This book is clearly the best one on microelectronics processing for chemical engineers that is currently available. It is enthusiastically recommended.

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Pressure Swing Adsorption

By Douglas M. Ruthven, Shamsuzzaman Farooq, and Kent S. Knaebel, VCH Publishers, New York, 1994, 352 + xxiii pp., $95.00.

The authors of this book have wide experience in both the adsorbent and process sides of pressure swing adsorption (PSA), as evident from the depth and breadth of their backgrounds. Also evident is the writing style which makes it relatively easy for a novice in the field to pick up the book and find something to learn on his or her level almost immediately.

The issue of the level and audience at which a book should be "pitched" is a key these days. In practice, very few engineers in industry actually do detailed design calculations. More and more, separation processes are being designed by specialized companies and sold to those companies which actually use the processes in their plants. In the case of adsorption processes, the adsorbents are also being supplied by specialized companies. So the vast majority of engineers, who reside in companies which use separation processes, don't need to know the fine structure of design and construction details nor the minute details of mass separating agents like adsorbents. These engineers are more concerned about such issues as: Is PSA a viable option for solving a given separation need? How do economics and performance of PSA compare with, for example, those of membranes? How can I make a given process perform better? Will a different adsorbent or adsorbent geometry bring some benefit to the process? To deal with these and many other questions, the engineer needs to know how a PSA process works and how adsorbents work, but not the excruciatingly complex details of process design. To the authors' credit, they seem to have appreciated more than most of their compatriots the plight of this engineer. Information is not only clearly presented, but also in a manner which progresses from simple, qualitative explanations to complex and involved descriptions.

Take, for example, the way in which the authors handle the issue of how the actual cycles of PSA processes are organized. For most people, the bewildering array of co- and countercurrent pressurization, feed, co- and countercurrent blowdown, pressure equalization, purge, and other steps—to say nothing of when and when not to use each one—is about as mysterious as quantum physics. To go about explaining PSA cycles, the authors first present in Chapter 3 a table which qualitatively explains the various steps and why they are used. They proceed to show in a qualitative fashion how concentration profiles move through the bed under the influence of these steps. Then, they illustrate how cycles are organized in several commercial processes. Only after all of this, do the authors "get mathematical" and develop: first the equilibrium theory of PSA (Chapter 4) and then dynamic modeling of a PSA system (Chapter 5). The format works. One can find an entry point into the book at whatever level of knowledge about PSA one currently possesses.

One appendix gives a useful and interesting synopsis of the patent history of PSA, replete with brief explanations of the significance of some of the most important patents. Such an addition is rather rare for a separation book.

Lest the reader of this review think that the book is totally without flaws, I must mention a few concerns. The first deals with the last chapter, whose purpose is to draw a comparison between membrane processes and PSA. For our archetypal engineer in a producing company, a key issue is often, which separation process should I use in a particular situation? So I eagerly turned to this chapter to see what the authors had to say. Unfortunately, the analysis is limited to only air separation and is quite qualitative, so that many questions are left unanswered. Nevertheless, the authors need to be congratulated even here. At least they tried to address the really important issue of how one decides which process to use. How many other books have you read in which this issue is even raised? A second concern is the lack of much discussion (see p. 251 ff) on the use of PSA and for the removal of trace contaminants in gas streams such as process vents and storage-tank vents. Separations of this sort will burgeon in the future, and already at least two companies—AWD (a subsidiary of Dow) and UOP—are offering PSA processes and process help in this area. Finally, although the information on adsorbents is beautifully presented, the discussion could have been usefully extended to cover the effects of adsorbent-particle size and shape on bed performance.

Overall, the book is well written and covers the field of adsorbents and PSA processes very well. Given this and the fact that PSA does not have a wide breadth of applications, there does not seem to be the need for another process-oriented book in this area for quite some time. This one is just fine for the vast majority of readers.

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An Introduction to Coal Technology

By Norbert Berkowitz, Academic Press, New York, 1994, 2nd ed., 398 pp.

The scope of this book is well described in the preface to the first edition: "... an overview that tells what coal is, how it came into being, what its principal physical and chemical properties are, and how it is handled or processed for particular end uses." This clearly attempts to appeal to all readers. Coal, however, is studied by people with a wide range of interests—mining engineers, geologists, and of course chemical engineers. Hence, any book on coal is bound to have problems in satisfying all interested parties.

The book is divided into two parts, with the first dealing with the origins, formation and properties of coal, and the second dealing with coal upgrading, handling and processing. The preface to the second edition indicates that relatively few substantial changes have been made in Part I since the first edition (published in 1977), while Part II has been rearranged and "modestly expanded."

Part I, Chapters 1-7, comprises an interesting background for chemical engineers. In these and all subsequent chapters, however, I was struck by the

existence of footnotes (at the bottom of the page), endnotes (at the end of every chapter), and a separate citation of references. The distinction between material suitable for footnotes and that for endnotes was not clear to me. In the chapter on coal compositions, a discussion of the results of modern techniques would have been most useful, but there are basically three references dated after 1985 and none dated after 1990. Chapter 5 on chemical properties contains a good description of the chemistry, including some NMR and FTIR work. Chapter 6 is particularly strong on caking, coking, and pyrolysis. Unfortunately, Chapter 7 on the effects of solvents contains little on the effect of aprotic solvents ("supersolvents").

Part II, chapters 8-14, is likely to be of more direct interest to chemical engineers. Surprisingly, Chapter 8 on coal cleaning makes no explicit mention of the technologies proposed and used in the massive "clean coal" program in the U.S. The treatment of transportation and storage contains a section on fluid mechanics which is unlikely to be useful to chemical engineers, but is strong on history. Some upgrading processes (used for coal storage) are also discussed here. While on Chapter 10 on Combustion, readers will have to go back to refresh their memory on some of the materials dealing with pyrolysis and volatile matter, a brief review (or even a mention of section numbers) would not have been out of place here. In the following chapter, the qualitative treatment of combustors is good, but more details on design would have been preferred to citing reviews in the literature. Chapter 11 deals with low- and high-temperature carbonization, and coal-tar processes. There is a good overall assessment, but the treatment of individual processes is uneven. Modern research and demonstration projects in this area are not treated. The chapter on gasification deals well with the distinction between producer gas, water gas, and synthesis gas, and with the processes used to obtain each of these. Only about one page, however, deals with catalyzed gasification, and the treatment of hot-gas desulfurization is relatively sparse. Chapter 13 on liquefaction appears to be a historical treatment. Exxon Donor Solvent (EDS) and Solvent-Refined Coal (SRC) processes are dealt with. Early work carried out in the Wilsonville Advanced Coal Treatment Facility (ACTF) is mentioned, but not the more interesting results with close coupling, nor the fact that the ATCF has recently been abandoned. Again, catalysis in liquefaction is dealt with in a page. Coprocessing (of coal with other fuels) is dealt with only in terms of the HRI scheme. The final chapter on environmental aspects of coal utilization deals extensively with electrostatic precipitators, venturi scrubbers, and the like. Selective Catalytic Reduction and similar schemes are relatively quickly described.

In summary, the book fulfills the mission that the author prescribed. The historical treatment is excellent, as is the description of technology in commercial use, either currently or historically. Treatment of modern research advances and descriptions of demonstration technology would appear to be lacking. Discussion of advances in solvent dissolution, clean coal technologies, disposable catalysts, coprocessing, and stationary source emission control would have made the book more useful to researchers and practitioners. Japanese and French contributions to the (English-language) literature could also perhaps have been dealt with in greater depth. The book is suitable for in-depth background and for a good broadbrush description of the technology of coal processing.

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Multicomponent Mass Transfer

by Ross Taylor and R. Krishna, Wiley, New York, 1993, 579 pp.

This is an important book on multicomponent mass transfer, written by two leading investigators in the field. It is meant for readers already acquainted with the theory of mass transfer and the fundamentals of transport phenomena at the undergraduate level. The book is notable for its wealth of examples, including real data and useful comparisons of alternate models and methods for multicomponent problems. It is attractively printed and illustrated, with numerous graphs and schematic drawings.

Part I, entitled Molecular Diffusion, contains the following chapters:

1. Preliminary Concepts
2. The Maxwell-Stefan Relations
3. Fick's Law
4. Estimation of Diffusion Coefficients
5. Solution of Multicomponent Diffusion Problems: The Linearized Theory
6. Solution of Multicomponent Diffusion Problems: Effective Diffusivity Methods

Chapters 2-6 are very useful and well done. Nonideal mixtures and electrolytes are treated in the latter part of Chapter 2. The relative merits of the Maxwell-Stefan and generalized Fick diffusion coefficients are well treated in Chapters 3 and 4. Chapter 4 is a useful survey of diffusivity estimation methods for gases and liquids. Chapters 5 and 6 compare two popular approaches for solving multicomponent diffusion problems and should be required reading for workers in this field. The pitfalls of effective diffusivity approaches are thoroughly demonstrated in Chapter 6.

Part II, entitled Interphase Transfer, contains the following chapters:

7. Mass-Transfer Coefficients
8. Film Theory
9. Unsteady-State Mass-Transfer Models
10. Mass Transfer in Turbulent Flow
11. Simultaneous Mass and Energy Transfer

These chapters review selected mass-transfer models for binary systems and develop analogous methods for multicomponent systems. Chapter 7 deals with definitions, starting from a binary mass-transfer coefficient and generalizing the definition to multicomponent systems. Chapter 8 is a thorough treatment of the authors' multicomponent film model, with many examples. Chapters 9 and 10 are less complete; the surface-renewal model and laminar sublayer model given there are historically important, but more realistic models are available. Chapter 11 is extensive and well done, including detailed numerical examples on distillation and stripping in binary and ternary systems.

Part III, entitled Design, contains the following chapters:

12. Multicomponent Distillation: Mass-Transfer Models
13. Multicomponent Distillation: Efficiency Models
14. Multicomponent Distillation: A Nonequilibrium Stage Model
15. Condensation of Vapor Mixtures