INFORMATION RETRIEVAL*

Pool boiling heat transfer to cryogenic liquids, parts I, II, & III, Kosky, P. G., and D. N. Lyon, **AIChE Journal, 14,** No. 3, p. 372 (May, 1968).

Key Words: A. Boiling-8, Nucleate Boiling-8, Pool Boiling-8, Heat Transfer-8, Liquids-9, Cryogenic-0, Low Temperature-0, Nitrogen-9, Oxygen-9, Argon-9, Carbon Tetrafluoride-9, Methane-9, Peak Nucleate Boiling Flux-8. B. Boiling-8, Nucleate Boiling-8, Pool Boiling-8, Nitrogen-9, Oxygen-9, Peak Nucleate Boiling Flux-8, Mixtures-9.

Abstract: Pool nucleate boiling heat transfer curves and peak nucleate boiling fluxes for pure nitrogen, argon, oxygen, methane, carbon tetrafluoride and oxygen and nitrogen mixtures were measured. The results were compared with various suggested nucleate boiling correlations.

Solids mixing in fluidized beds, Woollard, I. N. M., and O. E. Potter, **AIChE Journal, 14,** No. 3, p. 388 (May, 1968).

Key Words: A. Fluidized Bed-2, 10, Solids-1, 9, Particle-1, 9, Air-1, 5, Bubble-6, Interface Displacement-7, Tracer-1, 9, Bubble Injection-10, Mixing-8, Bubble Volume-7.

Abstract: The volume of bed solids displaced in a fluidized bed held in an incipiently fluidized condition by the passage of a single bubble has been measured using a layered bed of glass spheres over dyed glass spheres. Solids used were glass spheres of 380 μ in diameter. The profile of displaced solids was also determined and compared with that produced by a sphere moving in an inviscid fluid.

Concentration-dependent time-lag measurements, Phillips, J. R., and B. F. Dodge, **AIChE Journal, 14,** No. 3, p. 392 (May, 1968).

Key Words: A. Diffusion-8, Diffusivity-6, Permeation-7, 8, Time-Lag-7, 8, Gas-9, Metal-5, Hydrogen-9, Stainless Steel-5, Concentration-6, Pressure-6, Temperature-6, Interfacial Resistance-6.

Abstract: In gas-metal permeation, diffusion is normally considered to be the rate-controlling step. In addition, the diffusivity is usually taken to be independent of concentration. Under these conditions, the time-lag is found to be independent of the gas pressure applied to the inlet surface of the metal membrane. Further, the time-lag can then be directly related to the diffusivity of the system. In this paper, data on the hydrogen-type 321 stainless steel system are presented which show a pronounced effect of pressure on measured values of the time-lag. A model of the permeation process is presented which is consistent with the time-lag data and an estimate is made of the diffusivity of hydrogen in type 321 stainless steel.

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(*Continued on page 522*)

(*Continued from page 371*)

Chapters 1, 2, and 3 of the book are accessible to senior undergraduate students with some background in partial differential equations. The subsequent chapters are at a higher level and can be useful to research workers.

The strength of the book lies in the variety of examples treated and their close coordination with the development of the theory. This feature will be particularly welcomed by those who read the book on their own. The parts dealing with local potential methods appear to be less useful than the rest, since it is now known that comparable results can be obtained more easily by weighted residual methods (see Finlayson and Scriven, *Applied Mechanics Revue,* Vol. 19, p. 735, and *International Journal of Heat and Mass Transfer,* Vol. 10, p. 799).

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Vapour-Liquid Equilibrium, Second English Edition, E. Hala, J. Pick, V. Fried, and O. Vilim, Translated by Geo. Standart, Pergamon Press, New York (1968). 599 pages, $24.00.

A second edition of this book was welcomed as I had made considerable use of the first edition and regarded it as the outstanding work in the field. I must confess to a little disappointment in this edition for reasons that will appear as the various chapters are considered.

Like the previous edition the book is divided into three parts; I. "The thermodynamics of solutions," II. "Laboratory technique," and III. "Vapour-liquid equilibrium data." Chapters 1, 2, and 3 of Part I are identical to those of the first edition; they deal with general relations, the ideal solution, and real solutions. One wouldn't expect much revision of chapters 1 and 2; but since considerable development has taken place in the treatment of real solutions some revision of chapter 3 would have been in order. The main treatment of real solutions is in chapter 4 and it is here that I expected to find considerable revision and especially an addition of new material. There have been a few desirable deletions and some relatively small additions but many significant developments of the past 10 years have been omitted. For example the very extensive work on hydrocarbon systems is just mentioned in one short paragraph. There is no mention of Chao and Slader, Edmister, Van Ness, Ibl and Dodge, Kobayashi and Prausnitz;

(*Continued on page 522*)

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* For details on the use of these Key Words and the AIChE Information Retrieval Program, see **Chem. Eng. Progr.,** Vol. 60, No. 8, p. 88 (August, 1964). A free copy of this article may be obtained by sending a post card, with the words "Key Word Article" and your name and address (please print) to Publications Department, AIChE, 345 East 47 St., N. Y., N. Y., 10017. Price quotations for volume quantities on request.

(*Continued from page 521*)

The mechanism of heat transfer in a spray column heat exchanger, Letan, Ruth, and Ephraim Kehat, **AIChE Journal, 14,** No. 3, p. 398 (May, 1968).

Key Words: A. Temperature Profiles-10, Heat Transfer-8, Spray Column-10, Physical Model-9, Mathematical Model-9, Wakes-7, Kerosene-1, Water-1, Temperature-6, Holdup-6.

Abstract: Temperature profiles of dispersed kerosene and water were measured in a spray column heat exchanger, 15 cm. in diameter and 160 cm. long. Dispersed packing of drops and narrow temperature ranges were used. The flow rates used were 0 to 50 liters/min. of water and 5 to 40 liters/min. of kerosene. The physical picture that emerges from the temperature profiles is that heat is transferred from fully mixed drops to fully mixed wakes while the wakes are formed, by shedding and renewal of elements of wakes in most of the column and by complete mixing of all streams at the water inlet at the top of the column. Mathematical equations were developed from the physical model. The volume of the wakes and the rate of shedding of wake elements were estimated from the temperature profiles and were used to calculate the temperature profiles for this and for other studies. The agreement of the calculated profiles with the experimental data is very good.

Turbulent heat transfer in drag-reducing fluids, Wells, C. Sinclair, Jr., **AIChE Journal, 14,** No. 3, p. 406 (May, 1968).

Key Words: A. Heat Transfer-7, 8, Fluids-9, Non-Newtonian-0, Drag-6, Flow-6, 9, Pipe-9, Friction Factor-8, Thickness-8, Sublayer-9, Viscous-0, Pressure Drop-6, Nusselt Number-8, Diameter-6.

Abstract: An analysis is presented which extends the analogy between energy and momentum transport for turbulent pipe flow of purely viscous fluids to include drag reducing non-Newtonian fluids. The correlation is used to predict friction factor and sublayer thickness for the drag reducing fluids. The use of the friction factor correlation with the heat transfer analogy makes it possible to predict heat transfer rates from simple measurements of pressure drop and flow rate for the drag reducing fluids.

Determination of the profile of a growing droplet, Halligan, J. E., and L. E. Burkhart, **AIChE Journal, 14,** No. 3, p. 411 (May, 1968).

Key Words: A. Simulation-8, Drops-9, Growth-0, Mass Transfer-4, Flow Measurement-6, Orifices-6, Pressure Balance-2, Profiles-7, Mathematical Models-8, Extraction-4.

Abstract: The profile of a growing droplet was determined with a pressure balance which was similar to that derived by Laplace for the static droplet. An additional term was added to the balance to account for the pressure on the interface due to the motion of the fluid within the droplet. The entire pressure balance was then combined with differential equations describing the geometry of the droplet. Computed profiles compared favorably with those obtained experimentally.

An additional result was the definition of a parameter, f, indicating the importance of internal fluid motion on the shape of the profile. A method of establishing this parameter without solving the equations was developed.

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(*Continued on page 523*)

(*Continued from page 521*)

they, as well as others, have made significant contributions to the literature.

New material that has been added to chapter 4 includes a tabulation of equations for composition dependence of excess free energy, activity coefficients and activity coefficient ratios of multicomponent systems, a brief mention of the equations of Black and of Wilson, a section on separation factors of three and more component systems, a somewhat enlarged section on calculation of activity coefficients from the properties of pure components which brings in the Hildebrand solubility parameter, the equations of engineers of the Shell Development Co., and Blacks' equation for vapor-phase imperfections.

The most significant addition consists of two new chapters, one dealing with solutions of electrolytes and the other with multicomponent systems in which chemical reactions occur. This latter chapter includes a numerical example of the calculation of partial pressures in the ammonia–sulfur dioxide–sulfur trioxide–water systems.

Chapters 1, 2, and 3 of part II are essentially unchanged and this reviewer feels that sufficient development has taken place in the areas of criteria of purity, temperature measurement and pressure measurement to warrant some revision. Chapter 4 which treats vapour pressure and boiling point has a few additions here and there but not as many as might be expected in view of the extensive recent work on vapor-pressure equations.

Chapter 5 of part II "Direct experimental determination of Vapour-liquid equilibrium" adds a few new methods along with Figures and some discussion, but in most cases only the literature reference is given. The table evaluating the various instruments for direct determination has been enlarged by a section which compares the various techniques as distinct from the apparatus.

The section on consistency of measured data remains unchanged in spite of the considerable volume of work on this subject that has appeared in the literature in the past several years.

Part III, the index of systems and their literature references has been enlarged nearly three fold, from 66 to 174 pages. It provides a very valuable source of information on a large number of systems with 2,656 references to the literature. It would have been nice if the ranges of pressure, temperature, and composition could also

(*Continued on page 523*)

INFORMATION RETRIEVAL

(*Continued from page 522*)

Fluid flow through woven screens, Armour, James C., and Joseph N. Cannon, **AIChE Journal, 14,** No. 3, p. 415 (May, 1968).

Key Words: A. Correlation-2, 8, Pressure Drop-7, 8, Flow-8, Screen-9, Plain Square Weave-0, Full Twill Weave-0, Fourdrinier Weave-0, Plain Dutch Weave-0, Twilled Dutch Weave-0, Water-9, Helium-9, Nitrogen-9, Flow Rate-6, Laminar-0, Turbulent-0, Newtonian-0, Friction Factor-8, Reynolds Number-8.

Abstract: A packed bed model has been adopted to develop a general correlation applicable to the flow of Newtonian fluids through all types of woven metal screens. Both of the main theoretical approaches to studying pressure drop in packed systems have been used by visualizing the screen as a collection of submerged objects with surface area to unit volume ratio a for laminar flow, and as a bundle of tubes of diameter D for turbulent flow. In the usual manner viscous and inertial energy losses are added to give an expression for the total pressure loss. Rearrangement of the general equation to the form of a friction factor yields a unique definition of the Reynolds number for screens $N_{Re} = \rho u/\mu a^2 D$. Procedures are described for collection of pressure drop-velocity data for the flow of nitrogen and helium through plain square, full twill, fourdrinier, plain dutch, and twilled dutch weaves. The data are used to derive a viscous resistance coefficient $\alpha = 8.61$ and an inertial resistance coefficient $\beta = 0.52$. The validity of the correlation equation is tested by using additional data from the literature. The correlation successfully predicts pressure drop for a Reynolds number range of 0.1 to 1,000, void fractions from 0.35 to 0.76, screen pore diameters from 5 to 550 μ, mesh sizes from 30 to 2,400 wires/in., and surface area to unit volume ratios from 1,200 to 29,000 ft.$^{-1}$.

Mechanism of interfacial mass transfer in membrane transport, Kaufmann, Thomas G., and Edward F. Leonard, **AIChE Journal, 14,** No. 3, p. 421 (May, 1968).

Key Words: A. Mass Transfer-7, 8, Dialysis-8, Diffusion-8, Sugar-9, Resistance-8, Membrane-9, Cellophane-9, Dialyzer-8, 10, Sherwood Number-7, 8, Reynolds Number-6, Schmidt Number-6, Distance-6, Eddy Diffusivity-7, Testing-8.

Abstract: Dialysis of binary aqueous solutions of several sugars through a cellophane membrane was studied in a stirred, batch dialyzer. Sherwood numbers describing mass transfer resistance in the fluid adjacent to the membrane were determined as a function of the corresponding Reynolds and Schmidt numbers. The results establish a reproducible environment for membrane testing in which a known, controllable and small interfacial resistance is placed in series with that of the membrane. The results also are shown to support, for this geometry, the postulation of a third-power relationship between eddy diffusivity and dimensionless distance from the phase boundary as well as the Sherwood-Ryan nondimensionalization of this distance.

Density and pressure fluctuations in gas fluidized beds, Winter, Olaf, **AIChE Journal, 14,** No. 3, p. 426 (May, 1968).

Key Words: A. Fluidization-8, Density-8, Pressure-8, Bubble Diameter-2, 7, 9, Density Fluctuations-9, Pressure Fluctuations-9, Frequency Distributions-9, Fluidized Bed-10, Reactor-10, Photocell-10, Conductivity Cell-10, Geiger-Mueller Counter-10, Strontium^{90}-10, Statistics-10, Design-4, Model-4, Particle Size-6, Gas Velocity-6, Horizontal Screens-6, Bed Height-6, Distance from Air Distribution Plate-6, Intensity of Density Fluctuations-2, 7, Intensity of Pressure Fluctuations-2, 7, Degree of Freedom of Probability Distribution-1, 7, Air-1, Glass Beads-1, Light Rays-1, β-rays-1, Characteristic Numbers-2, Gas-5, Solid-5.

Abstract: A Bench scale size fluidization system was constructed for the purpose of conducting experiments to determine density and pressure fluctuations in gas fluidized beds. Density fluctuations and bubble sizes were measured with a photocell device and β-ray absorption. Pressure fluctuations were determined with a conductivity cell. The frequency distributions of the density and pressure fluctuations and bubble sizes were determined as functions of several variables. They could be described by dimensionless coefficients and χ^2-distributions with different degrees of freedom. Such variables as distance from the gas distribution plate, bed height, particle size, gas flow rate, and internal screens were considered.

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(*Continued on page 524*)

(*Continued from page 522*)

have been tabulated but this is expecting too much of what is already a monumental piece of work.

In spite of the shortcomings of this new edition, which have been pointed out, it is my opinion that this book is still the best in its field and most scientists and engineers whose work involves vapour-liquid equilibrium will surely wish to add this new edition to their library.

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Mathematical Modeling in Chemical Engineering, Roger G. E. Franks, John Wiley and Sons, Inc., New York, 285 pages, $10.95.

The title of this book quite accurately describes what it is about; and since the word "model" causes nearly every engineer and scientist to salivate, this book ought to be a best seller. However, some poor editing may make it worthwhile delaying purchase until the second, and hopefully corrected, printing rolls off the presses.

Quite often one hears an engineering professor exclaim that his students can't integrate, quite apart from the problem of having them properly formulate a mathematical equation which should be integrated! In the Preface to this book, Dr. Franks essentially tosses aside the first problem, namely, solving differential equations. To quote, "The recent development of macrocomputer languages, such as digital simulation programs, eliminates the need for many of the mathematical procedures that discourage the average engineer from adopting the analytical approach. Having removed the complexities of problem solution by the simple expedient of substituting computerized methods, a more serious deficiency is revealed, namely, that of problem formulation."

However, before going into the details of formulating models, three chapters are devoted to digital simulation languages which are designed to handle systems of nonlinear differential and algebraic equations. In particular, two are described in some detail, MIDAS and MIMIC. These systems are a collection of mathematical subroutines similar, or analogous, to the units in an analog computer. With these languages, the scaling problem of analog computers disappears. (This reviewer had hopes of introducing some of the book's material in a course in process dynamics and control, but the possibility of doing this faded considerably when the computing center here

(*Continued on page 524*)