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tion of pressure and composition. The flux-ratio function w is a constant, as seen when Equations (3) and (7) are divided:

$$\frac{dN}{dx} \Big/ \frac{dN_A}{dx} = \frac{dN}{dN_A} = 1 - n$$

When they are integrated one obtains

$$\frac{N}{N_A} = w = 1 - n \qquad (9)$$

or

$$\frac{N_B}{N_A} = -n \qquad (10)$$

This result is a consequence of the stoichiometry of the reaction. Equation (9) permits the effective diffusivity to be expressed in a somewhat simpler way:

$$D_e = \frac{1}{\dfrac{1-(1-n)y_A}{D_{AB}} + \dfrac{1}{D_k}} \qquad (11)$$

To complete the description of the problem an expression is needed which relates the flux N to the pressure gradient and the properties of the porous solid and reaction gases. An exact equation in terms of measureable physical properties has not been obtained but there are available useful expressions which contain one or more constants. For example, Evans and colleagues (2) presented two relationships: one the result of momentum balance and the other from the dusty-gas model. Both give the flux as the sum of a flow at constant pressure and a contribution due to the pressure gradient. The second form, which is more suitable for our problem, can be written as

$$N - \left[1 - \left(\frac{M_A}{M_B}\right)^{1/2}\right] N_A = -\frac{C}{RT}\frac{dP}{dx} \qquad (12)$$

where C is a flow coefficient.

The second term on the left side of Equation (12) is the diffusive slip contribution to the flow; that is, the diffusion at constant pressure. For example, if the pressure gradient is zero Equation (12) reduces to the form

$$N = N_A + N_B = \left[1 - \left(\frac{M_A}{M_B}\right)^{1/2}\right] N_A \qquad (13)$$

$$\frac{N_B}{N_A} = -\left(\frac{M_A}{M_B}\right)^{1/2}$$

or

$$\frac{N_B}{N_A} = -n^{1/2} \qquad (14)$$

where M_A and M_B are the molecular weights of the two components. Equa-

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which are used in the solvent treatment of lubricating oils. But this association also leads him to develop in some detail the difficulties which may arise when the complex systems of that industry are simplified for the sake of expediency to "equivalent" ternaries, as is so often done in the practice of solvent refining. Systems of interest in metallurgy are not specifically mentioned nor are the complex equilibriums found in the distribution of metal compounds between aqueous and organic liquids discussed.

There is an excellent short chapter on experimental techniques, over a hundred pages of tables listing published systems which form two liquid phases(not including some 1,500 systems studied by Francis in unpublished work), a long supplement to the author's earlier book on critical solution temperatures, and a bibliography of over 900 entries. The detailed table of contents and a good glossary of terms substitute for an index.

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Design of Equilibrium Stage Processes, Buford D. Smith, McGraw-Hill, New York (1963). 647 pages. $17.50.

This is a well-written book and fills a very real need. The theoretical equilibrium stage presentation is an excellent method for both teaching and carrying out the calculations involved in separation processes. The concept of a theoretical mixer-separator is an easy one to grasp and generalizations can be extended to cover distillation, extraction, and adsorption. In some chemical engineering curricula a simplified staged operations' course follows the usual mass and energy balances that are the student's introduction to chemical engineering. Frequently, advanced courses in the various separation processes are offered at the graduate level. This book is intended to offer a single approach, and presumably a single course, that would make both students and practicing chemical engineers proficient in the stage calculations of the separation processes.

To a certain extent, the author encounters difficulties in trying to adapt the book for both students and practicing engineers. However, the contradictions involved are recognized by the author in the preface. The first sentences of each of the first three paragraphs of the preface are quoted: "This text was prepared primarily for the plant engineers. . . . Although it is anticipated that the major use of this book will be by practicing engineers, a strong attempt was made to make it suitable also for classroom use. . . . It is, unfortunately, impossible to satisfy both the practicing engineer and the engineering professor with one book." The author also notes that the reader is assumed to have the equivalent of an undergraduate education in chemical engineering. Actually, certain parts of the book assume a familiarity and working knowledge of thermodynamics and calculation methods not necessarily possessed by the average graduate. These factors might indicate that a more unified approach aimed at teaching an engineer or an undergraduate student the subject matter, or additional references to other texts for more detailed presentation of some subjects, would have produced a book that would be easier to use.

The chapter on design variables and the application of this subject matter in all succeeding chapters is an outstanding feature of the book. Beyond its use in phase-rule applications, this subject has been ignored in other texts. The general application of this method of determining variance to design calculations is fully as important as its use in the phase rule.

The author employs difference equations indicating constant net flows in the chapters on enthalpy-composition diagrams and extraction but uses the operating line form of the same equations in x-y diagram methods. This reviewer would prefer that true phase diagram calculations using enthalpy- or temperature-composition diagrams be used to introduce separation calculations for binary systems rather than the McCabe and Thiele method. In this way the importance of constant net flows, discontinuities, and ratios of phases could be emphasized. The use of the x-y-diagram could then be introduced as a shortcut or sufficiently accurate approximation.

Shortcut methods are presented prior to the rigorous methods for multicomponent separations. Here again the conflict between using the book for teaching or practice arises. Presumably the practicing engineer would want to use shortcut methods and might investigate them first. For a complete understanding of the subject matter and adaptation to computer calculations, the reverse approach might be more rewarding.

It should be emphasized that the comments contained in this review represent little more than an expression of a difference in point of view. The book should prove to be extremely useful, and it is hoped that more and more chemical engineers will be exposed to this approach to separation processes.

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