BOOKS

Introduction to the Analysis of Chemical Reactors, Rutherford Aris, Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1965). xi and 337 pages, $14.50, text edition $10.95.

Few areas of chemical engineering have received more attention than that of reactor design and analysis and, although the literature is vast, it has been only recently that the mere trickle of books on the subject has been enlarged to the point that coverage is provided for most of its many facets. Although the subject of chemical reactors is yet to be treated capably as a unified whole, Professor Aris has contributed a necessary link in the progression toward that end.

Chapters are devoted to the Continuous Flow Stirred Tank Reactor, Adiabatic Reactors, The Tubular Reactor, and The Batch Reactor, after brief chapters on Stoichiometry, Thermostatics, Reaction Rates, The Progress of the Reaction Rate in Time, and The Interaction of Chemical and Physical Rate Processes. Exercises for the reader are provided at the end of most sections, and a table of nomenclature is provided conveniently at the end of each chapter, as well as a list of pertinent references, with comment, for further reading.

The approach taken in the main is that (idealized) models for the given reactor types are selected a priori, and their characteristics and behavior deduced formally, so far as possible, for an arbitrary net chemical reaction rate expression. Particular simple cases such as single exothermic and endothermic reactions are treated in detail. The idealized models considered are limited essentially to those that lead to first-order ordinary and, to a lesser extent, partial differential equations. Models including phenomena such as transport on a molecular scale that lead to second-order equations are considered only in passing. Some of the special problems presented by the second-order equation are touched upon in a single brief section.

The concepts of stability of the steady state and of optimization are introduced in the context of the simplified models and a demonstration of the use of the mathematical apparatus for determining their characteristics is provided for the associated first-order equations. Alternative problems are seldom discussed and a comprehensive presentation of the techniques and procedures of optimization is not attempted. It is in this sense that the book is "introductory."

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Communications to the Editor

INFORMATION RETRIEVAL*

Heat transfer and reaction in laminar tube flow, Rothenberg, R. I., and J. M. Smith, **A.I.Ch.E. Journal, 12,** No. 2, p. 213 (March, 1966).

Key Words: A. Temperature Profile-8, 7, Composition Profile-8, 7, Nusselt Number-8, 7, Heat Transfer Coefficient-8, 7, Laminar Flow-9, Tube-9, Reaction-6, Energy-9, Flux-6, Diffusion-6, Radial-0, Axial-0, Heat of Reaction-6, Exothermic-0, Endothermic-0, Lewis Number-6, Heat Exchange-8, 7, Chemical Properties-6, Heats (Energies)-6, Physical Properties-6, Thermal Properties-6.

Abstract: An analytical study was made of the temperature and composition distribution and heat transfer characteristics for a reacting fluid in a tube. The reaction was assumed to be first order and irreversible, and the flow to be laminar. The results consisted of radial and axial profiles of temperature, composition, and Nusselt number.

Heat transfer to non-Newtonian fluids in transitional and turbulent flow, Petersen, A. W., and E. B. Christiansen, **A.I.Ch.E. Journal, 12,** No. 2, p. 221 (March, 1966).

Key Words: A. Heat Transfer-8, 9, Correlating-8, Convection-8, Forced-0, Fluid Flow-8, Turbulent-0, Laminar-0, Transitional-0, Fluids-9, Non-Newtonian-0, Newtonian-0, Nonisothermal-0, Pseudoplastic-0, Bingham Plastic-0, Heat Transfer Coefficient-9, Rates-9, Calculating-8, Prandtl Number-2, 9, Reynolds Number-2, 9, 7, Hedstrom Number-9, 6, Stanton Number-2, 9, Friction Factor-2, 9, Viscosity-6. B. Modifying-8, 10, Normalizing-8, 10, Prandtl Number-1, 2, 9, Correlating-4, 8, Predicting-4, Rates-9, Heat Transfer-9, Heat Transfer Coefficients-9, Fluids-9, Non-Newtonian-0, Pseudoplastic-0, Bingham Plastic-0.

Abstract: Turbulent and transitional flow heat transfer correlations for non-Newtonian fluids are presented. Turbulent flow data are correlated by means of an extension of the Richard-Metzner-Friend correlation to nonisothermal flow, and a new definition of Prandtl number to account for deviations from Newtonian behavior. A basic similarity in Newtonian and non-Newtonian heat transfer mechanisms is suggested.

Dynamic characteristics of perforated distillation plates operating at low loads, Chan, B. K. C., and R. G. H. Prince, **A.I.Ch.E. Journal, 12,** No. 2, p. 232 (March, 1966).

Key Words: A. Predicting-8, Describing-8, Dynamics-9,8, Distillation-9,4,8, Columns-10,9, Perforated Plates-10,9, Weir Height-8,9, Seal Point-8,9,2, Minimum Load-8,9,2, Oscillation-8,7,2, Fluctuation-8,7,2, Pressure-9,7, Vapor-9, Rate-6, Flow-9,6, Liquid-9, Calculating-8,4, Mathematical Model-10, Equations-10.

Abstract: Analysis of the equations describing the instantaneous vapor and liquid flow through the holes of perforated distillation plates at low loads is reported. These equations can be used to describe the periodic and stable pressure oscillations between the distillation plates. A mathematical model is provided for the qualitative explanation of the weeping phenomenon and the quantitative prediction of the seal point.

Free tear sheets of the information retrieval entries in this issue may be obtained by writing to the New York office.

* For details on the use of these Key Words and the A.I.Ch.E. 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, A.I.Ch.E., 345 East 47 St., N. Y., N. Y., 10017. Price quotations for volume quantities on request.

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It is not introductory in the sense that it provides a more or less general discussion and formulation of the problem after which the special cases are taken with the invocation of appropriate restrictions and approximations. Nor is it introductory in the sense that the many restrictions are clearly and explicitly stated that are contained implicitly in the statements of the problems treated. The lack of the former causes the scope of the book to appear limited, with the result that an initiate may have difficulty grasping the total problem. The latter appears as a shortcoming in that the relation of the problems worked to physical reality tends to be obscured and the definition of the model tends to be diffuse. A neophyte may therefore be left groping for the connection between the problems as stated and the physicochemical reality to which engineers are prone to look for their motivation.

Admittedly these shortcomings are suggested by concepts that transcend the strict confines of analysis, but there is analysis as well as synthesis in the formulation of useful models, and also in their interpretation relative to a given physical situation. A closer tie with other aspects of the design problem and with a more general formulation of the transport problem would have provided the groundwork for the generation of alternative proposals for additional analysis. With the problem so limited from the outset it is possible that the initiate might leave the subject without an appreciation of the problems remaining in reactor design, analysis, and interpretation. This is, of course, part of the price one must pay if he wishes to treat aspects of a larger problem somewhat out of context.

Although these points detract from the book's many good qualities for use as an introductory textbook, the book provides a needed supplement for those in reactor design.

There is the usual sprinkling of typographical errors associated with first editions, but a minimum of error in concept and execution (although, for example, on p. 63 the statement $\Delta H = E - E'$ is misleading as well as is the discussion on p. 119 concerned with determining the rate controlling step in a sequence of events such as transport, adsorption, and reaction). The concept of locally time-averaged concentrations and hence, statistical behavior, is not introduced. The discussion of the stability of the steady state, paragraph 7.5, is especially good. There are occasional lapses of clarity, for example, paragraph 4.1.

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Effects of interfacial instability on film boiling of saturated liquid helium I above a horizontal surface, Frederking, T. H. K., Y. C. Wu, and B. W. Clement, **A.I.Ch.E. Journal, 12,** No. 2, p. 238 (March, 1966).

Key Words: A. Models-8,9, Thermohydrodynamics-8, Theoretical-0, Thermohydrodynamic Models-8,9, Heat Transfer-8,7, Film Boiling-10,8,7, Helium I-1,9, Cryogenic Liquids-1,9, Surfaces-9, Horizontal-0, Gravity-6, Interfacial Instability-6,7, Viscosity-6, Temperature Differences-6, Heat Transfer Coefficients-7,9, Correlating-8.

Abstract: Film boiling above a horizontal surface has been investigated theoretically and experimentally at standard gravity and 1 atm. Theoretical film boiling results for conventional fluids have been extended, on the basis of interfacial instability due to gravity, to include liquefied gas properties, such as low viscosity and small surface tension. Heat transfer data taken at surface excess temperatures ΔT (above the boiling point) between 80° and 300°K. have been correlated with a theoretical model.

Why thermodynamics is a logical consequence of information theory, Tribus, Myron, Paul T. Shannon, and Robert B. Evans, **A.I.Ch.E. Journal, 12,** No. 2, p. 244 (March, 1966).

Key Words: Developing-8, Deriving-8, Physical Properties-7,9, Properties (Characteristics)-7,9, Mechanics-9, Thermodynamics-7,9, Entropy-9,10, Newtonian-0, Information Theory-6, Equilibrium-6.

Abstract: The purpose here has been to show how the basic ideas of classical thermodynamics arise quite naturally out of the information theory approach.

Surface motion and gas absorption, Muenz, Kurt, and J. M. Marchello, **A.I.Ch.E. Journal, 12,** No. 2, p. 249 (March, 1966).

Key Words: A. Mass Transfer-8, 9, Interfacial-0, Absorption-10, 8, 9, Gases-1, Oxygen-1, Helium-1, Carbon Dioxide-1, Propylene-1, Water-5, Rate-8, 7, 2, Effective Diffusivity-2, 10, 7, Molecular Diffusivity-2, Diffusivity-2, 7, Waves-6, 9, Marangoni Instability-6, Frequency-6, Surface Tension-6, Calculating-8, Correlating-8, Grashof Number-2, 6, Experimental-0, Theoretical-0, Data-9.

Abstract: The influence of small waves on mass transfer from pure gases into water is investigated. Small-amplitude progressive two-dimensional waves are mechanically generated at the liquid surface for the wave studies. Control experiments with nonwaved surfaces are also conducted. The effect of surface motion arising from Marangoni instability is considered for nonwaved surface. An effective diffusivity is used to correlate the data.

Bubble motion and mass transfer in non-Newtonian fluids, Barnett, Stanley M., Arthur E. Humphrey, and Mitchell Litt, **A.I.Ch.E. Journal, 12,** No. 2, p. 253 (March, 1966).

Key Words: A. Mass Transfer-8,9, Absorption-8, Bubbles-1,9, Carbon Dioxide-1, Sodium Carboxymethylcellulose-9, Carboxymethylcellulose-9, Fluids-9, Non- Newtonian-0, Ellis Model Fluid-9, Rheology-8, Drag Coefficients-8, Age-6, Diameters-6, Shapes-6,7, Motion-6, Instantaneous-0, Mass Transfer Coefficients-7,8. B. Correlating-8, Drag Coefficients-9, Reynolds Number-9, Ellis Model Fluid-9, Non-Newtonian-0, Bubbles-9, Fluids-9.

Abstract: Instantaneous mass transfer coefficients were obtained for the absorption of carbon dioxide bubbles rising in an aqueous solution of sodium carboxymethylcellulose. The rheological character of the non-Newtonian solutions was described by the Ellis model. The effects of bubble age, bubble diameter, and bubble shape transitions on mass transfer coefficients were studied. Drag coefficient data were correlated with a new Reynolds number which was derived from both the Newtonian and power law-like terms of the Ellis model.

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The significant contributions provided are, first, the organization and merging of many techniques that have been receiving increasing attention in recent years and, second, a demonstration of the use of these techniques in the language and idiom of chemical engineering. This is sufficient alone to insure the use and success of the book.

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Heat Exchanger Design, Arthur P. Fraas and M. Necati Ozisik, John Wiley & Sons, Inc., New York (1965). 386 pages, $17.50.

Heat Exchanger Design may augur for the ever-hopeful an encyclopedic, information retrieval work. This was not the authors' objective. Rather, they sought to fill the void created by "the rapid evolution of technology since World War II, particularly in the aerospace and nuclear fields"—which is not necessarily the chemical engineer's domain.

Aerospace is disposed of in eight pages with illustrations to spare. What remains are reflections on elementary heat transfer from the vantage of one national nuclear laboratory. The treatment is from the buyer's point of view rather than the seller's, the latter being much more demanding.

The two hundred and seventy pages of 8½ in. × 11 in. text are divided into sixteen chapters covering an ambitious array of subjects. Chapter titles new to heat transfer primers include "Heat Exchanger Types and Construction," "Heat Exchanger Fabrication," "Stress Analysis," "Heat Exchangers for Liquid Metals and Molten Salts," "Cooling Towers," and "Heat Exchanger Tests." From an organizational standpoint the book's major shortcoming lies in the authors' compulsion for scope. If their objective was a concise elementary survey of heat transfer it became necessary to treat each of the sixteen chapters with less than admissible superficiality.

Under scrutiny, the sources of much of the material do not fare very well. Many of the references were gleaned from the recent literature where experimental results were correlated as *mean* values. It is well known in industry that the use of such procedures in commercial design is hazardous. First, by definition half the values one might compute from such correlations must be unsafe. Second, the deficiency must usually be compounded with similitude

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