backgrounds and geographic locations. A few of these are well known contributors to their fields, with a broad view of the current state of knowledge and the ability to summarize it in a way one would hope to find in an encyclopedia article. Unfortunately, many are not, and some contribute little more than a narrow account of a particular contribution of their own. On the positive side, one might mention an excellent review of bubble dynamics in fluidized beds, written by the editor, and a number of other chapters which, if nothing else, end with useful bibliographies.

In a multi-author work of this type some uneveness of quality is to be expected, but in a book which described itself as an "encyclopedia" one might expect more evidence that the authors had received guidance on the nature of their contributions, and been required to follow it. The production of the volume also seems to have received little attention. The table of contents lists forty-four articles and an index, occupying a total of 1391 pages. However, the review copy actually ends on page 1329, after the forty-second article!

In summary, this is a poor production, not at all to be compared with the great scientific encyclopedias, whose articles have often become classic expositions of their fields. Its price is such that its main market would be expected to be academic and technical libraries, and even for them it does not represent good value.

Roy Jackson
Dept. of Chemical Engineering
Princeton University
Princeton, NJ 08544

Supercritical Fluid Extraction Principles and Practice

By Mark McHugh and Val Krukonis, Butterworth Publishers, Stoneham, MA, 507 pp., 1986, $39.95

Supercritical fluids have attracted considerable attention from the industrial and academic research communities over the past 15 years. Higher-than-ideal gas compressibilities, liquid-like densities, low viscosities (typically an order of magnitude lower than for organic solvents), and kinematic viscosities that are lower than for liquid metals are among the remarkable combination of properties exhibited by fluids in the (approximate) range [$1 < T_r < 1.2$; $1 < P_r < 2$; $T_r \equiv T/T_c$, $P_r \equiv P/P_c$]. As chemical engineering continues its commodity/specialty transition, supercritical fluids will hopefully find their way into more and more novel applications that exploit their still largely untapped potential. The casting away of supercritical extraction's heavy "distillation-substitute" yoke is prominent among the positive developments which this trend toward diversification will undoubtedly bring about.

The authors of this book are active in supercritical research, to which they bring an interesting blend of academic (Mark McHugh) and entrepreneurial (Val Krukonis) perspectives. They have organized their work into 12 chapters, an epilogue, and two appendices. Chapters 1 through 5 provide historical and thermodynamic background information on the subject, through a discussion of: history (Chapter 2), phase diagrams (Chapter 3), experimental methods (Chapter 4), and thermodynamic modelling (Chapter 5). Chapters 6 through 12 discuss past, present and future applications of supercritical technology. The emphasis is heavily descriptive, and the topics covered include basic operating modes for supercritical processing (Chapter 6), pre-1976 applications (Chapter 7), activated carbon regeneration and water-organic separations (Chapter 8), polymer processing (Chapter 9), coffee decaffeination, edible oils extraction, pharmaceuticals processing, isomeric separations and waste stream treatment (Chapter 10), chemical reactions (Chapter 11), and supercritical fluids as nucleation media, porous polymer formation, and polymer swelling (Chapter 12). Appendix A, comprising more than 40% of the book's length, is a critical review of 95 patents; Appendix B contains computer programs for the calculation of phase equilibria via the Peng-Robinson equation of state.

The whole field of supercritical fluids is presented by the authors from an analytical, descriptive perspective, at the expense of synthetic rationalization. Readers interested in exploring potential applications and learning some of the trade's rules of thumb and exciting possibilities will find the book's seven descriptive chapters (6 through 12), 273 literature references, and 95 critically reviewed patents extremely useful and informative.

This is not, however, the place to look for an understanding of the scientific fundamentals underlying the fascinating phenomenology of supercritical behavior. No attempt is made at addressing the physical (molecular) origin of such crucially important phenomena as large negative solute partial molar volumes (Chapter 11). Also lacking are thorough discussions on transport of heat, mass, and momentum in supercritical fluids, and on critical phenomena. The treatment of the density dependence of solubility in supercritical fluids provides an excellent example of the authors' approach. We are told that ". . . the authors of virtually all the previously mentioned review papers suggest that, to a first approximation, the solvent power of a supercritical fluid can be related to the solvent density in the critical region." This is followed by a qualitative discussion of the similarities existing between equilibrium solute mole fraction vs. pressure isotherms and solvent reduced density vs. reduced pressure isotherms. Indeed, it is true (and very useful to know) that solubility is "related to" density. But shouldn't a book subtitled "Principles and Practice" do more than inform us about useful facts? It goes without saying that these closing remarks originate from this reviewer's perception of a lack of correspondence between title and contents. The same book, subtitled "in Practice," would have earned my unreserved commendation. If, in other words, you are interested in what to do with a supercritical fluid and how to do it, but not in understanding how things behave as they do, ignore the contested sub-title, forget this last paragraph, and buy the book.

P. G. Debenedetti
Dept. of Chemical Engineering
Princeton University
Princeton, NJ 08544

Supercritical Fluid Technology

Edited by J. M. L. Penniger, M. Radosz, M. A. McHugh, and V. J. Krukonis, Elsevier, 1985, 464 pp.

Supercritical Fluid Technology is a collection of papers devoted to various topics relevant to researchers and practitioners in this field. The volume is divided into four sections: thermodynamic modeling of supercritical fluids, experimental data and techniques, process development, and special applications.

The papers in the first two sections cover a wide range of phenomena and analyses and deal with some unusual topics such as retrograde solubility behavior and its potential significance in separation process design, continuous thermodynamic models and the particular relevance of partial and excess properties for understanding the thermodynamic behavior of the supercritical fluid phase. A number of papers on various equations of state modeling approaches are given; however, the virtues of using one approach over another are not made clear. A recent survey paper on comparative studies of equations in both the near-critical and more dense regimes would have been a useful addition to this section.

The experimental section contains excellent papers covering technique and analyses for both thermodynamic and transport properties in supercritical fluids. It covers a wide variety of systems with their unique features, ranging from polymer-supercritical fluid mixtures (i.e., polystyrene, toluene, carbon dioxide) to the ternary isopropanal, water, carbon dioxide.

The last two sections are process-oriented, involving systems and processes considerably more complex than those discussed in the preceding sections. They include a number of processes, from coal liquefaction to biomass hydrolysis.

The papers have been generally well written, edited, and presented. This valuable volume helps gain a broader perspective of some of the issues of current concern in the supercritical fluids area.

Eldred Chimowitz
Dept. of Chemical Engineering
University of Rochester
Rochester, NY 14627

Temperature Programmed Reduction for Solid Materials Characterization

(Chemical Industries Series, Volume 24)

By Alan Jones and Brian D. McNicol, Marcel Dekker, Inc., 1986, 208 pp., $59.75

Temperature-programmed reduction (TPR) is a relatively new technique for solid materials characterization. In this book, Jones and McNicol review the various aspects of the technique. As stated in the preface, it is intended as an informative guide for both experts and initiates in the field. It is divided into five chapters. After a short introduction to the technique in chapter 1, the underlying theory of TPR is discussed in chapter 2. Chapter 3 is a short chapter describing the required instrumentation. In Chapter 4 applications of TPR to a wide variety of systems are discussed at length. Chapter 5 is a short discussion of future developments in TPR.

The emphasis of the book is on the use of temperature-programmed reduction to characterize heterogeneous catalysts. However, the book correctly points out that TPR is applicable to other solid systems as well.

Chapter 4 on the numerous catalyst systems to which TPR has been applied serves as an excellent reference to the TPR literature. In the section on supported monometallic materials, the use of TPR as a valuable diagnostic tool in catalyst preparation and regeneration is discussed in detail. Unfortunately, most of this chapter, especially the section on zeolites, simply presents examples of TPR spectra and their interpretation. Little attention is paid to describing how that information is derived from TPR spectra. In most cases, the conclusions could not have been drawn from the TPR results alone. This chapter would have been far more informative if the use of other techniques in conjunction with TPR results were discussed. Then, when examples were given, the authors should have explained what other techniques were used and how those results were combined with the TPR results to arrive at the conclusions.

The weakest point of this book is that the authors do not emphasize that TPR is just one of several temperature-programmed techniques which can be used for catalyst characterization, all of which are variations on temperature-programmed-desorption (TPD). In TPD, a catalyst is predosed with an adsorbate, and its temperature is increased linearly in time. Desorption occurs either in vacuo or into a carrier gas which flows over the catalyst, and the desorption products are monitored. In TPR, as described in this book, the carrier gas is replaced by a reducing gas, typically hydrogen, which flows over an oxidized catalyst. In this case, hydrogen consumption is monitored while the catalyst temperature is increased. In chapter 3, the authors mention that they are not aware of any examples in which TPR was done where the products were monitored. Only as a fu-