data, methods for estimating vapor-liquid equilibria, group-contribution methods, data sources, and computerized data banks. Finally, the CHEMCO data bank, whose manual is in Appendix E, is described with a sample program illustrated as Example 10.1. In Chapter 11, several topics are addressed concerning the practical usage of a flowsheet program. These are followed by the simulation of a toluene hydrodealkylation process, with a program presented in Table 11.1 for simulation using the UNICORN program, whose "mini-manual" is in Appendix E. The approach in Chapters 8–11, although helpful, does not appear to teach the important concepts as effectively as can be accomplished with numerous examples using one or more flowsheet programs.

Chapter 12, Process Optimization, offers a 38 page introduction to this important subject. The concepts of linear programming are reviewed, but not taught. For nonlinear systems, univariate search procedures are introduced. These are followed by 12 pages of qualitative descriptions of the direct search, steepest ascent, generalized reduced gradient, quadratic programming, simplex, and adaptive random search algorithms, with some comparative performance results. The chapter finishes with introductions to integer optimization and the optimization of batch processes, and Example 12.5, in which a network of heat exchangers is optimized.

Chapter 13, Safety and Loss Prevention, is especially timely and contains a fine qualitative introduction to this subject. After a brief introduction, the section on loss prevention identifies the kinds of hazards, followed by considerations in reducing the danger, either in the design stage or during the operation of a plant. Then, a section on implementing safety measures during design completes the qualitative treatment very effectively. The next section focuses on the more quantitative methods of risk analysis. First, hazard indices are introduced followed by formal hazard studies, such as the HAZOP, Failure Mode and Effect Analysis, and Fault Tree Analysis, and finally the use of expert systems. These measures and methods of risk analysis need more emphasis in design courses, but unfortunately the Wells and Rose discussion seems inadequate for teaching students how to apply and utilize these quantitative methods. Three brief sections follow with qualitative discussions on site and plant layout, implementing loss prevention programs, and the consideratons in storing and unloading chlorine. The last section considers the application of all of these methods to a process for the hydrodealkylation of toluene. This process study is well-conceived, but nine pages are barely sufficient to confirm the importance of hazard analysis and the utilization of the methods presented in the chapter.

Chapter 14, Storage Scheduling and Plant Availability, provides a brief introduction to the optimal use of storage for raw materials, products, and intermediates in continuous and batch processes. This is followed by similarly brief sections on the scheduling of batch operations, plant availability, and the use of stochastic simulation.

Finally, Chapter 15, Flow Diagrams and Control, in just 34 pages introduces some important design considerations with sections devoted to the synthesis of the control system, microprocessor based controllers, and the piping and instrumentation diagram.

In summary, The Art of Chemical Process Design, provides coverage of the topics most educators seek to include in a modern process design course. However, the treatment is too introductory, with many examples, but too little information for students to master the design methodologies that enable them to undertake quantitative design studies as seniors in chemical engineering curricula. The book contains many exercises following the chapters and these should be very helpful to design instructors.

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Polymer Surfaces and Interfaces

By W. J. Feast and H. S. Munro, Eds., John Wiley and Sons, New York, NY, 257 pp., 1987

This book is a collection of 12 articles summarizing presentations made at a symposium of the same title that was held in Durham, UK in April 1985 under the auspices of the Pure and Applied Macromolecular Chemistry Group of the Royal Society of Chemistry and the Society of the Chemical Industry of the UK.

The volume has several strengths. First there is a diversity of topics, covering polymer blends to proteins to plasmas, with especially good introductions to an array of modern instrumental techniques that those in the field working on surfaces will find useful even if they are not particularly concerned with each specific application discussed by the author. The chapters are authoritative and the material is up-to-date.

Several chapters are particularly good in surveying the topic well and providing a good basis for research in their area. These include Winnik's on luminescence techniques, Kinloch's on metal-adhesive interfaces, Petty's on Langmuir-Blodgett techniques and Lundstrom, et al., on protein adsorption. Several of the articles focus more narrowly than they should on the author's own contributions to the field, thus limiting their usefulness as survey articles. This certainly is not unusual in a symposium volume where it is difficult to enforce complete uniformity of style and coverage.

There is no doubt that anyone interested in polymer surfaces and interfaces will want to peruse this volume.

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Annual Review of Numerical Fluid Mechanics and Heat Transfer, Volume 1

By T. C. Chawla, Ed., Hemisphere Publishing, 454 pp., 1987 $149.95

The editor's preface states that this new series will survey fluid mechanics and heat transfer for nonspecialists such as graduate students. The chapter titles are:

Chapter 1. Thermal Radiation in Particulate Media with Dependent and Independent Scattering (Tien and Drolen)

Chapter 2. Pressure-Velocity Coupling in Incompressible Fluid Flow (Comini and del Giudice)

Chapter 3. New Explicit Methods for the Numerical Solution of Diffusion Problems (Evans)

Chapter 4. Numerical Methods for One-Dimensional Reaction-Diffusion Equations Arising in Combustion Theory (Ramos)

Chapter 5. Buckling Flows: A New Frontier in Fluid Mechanics (Bejan)

Chapter 6. Numerical Methods for Multidimensional Radiative Transfer Analysis in Participating Media (Chan)

Chapter 7. Fundamental Aspects of Analytical and Numerical Methods on

Freezing and Melting Heat-Transfer Problems (Fukusako and Seki)

Chapter 8. Complex Heat Transfer Processes in Heat-Generating Horizontal Fluid Layers (Cheung and Chawla)

The chapters vary widely in quality: chapters 1, 4, 6, 7 deserve A's; chapter 5, a C; chapter 8, an F; and the remaining chapters, B's. Perhaps the editor should have paid more attention to quality control. This volume lacks depth because a single editor tried to cover a broad range of topics: from radiative heat transfer to algorithms for parabolic equations. Also, readers would have been better served if the authors focused on producing a critical guide to published literature instead of giving a detailed exposition of material. The style varies from that of a textbook to that of a research paper. For example, in chapter 3 (group explicit methods) the author even presents details of stability analyses for the algorithms he is reviewing (or proposing). This leaves the reader uncertain as to whether the material has been critically refereed elsewhere.

Chapter 8 (convection in layers with internal heating) contains slabs of detailed exposition (e.g. 3.1, 3.2) more appropriate to a text. This chapter presents the relation between thermal boundary-layer thickness and Nusselt number $\delta \sim Nu^{-1}$ as a theoretical result supported by experiment, rather than as a consequence of the definition of Nu. It contains other gems, but this tells you its caliber.

It is unfortunate that the quality is so spotty. The authors of chapters 1, 4, 6, 7 have been betrayed by the editor. The volume is expensive for only four good reviews. It does not approach the quality of *Advances in Heat Transfer or Annual Reviews in Fluid Mechanics*. I do not recommend it either for browsing by graduate students, or for purchase by libraries.

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Mixing: Theory and Practice, Vol. III

By V. W. Uhl and J. B. Gray, Eds., Academic Press, Orlando, FL., 1986, $89.50

This text is the third volume in a series. The first two volumes were published in 1966. Mixing research has changed since then, and a significant amount of work has been accomplished that challenges authors in the area. The chapters in Volume III cover: 1) agitation of solid-liquid mixtures, 2) turbulent mixing in pipes, 3) flow fields produced in tanks by axial flow impellers, 4) scale-up, and 5) mixing of solids. Accordingly, the text emphasizes the physical aspects of mixing.

Gray and Oldshue are the authors of the first chapter. The chapter covers a broad range of the important aspects of solid-liquid mixing. The chapter is well organized. References are cited often, permitting the reader the oppportunity for further study. References include important work done in Europe. Mass transfer and the effects of tank and particle geometrics on solid-liquid mixing are discussed. This chapter warrants close study.

Much the same can be said about the second chapter on turbulent pipe-mixing by Gray. Japanese literature is also cited in the second chapter. It is important to note that Joe Gray was the senior mixing consultant for E.I. DuPont de Nemours and Co., Inc. for a number of years. His experience and knowledge are demonstrated in these chapters.

In the third chapter of Volume III by Fort, the author claims 'to completely describe the velocity of axial impellers in baffled tanks." Unfortunately, he does not accomplish this task (see Smith, 1985), nor does he explain the need for such detailed information about flow fields in the first place. In essence, the chapter is a summary of the author's work. There are 51 references cited; 40% are by the author, ten are general reference texts and the remaining twenty references are primarily from the Czech mixing community. The chapter does not contain a definitive study of flow fields produced by axial flow impellers.

The chapter on scale-up by Uhl and Von Essen is a fairly complete discussion of standard scale-up techniques for agitated tanks. Scale-up of other mixing devices, such as static mixers, is not presented. Practical advice, methodology, and example problems are given, apparently summarized from the literature. The chapter is at the introductory/intermediate level and is a worthy study for the design engineer.

Negative aspects of the chapter include a wordy writing style and citing of specific references is limited. The work does not emphasize testing for actual process performance after scale-up, which is obviously very important. The origins of the various scale-up procedures are not given, and statements concerning the inability to apply the various equations of motion to mixing are not correct (see for example: Hiraoka et al. 1979, Kuriyama et al. 1982, and Middleton et al. 1984). Advances in scale-up methods will be based upon computational fluid dynamics in the coming years. Such work is well developed at the present time.

Chapter 5, by Williams, concerns the mixing of solids. This chapter is well-written and serves well as an introduction, covering a breadth of information including statistics of mixing indices, solids segregation, mixer selection, testing, continuous solids mixing and mixing of cohesive solids. There is also discussion of research needs.

The editors promised in the preface to provide a "combination of in-depth scrutiny and reduction to practice." The text fulfills this objective with few exceptions. The volume, overall, is a very fine professional level text which is in the tradition of the first two volumes in this series.

Literature Cited

Hiraoka, S., I. Yamada, and K. Mizoguchi, "Two Dimensional Model Analysis of Flow Behavior of Highly Viscous Non-Newtonian Fluid in Agitated Vessel with Paddle Impeller," *J. Chem. Eng. Japan*, 12, 56 (1979).

Kuriyama, M., H. Inomata, K. Arai, and S. Saito, "Numerical Solution for the Flow of Highly Viscous Fluid in Agitated Vessel with Anchor Impeller," *AIChE J.*, 28, 385 (1982).

Middleton, J. C., F. Pierce, and P. M. Lynch, "Computations of Flow Fields and Complex Reaction Yield in Turbulent Stirred Reactors, and Comparison with Experimental Data," *Int. Chem. E. Sym. Ser. No. 87*, ISCRE8, Edinburgh, p. 239 (1984).

Smith, J. M., "Dispersion of Gases in Liquids," Chap. 5, *Mixing of Liquids by Mechanical Agitation*, Eds., J. J. Ulbrecht and G. K. Patterson, Gordon and Breach Science Publishers, 158 (1985).

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First-Order Partial Differential Equations: Volume I Theory and Application of Single Equations

By Hyun-Ku Rhee, Rutherford Aris, and Neal R. Amundson, Prentice-Hall, Englewood Cliffs, New Jersey, 543 pp. 1986

This book is the first of two volumes in a major revision of *Mathematical Methods in Chemical Engineering: Volume 2 First-Order Partial Differential Equations with Applications* by Aris and