able parameters are given, detailed computer programs are listed, and many examples are presented. The book should indeed, as the authors intend, serve as a manual for the design engineer concerned with distillation and other separation processes.

The authors also carefully call attention to the present limitations of the method, for example, illustrating in a separate chapter that while qualitatively useful predictions of excess enthalpies and phase splitting may be made, the results should not be taken as quantitatively valid.

Since I was a visitor at the Technical University of Denmark during the time of greatest activity in the preparation of the manuscript for this book, I can attest to the painstaking care that went into all matters of accuracy and detail. The parameter tables inevitably contain gaps owing to the lack of data; however, the availability to the authors of the Dortmund data bank allowed their completion to the fullest extent possible.

This book is a large contribution to the fulfillment of a long-standing need.

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Multicomponent Diffusion, E. L. Cussler, Elsevier Scientific Publishing Company, New York and Amsterdam, 1976. 176 pp. $24.95.

This third volume in the Elsevier chemical engineering monograph series is a highly personal guided tour through the frequently bewildering area of multicomponent diffusion. While not a definitive fundamental reference it will prove a useful introduction, and a continuing challenge to the reader to do something with this material. This is clearly a book meant to be used, and it reflects both the energy and the entrepreneurial instincts of the author.

The first three chapters, which are devoted largely to phenomenology, should be very helpful to the beginner trying to orient himself, and to relate the many different kinds of diffusional formulations in the literature.

Chapter four is an excellent introduction to the measurement of multicomponent diffusion coefficients and reflects the hard-won experience of the author. It is a compact summary of material not well organized elsewhere to my knowledge.

Chapters five through seven are a praiseworthy attempt to summarize the behavior of frequently encountered systems. They are particularly useful for answering the key questions of when to use the formidable multicomponent formalisms and when to be on the lookout for major surprises. Much remains to be accomplished here, however, and accurate reliable predictions are not yet often possible.

Chapter eight describes carrier transport in membranes, an area in which the author has made particularly important contributions.

Chapter nine shows how one may apply multicomponent formalism in convective mass transport, a subject of particular importance to engineers working on kinetic and separation problems.

This book is generally clearly written in an informal style and imparts atmosphere as well as facts. The author has, for example, a "fast, eager, proton forever tugging on the leash, pulling the slow, stodgy chloride along behind." This occasionally breezy approach has pedagogical value for the receptive reader. A few unfortunate typographical omissions occur in key equations, and an erratum list should be requested of the author.

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LETTERS TO THE EDITOR

To the Editor:

Funk and Prausnitz [*AIChE J.*, 17, 254 (1971)] have discussed application of thermodynamic analysis to correlations of propane-propylene vapor-liquid equilibria and consequences affecting design of propane-propylene distillation columns (C_3 splitters). Related studies which I have made lead to the conclusion that it may be advantageous to operate C_3 splitters at pressures below 300 psia (2068 kPa) especially when methyl acetylene is present. I have made computer correlations similar to those reported by Funk and Prausnitz which produce propane-propylene relative volatilities essentially in agreement with those given in their paper. They stated that the relative volatility of propylene to propane was relatively unaffected by system pressure for high propylene concentrations and that little advantage would be gained by operating separation equipment at lower pressures for production of pure propylene. I agree that the relative volatility of propylene to propane is only slightly affected by system pressure for the high (95-99+ mole percent) propylene purities, but I would like to suggest modification of their latter conclusion for at least some cases.

The C_3 splitters employed in olefin plants generally contain in excess of 100 trays. Feed to these distillation columns contains methyl acetylene (propyne) and propadiene (allene) as well as propane and propylene if these former compounds are not removed by prior selective hydrogenation. It is desirable to produce a bottoms product as free of propylene as feasible and to reduce methyl acetylene concentration in overhead product to meet very low specifications in most cases.

In order to determine the effect of pressure on separations in a C_3 splitter on as simple a basis as possible I have set up computer simulations of such a column operating at total reflux with constant molal overflow. I have utilized equilibrium data for methyl acetylene and propadiene in C_3 hydrocarbon mixtures presented by Hill *et al.* [*AIChE J.*, 8, 681 (1962)] along with other selected propane-propylene data as listed in Funk and Prausnitz' paper. I would like to present two results which should be considered relative to C_3 splitter design. First, due to the fact that the C_3 splitter contains a very wide range of propylene concentrations from bottom to top, the theoretical tray requirement for production of polymer-grade (99+%) propylene is increased by about 7% by increasing tower pressure from 280 psia (1931 kPa) to 320 psia (2206 kPa). In a tower containing over 100 trays this extra 7 to 10 trays can be appreciable, especially if height restrictions are limiting. As could be deducted from Funk and Prausnitz' report, pressure has extremely little effect on propane-propylene separation in the upper portion of the tower (above the 95% propylene locus). It has a pronounced effect on methyl acetylene-propylene separation however. For example, with tower operation at total reflux producing a bottom product containing 4 mole percent methyl acetylene, 90 percent propane, 2 percent propylene and 4 percent propadiene and an overhead product of 99.0 mole percent propylene, the overhead product contains 91 mole ppm methyl acetylene at a pressure of 320 psia as compared to 60 ppm at 280 psia. Thus lower pressure would be favored from this standpoint.

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To the Editor:

Mesler's objection to Dengler and Addoms' concept of boiling heat transfer inside vertical tubes can be wrong. His whole argument is based on equations (1), (2).

$$x_z = \frac{\pi D}{W\lambda}\int_0^z \left(\frac{q}{A}\right)_{0z} dz \qquad (1)$$

$$\frac{h_z}{h_{Lz}} = \frac{\left(\frac{q}{A}\right)_z \frac{1}{\Delta T}}{0.023\frac{K}{D}\left(\frac{4W}{D\mu_L}\right)^{0.8}\left(\frac{C_p\mu_L}{K}\right)^{0.4}} \qquad (2)$$

According to Mesler, since q/A is in both of the equations, Dengler and Addoms' suggestion of plotting h_z/h_{Lz} vs. x_z (or $1/X_{tt}$) will include "the same variable" in the two quantities plotted against each other.

Actually, Equation (1) should be of the form

$$x_z = x_b + x_i \qquad (3)$$

where

$$x_b = \frac{\pi D}{W\lambda}\int_0^z \left(\frac{q}{A}\right)_{0z} dz$$

and x_i is the fraction of vapor injected directly into the tube at any location between 0 and z. The value of x_b, as well as that of x_i, can be zero, i.e., variable q/A may not be involved in quantity x_z while plotting this term vs. h_z/h_{Lz}.

Furthermore, $(q/A)_z$ and $(q/A)_{0z}$ are neither the same, nor two dependent variables. $(q/A)_z$, heat flux at point z, can be isolated from the influence of its history $(Q/Z)_{0z}$ by simply applying two different electrical heaters to tube section $\overline{0z}$ and point z. Hence, curves of h_z/h_{Lz} vs. $1/X_{tt}$ does not necessarily have a "same value" of q/A in both of its X and Y axis.

Above all, Mesler's conclusion is based on the observation that Dengler and Addoms' plot of h_z/h_{Lz} vs. $1/X_{tt}$ contradicts with his expectation of an increasing of $1/\Delta T$ with convection. However, what will be influenced by the degree of convection is ΔT_e, the temperature difference responsible for nucleate boiling heat transfer, but not ΔT_{sat}, which can be treated as a constant in this case, for convective boiling heat transfer. (See Figure 7.4, of Collier's book.) The effect of convection on ΔT_e has been taken into account by Chen's suppression factor, and this effect does not appear in Dengler and Addoms' plot is just a course of nature.

Therefore, the concept of convective heat transfer for boiling inside vertical tubes, as first proposed by Dengler and Addoms, can still be considered valid.

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LITERATURE CITED

Chen, J. C., "A Correlation for Boiling Heat Transfer to Saturated Fluids in Convective Flow," *Ind. Eng. Chem. Process, Des. Develop.*, **5**, 322 (1966).

Collier, John G., Convective Boiling and Condensation, McGraw Hill, London (1972).

Dengler, C. E., and J. N. Addoms, "Heat Transfer Mechanism for Vaporization of Water in a Vertical Tube," *Chem. Eng. Progr. Symp. Series* **52**, 95 (1956).

Mesler, R. B., "An Alternate to the Dengler and Addoms Convection Concept of Forced Convection Boiling Heat Transfer," [*AIChE J.*, **23**, 448 (1977)].

Reply:

I appreciate Hsieh's remarks on my paper and find them helpful in my thinking about the subject. His remarks, however, may be based on a different view than I took when I attempted to analyze Dengler and Addoms' work.

Hsieh's initial comment that my objection to the Dengler and Addoms concept may be wrong, could I suppose, be true but not, I feel, on the basis of his subsequent remarks. Hsieh's comments appear to center around ways that Dengler and Addoms might have done the experiment and ways that they might have interpreted their results. In making my response to Hsieh I shall reiterate what Dengler and Addoms did, and not, what they might have done.

1. Hsieh states that the change in quality of the stream might be zero. Indeed, it might be, but in Dengler's thesis it wasn't. Even for dry wall conditions he reports an increase in quality.
2. Hsieh states that the heat flux at some point can be isolated from the influence of its history by simply applying two different electrical heaters. Perhaps so, but Dengler and Addoms did not use electrical heating.
3. Finally Hsieh states that my conclusion is based on the observation that The Dengler and Addoms plot of h/h_L vs. $1/X_{tt}$ contradicts my expectation of an increasing of $1/\Delta T$ with convection. Hsieh then goes on to state his belief that the proper ΔT should be another ΔT and not the ΔT of Dengler and Addoms. This may be, but again the point of my analysis of the Dengler and Addoms' paper is to test their hypothesis and not some other one.

As a matter of consistency I believe that Hsieh in Equation 3 has changed the meaning of the limits 0 to z from those of Equation 1.

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To the Editor:

Gas-Liquid Contacting in Mixing Tanks

Twice in recent months I have reviewed articles (submitted to Journals for publication) involving the contacting of gas and liquid in a mixing vessel. I have just read another published in R & D Notes [*AIChE J.*, **23**, 931 (1977)].

In all three, a paper by Rushton, J. H., and J.-J. Bimbinet on this same subject has been overlooked. Other European papers on this subject have also overlooked our publication.

This is to call attention to the paper by Rushton and Bimbinet which was published in the *Canadian Journal of Chemical Engineering*, **46**, 16 February (1968). Workers in the field of gas-liquid contacting in mixing tanks should be aware of the large amount of information in this paper. It gives data on impeller power and on gas added power, these more recent research efforts overlap and at least partially duplicate this earlier work. Furthermore, our data cover 5 different tank diameters, from 9 to 36 inches, and are useful for industrial scale-up. This compares with tanks of 22 cm. and smaller in the three recent presentations.

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