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Equation (6) therefore becomes

$$\sum_{i=1}^{n-1} x_i \ln \gamma_i = \int_0^{1/(1+\sum_{i=2}^{n-1} M_i)} \left[\ln \frac{\gamma_1}{\gamma_n} + M_2 \ln \frac{\gamma_2}{\gamma_n} + M_3 \ln \frac{\gamma_3}{\gamma_n} + \cdots M_{n-1} \ln \frac{\gamma_{n-1}}{\gamma_n} \right] dx_1 \quad (8)$$

The consistency test is carried out by the arbitrary selection of a set of parameters and the numerical (or graphical) evaluation of the integral in Equation (8) with activity-coefficient data for the solution of n components utilized. This integral must then be equal to the excess free energy of a solution of $n - 1$ components having the composition

$$x_1 = \frac{1}{1 + \sum_{i=2}^{n-1} M_i}; \quad x_2 = M_2 x_1;$$

$$x_3 = M_3 x_1; \cdots x_{n-1} = M_{n-1} x_1$$

If this equality is met, the data tested are thermodynamically consistent. To cover a large section of the data it will of course be necessary to repeat the calculation several times with new sets of parameters each time. For a system of many components the calculations are necessarily quite tedious. However the form of this consistency test is very well suited for programming on an electronic computer.

NOTATION

ΔG^E = excess free energy
M = parameter defined by Equation (2)
n = number of components in solution
R = gas constant
T = absolute temperature
x = mole fraction in the liquid phase
γ = activity coefficient

Subscript

i = component i
$1,2 \cdots n$ = component $1,2 \cdots n$

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ERRATA

Vapor-Liquid Equilibria and Heat of Mixing: n-Octane-Ethylbenzene-Cellosolve System. P. S. Murti and Matthew Van Winkle.

Figure 4 of the above paper is in error. The corrected plot is presented below. *This article appeared on page 517 of the December, 1957, issue of the Journal.*

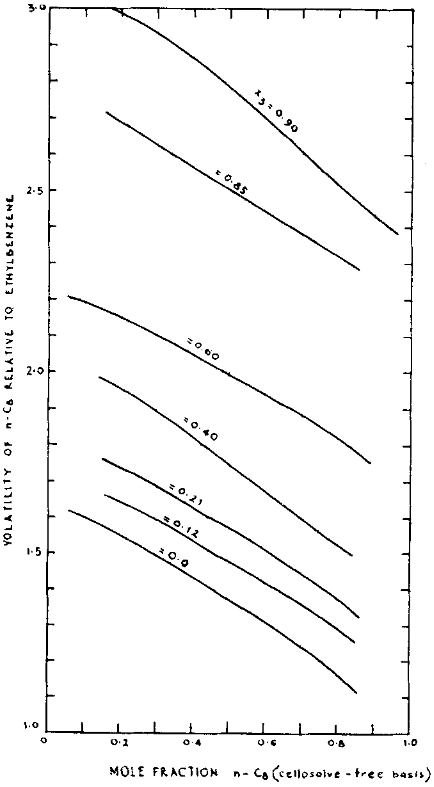

Fig. 4. Relative volatility parameter: mole fraction Cellosolve in ternary mixtures

Liquid-Side Mass Transfer Coefficients in Packed Towers. Kakusaburo Onda, Eizô Sada, and Yasuhiro Murase.

Equation (3) of the above paper is in error. It should read

$$a_w/a_t = 1 - 1.02e^{-0.278(L/a_t\mu)^{0.4}}$$

This article appeared on page 235 of the June, 1959, issue of the Journal.

(*Continued from page 276.*)

Fluid Dynamics and Heat Transfer, James G. Knudsen and Donald L. Katz, McGraw-Hill Book Company, Inc., New York (1958). 576 pages. $12.50.

The need for solving problems concerned with fluid heat transfer has always faced many engineers. In the past, because of the complex nature of fluids in motion, solutions to these problems have been found by an approach which was basically empirical. One illustration of this approach is an early edition of McAdams's comprehensive book "Heat Transmission." However there has been a growing awareness that fluid heat transfer could best be understood by first understanding the

(*Continued on page 9S.*)

(*Continued from page 8S.*)
nature of fluid flow in the turbulent and transiton regions. Although much of the treatment of turbulence has only progressed to the semitheoretical, substantial progress has been made in many areas of fluid dynamics—including transition and boundary layer flow. Nevertheless the record of accomplishments, which is spread through technical journals, has not been available in a textbook until recently.

Texts concerned with flow problems have appeared in the past five years, but most are too specialized for the purpose of introducing chemical engineers to those aspects of fluid flow which are useful for fluid heat transfer.

Recognizing this need for presenting the fundamentals of fluid dynamics basic to an understanding of convection heat transfer, Knudsen and Katz have prepared this text. In doing so the authors have codified and selected their choice of topics from the fluid dynamics literature. Since the material was organized and used in a specific graduate course in chemical engineering, the form has been arranged for class presentation. This form is also useful for the practicing engineer.

The title was probably intended to denote the relationship between heat transfer and fluid dynamics, for the authors make no attempt to be comprehensive in either field. Since the authors restrict themselves to certain fluids, many topics frequently included in a graduate course on fluid flow and heat transfer have been omitted; for example only incompressible liquids under forced convection are described. The authors clearly explain this narrowed scope as necessitated by the limitations of a one-semester course and also imply that this more integrated approach to heat transfer and fluid flow is a good basis for further, more comprehensive study of the applications of these two areas of study.

The greater part of the book is devoted to fluid dynamics, which is the subdivision of fluid mechanics concerned with the forces acting on the fluids. Starting with the partial differential equations of motion, using both the usual notation and the vector notation, the authors demonstrate some of the solutions to these equations, such as those for nonviscous flow and laminar pipe flow. The discussion of conduit turbulent flow is centered around the universal velocity profile obtained from Prandtl's mixing-length theory. From an introduction to boundary-layer theory immersed body flow is developed and is followed by an important chemical engineering application of immersed body flow, that is, flow on the shell side of heat exchangers.

The approach used throughout this section is one of presenting the theory briefly and then justifying or criticizing the theory with substantial experimental results. It is presumed that a reader interested in detailed, rigorous solutions of the applicable equations may refer to more theoretical references such as Schlichting's "Boundary Layer Theory."

Since the heat transfer section builds on the concepts and the developments described in fluid flow, and since only forced convection transfer is discussed, this section comprises only the last third of the text. General equations are developed and examples solved for the case of heat transfer through laminar films. Turbulent flow heat transfer is first discussed in terms of empirical correlations and then in terms of the analogy between momentum and heat transfer and for cases of immersed body heat transfer. Although the discussion of the empirical correlations does not require the previous fluid flow developments, discussions of the analogy and the immersed body heat flow rely heavily on the university velocity profile and Prandtl mixing length developed earlier in the text. A section on liquid metals is also included, ostensibly to illustrate low Prandtl Number heat transfer and because of current commercial interest, but also to fulfill a need for discussion of this new field in a textbook.

Perhaps the greatest limitations to this book, especially for teaching purposes, are the topics omitted, such as compressible fluids and radiation. Some of these other topics might feasibly be included if some of historical-developments discussions were condensed, especially in the area of turbulence where only an approximate solution to the theory is currently available. Another limitation is the treatment of the terms which contain the phrases "boundary layer." Since terms such as "laminar boundary layer," which is not a "boundary layer" at all but rather the "boundary to the laminar sublayer," are included, there is a need for either revised terminology or precise description of the interrelation of all the "boundary" terms used. Perhaps boundary-layer theory could have been presented before rather than after the discussion of conduit flow and laminar and buffer layers.

Nevertheless this book is an excellent basis for a course on fluid dynamics and heat transfer. It is clearly written; its continuity is strong, and its development proceeds smoothly. It is the first book on fluid flow suitable for chemical engineering needs. The authors are also to be commended for filling the gap between the rigorous detailed treatment of fluid flow and the empirical approach of forced convection heat transfer. As such this book is a welcome addition to the engineering literature.

John A. Tallmadge, Jr.

(*Continued on page 10S.*)