pendent variable as it is in standard reflux columns discussed in the books. The second column pressure has to be controlled at the condensate drum, and the first column pressure would then find its own equilibrium value, much like it does in a double effect evaporator. Had the problem been terminated at the textbook stage, this "discovery" would have been lost.

CONCLUSIONS

Flow sheet is process language. Process language is exciting. Process language transforms book examples into process plant examples. Process language resorts to the use of utilities to vitalize unit operations teaching. Process language is a stimulating teaching tool.

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ChE book reviews

DISTILLATION TRAY FUNDAMENTALS

by M. J. Lockett
Cambridge University Press, Cambridge and New York, 1986. 224 + xxiii pp. $54.50

Reviewed by
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The distillation column continues to be the principal separation device for the chemical and petroleum processing industries. For many years it was characterized as a vertical, cylindrical column containing plates or trays upon which rising vapor and descending liquid were brought into intimate contact, for purposes of effective mass transfer. In recent years designers of distillation columns have shifted some attention to the use of structured (as opposed to random) packings as vehicles for effecting intimate phase contacting. However, such packings are considerably more expensive than trays, and their cost is often justified only when their lower pressure drop carries an economic advantage, as in some vacuum distillations. Thus, the tray column remains as the standard and basic device for vapor-liquid contacting.

Despite the title, this book deals not only with trays for distillation services but also covers applications in absorption and stripping. It covers all of the important aspects of tray design, those of a more hydrodynamic nature as well as those relating directly to the mass transfer propensity of the two-phase mixture on the tray. Considerable space is devoted to the characterization of this mixture: foam, emulsion, froth, spray, and so on. The overall coverage is quite complete, with no detail of design left unaddressed. Such important topics as phase flow distribution, capacity limits, pressure drop and interphase mass transport are dealt with on quantitative bases. A commendable effort has been made by the author to consider all historical approaches (mostly empirical) that deal with the various design parameters. The literature coverage is near exhaustive, and the reader will not find elsewhere as complete a bibliography on the distillation tray as is provided here. For each design consideration, a method with some fundamental and mechanistic support is provided—and for practitioners of distillation system design this is a welcome advance from the art and empiricism that have often prevailed.

There are some limitations to the treatment that should be mentioned. First, the author has not always found it possible to make a forthright recommendation when several alternate models or procedures are available for a particular design step. The reader must then make his own choice. Also, despite the title, all tray-type contacting devices are not considered. There is very little on valve trays, essentially nothing on bubble-cap trays, and complete silence on dualflow trays (those without downcomers). Emphasis is clearly on crossflow sieve trays, but this is not all bad. While there are still many bubble-cap tray columns in operation, very few new ones have been designed during the last few decades. The valve-tray is really a proprietary contactor, with design often left up to the proprietor. The dualflow tray is a rather specialized device (and tricky to design), used mostly for fouling services. On the other hand, the sieve tray is an efficient and relatively inexpensive non-proprietary device that has been the object of many basic studies, and its simple geometry (in effect, one or more sheets of perforated metal, joined to a downcomer for handling liquid passage) makes it reasonably amenable to fundamental modeling. Still, the title might have read "Distillation *Sieve* Tray Fundamentals."

The book might have been improved by the inclusion of some worked-out design examples, some advice on laboratory or pilot plant scaleup procedures, and an author index. Still, the development of rational, fundamental-based approaches to the handling of complex two-phase mixtures, as are found on trays, is refreshing and encouraging. The author has an extensive background in the research, testing and modeling of distillation devices, and his authoritative text reads very well. There is no equal to the book presently on the market. Anyone concerned with the design or analysis of distillation, absorption or stripping columns of the tray type will want to take advantage of the modern approaches presented in this book. □

GAS SEPARATION BY ADSORPTION PROCESSES

by Ralph T. Yang
Butterworth Publishers,
80 Montvale Avenue, Stoneham, MA 02180;
352 pages, $52.95 (1986)

Reviewed by
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The importance of adsorption as a separation process in the chemical and petroleum industries has increased dramatically in recent years, but the subject is still not covered in any significant way in most chemical engineering curricula. There have been three recent books on the subject: *Principles of Adsorption and Adsorption Processes*, by this reviewer, published by Wiley in 1984; *Large Scale Adsorption and Chromatography*, by P. C. Wankat, published by CRC Press in 1986; and the present volume by Ralph Yang, published by Butterworth Publishers in 1987. None of these is really a textbook in the formal sense, but any of them could be used as the basis for a graduate level (or possibly a final year elective) course on the subject.

The coverage of the present volume is broadly similar to that of *Principles of Adsorption and Adsorption Processes*, and there is considerable overlap, which is probably inevitable since many of the source references are common. The emphasis is, however, different—reflecting the different areas of interest and expertise of the authors. The book provides a coherent and comprehensive account of the subject, including the basic physico-chemical principles as well as process technology. Although the title is *Gas Separation by Adsorption Processes* (and this is indeed the main focus), liquid phase separation processes such as the "Sorbex Process" and parametric pumping are also covered briefly. As with its predecessors, the emphasis is on fundamentals rather than on technological details, and the level of background knowledge which is assumed is also similar.

The book is divided into eight chapters: 1. Introduction; 2. Adsorbents and Adsorption Isotherms; 3. Equilibrium Adsorption of Gas Mixtures; 4. Rate Processes in Adsorbers; 5. Adsorber Dynamics—Bed Profiles and Breakthrough Curves; 6. Cyclic Gas Separation Processes; 7. Pressure Swing Adsorption—Principles and Processes; 8. Pressure Swing Adsorption—Models and Experiments.

It is not a book for the undergraduate, but it should be easily understood by graduate students and those with some experience in research and development. Since most adsorption processes operate under transient conditions, some familiarity with partial differential equations is needed to follow the sections dealing with column dynamics and process modeling (Chapters 5 and 8). I found Chapter 3, which contains a good review of the various approaches to the correlation and prediction of multicomponent adsorption equilibria, and Chapters 7 and 8, which provide an authoritative summary of PSA technology and modeling, to be most useful.

There is no discussion of membrane separation processes which compete directly with pressure swing adsorption in a number of applications. While membrane separations may not be included within the narrower definition of adsorption processes, some such discussion would have been useful to allow the reader to assess the relative merits of either approach, particularly in view of the publisher's claim that this is a "complete treatise covering all aspects of adsorption processes . . ."

Inevitably in a book which covers such a wide range of subjects, one can expect controversy over the treatment of certain topics. For example, in the discussion of surface diffusion and intracrystalline diffusion in zeolites (pp. 113-121) it should probably have been pointed out that the kinetic treatment (which is emphasized) and the quasi-thermodynamic treatment (which is criticized) are not necessarily in conflict, but merely represent different ways of looking at the same phenomenon. The advantage of the quasi-thermodynamic treatment is that it allows meaningful transport co-efficients to be derived without knowledge of the detailed diffusion mechanism. This may not be obvious to the casual reader. Such criticisms are, however, minor, and any lack of balance is more than offset by the advantages in the presentation of coherent perspective.

Taken as a whole, the book presents a concise and readable summary of the voluminous literature of the subject. It will no doubt become required reading for those working in this area, both in universities and in industry. At US $52.95 it is (just about) within the affordable price range for individuals. □