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The kinetics of sorption by ion exchange resin beds, Colwell, Charles J., and Joshua S. Dranoff, **A.I.Ch.E. Journal, 12,** No. 2, p. 304 (March, 1966).

Key Words: A. Kinetics-8, 7, Rate-8, 7, Sorption-9, 8, 4, Solutes-1, 9, **n**-Propanol-1, 7, Ethylene Glycol-1, 9, Acetone-1, 9, Glycerine-1, 9, Ion Exchange Resin-9, 10, Packed-Bed-0, Dowex 50W-X8(H^+)-9, 10, Water-5, Mass Transfer-4, Calculating-8, Diffusivity-2, 6, 8, Intraparticle-0, Distribution Coefficients-2, Mathematical Model-10, Breakthrough Curves-10, Experimental Data-10, 1.

Abstract: The kinetics of sorption of dilute aqueous solutions of acetone, ***n***-propanol, ethylene glycol, and glycerine by packed beds of Dowex 50W-X8(H^+) resin are investigated experimentally. New single-solute sorption data are presented and these data are characterized by a mathematical model. The model, which is based on the intraparticle diffusion resistance to mass transfer of solute molecules, produces breakthrough curves that are fitted to experimental data. Density mixing and nonlinear equilibrium effects are also considered in this analysis.

Heat transfer to molten flowing polymers, Griskey, Richard G., and Irwin A. Wiehe, **A.I.Ch.E. Journal, 12,** No. 2, p. 308 (March, 1966).

Key Words: A. Heat Transfer-8, Measuring-8, Temperature Profiles-9, 1, Temperatures-9, 1, 6, Polymers-9, Polyethylene-9, Polypropylene-9, Fluids-9, Molten-0, Flowing-0, Non-Newtonian-0, Velocity-6, 1, Velocity Profiles-6, 1, Viscoelasticity-6, Dissipation-7, Viscous Dissipation-7, 8, Heat-9, Calculating-8, Nusselt Number-2, Heat Transfer Coefficient-2. B. Comparing-8, Correlating-8, Nusselt Number-9, Graetz Number-9, Temperature Profiles-9, Experimental-0, Theoretical-0.

Abstract: A method has been developed for measuring temperature profiles in flowing molten polymers with heat transfer. The effects of fluid velocity profiles, changing physical properties, and fluid viscoelasticity on viscous dissipation of heat are considered. Nusselt numbers are calculated from the data and compared to theoretical Nusselt-Graetz solutions.

The dehydrogenation of isopropanol on catalysts prepared by sodium borohydride reduction, Mears, David E., and Michel Boudart, **A.I.Ch.E. Journal, 12,** No. 2, p. 313 (March, 1966).

Key Words: A. Preparation-8, Reduction-10,8, Nickel Acetate-1, Sodium Borohydride-1, Nickel-1,2, Transition Metals-1,2, Nickel Boride-2, Catalysts-2,4, Promoted-0, Catalysis-4, Dehydrogenation-4, Water-5. B. Kinetics-8,2, Thermodynamics-8,2, Calculation-8, Dehydrogenation-9,8,4, Oxidation-10,9,8,4, Isopropanol-1, Acetone-2, Secondary Alcohols-1, Ketones-2, Catalysts-10,6,9, Nickel-10,6,9. Promoted-0, Promotion-6, Agitation-6, Solvents-6, Surface Area-7,6, Rate-7,8, Inhibition Coefficient-7, Activity-7, Specific Activity-7, Liquid Phase-0.

Abstract: The reduction of nickel acetate with sodium borohydride to prepare both promoted and unpromoted nickel catalysts is investigated. Surface areas of these catalysts and the effects of these catalysts on the liquid phase dehydrogenation of isopropanol are studied in detail. Kinetic and thermodynamic calculations for the dehydrogenation of isopropanol to acetone are also presented.

Accessibility of surface to gases diffusing inside macroporous media, Hedley, W. H., F. J. Lavacot, S. L. Wang, and W. P. Armstrong, **A.I.Ch.E. Journal, 12,** No. 2, p. 321 (March, 1966).

Key Words: A. Diffusion-8, 7, Diffusibility-8, 7, 2, Porosity-8, 9, Flow Porosity-8, 9, 2, 6, Measuring-8, Conductivity-10, Electrical-0, Porosimeter-10, Calculating-4, 8, Diffusion Coefficient-2, 7, Tortuosity-6, Shape Factor-6, Pores-9, Porous Materials-9, Flow Pores-9, 6, Dead-End Pores-6, Porous Materials-9.

Abstract: The measurement of flow porosity by penetration porosity and porosimeter measurements is described. The accuracy of electrical conductivity measurements used to obtain net diffusibilities is verified. It is pointed out that long dead-end pores feeding into larger diameter flow pores can contribute to the effective diffusion coefficient and methods of estimating this contribution are described.

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the partial volume of one component from that of the second component in a binary system is illustrated with data for the ethane–*n*-pentane system. No consideration seems to be given to the error introduced in using the Gibbs-Duhem equation when both pressure and temperature cannot be constant, which is the situation for a binary system. Effects of the gravitational force and surface tension on the partial free energy are included in this section.

There is a significant Appendix which includes Pitzer's reduced equation of state with tables of the pertinent parameters, tables of experimental data for multicomponent hydrocarbon systems measured in the author's laboratory, and a partial list of Goransons' derivative expressions from which thermodynamic equations for multicomponent systems can be assembled.

This somewhat specialized treatment of equilibrium thermodynamics should be a useful reference for those interested in properties and phase equilibria in multicomponent systems. The most valuable contribution is the explanation of methods, usually graphical, for calculating thermodynamic properties from volumetric data. A summary of the available data and prediction methods for properties of multicomponent systems would have been helpful. Views on the possibility of predicting thermodynamic properties from molecular interactions, from the vantage point of the author's extensive experience, also would have been valuable.

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Nonlinear Partial Differential Equations in Engineering, W. F. Ames, Academic Press, New York (1965). 511 pages + xii. 50 figures in the text.

This monograph deals with methods of solution of nonlinear partial differential equations. For the most part the methods are explained by citing examples of successful procedures gleaned from the current applied mathematics literature. Over six hundred sources, mostly journal articles, are referred to in the book. The examples are taken from such fields as fluid dynamics, diffusion, vibrations, boundary-layer flows, shock wave phe-

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nomena, and magneto-gas dynamics. There are only several examples in which chemical reactions are involved, none involving viscoelasticity, and none involving industrial contacting or heat exchange equipment.

Chapter 1 is concerned with the origin of nonlinear differential equations. Here some standard equations for diffusion, heat conduction, flow through porous media, boundary layers, gas dynamics, plasma oscillations, and oscillations are listed. No attempt is made to derive these equations, nor is any special attempt made to list the physical assumptions implied by the equations.

Chapters 2 to 4 deal with general solutions and analytical methods. These include general solutions of first- and second-order equations, transformations on dependent and independent variables, similarity methods, and hodograph methods.

Chapters 5 and 6 treat approximate methods; these include perturbation theory, weighted residual methods, the von Karman integral methods of fluid mechanics, and series solutions. Variational methods are not included. A large percentage of the examples used here is taken from literature references since 1945.

A long Chapter 7 (about one hundred sixty pages) concerns itself with numerical procedures. This chapter has four major headings: parabolic equations, elliptic equations, hyperbolic equations, and mixed systems. A short Chapter 8 (about sixteen pages) deals with questions of uniqueness and existence for a few reasonably well-understood systems.

The author, currently in the Department of Statistics and Computer Science and the Department of Mechanical Engineering, had his formal training in mathematics. This is reflected in his handling of illustrative examples. Little or no attempt is made to give physical interpretations to intermediate or final results. In some cases rather unrealistic problems are discussed, such as the boundary-layer flow of a Reiner-Rivlin fluid (to this reviewer's knowledge no fluids have been found to be described by this model) and heat conduction with thermal conductivity depending on the gradient of the temperature (there seem to be no experimental data to support this idea). Hence, "Engineering" in the title of the book may be questioned by some readers.

In spite of these minor objections the reviewer feels that this will be a valuable reference book and guide to the applied mathematics literature. If

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Axial laminar flow of a non-Newtonian fluid in an annulus, McEachern, Donald W., **A.I.Ch.E. Journal, 12,** No. 2, p. 328 (March, 1966).

Key Words: A. Estimating-8, Predicting-8, Fluid Flow-9, 8, 4, Flow-9, 8, 4, Fluids-9, Non-Newtonian-0, Ellis Model-0, 10, Laminar-0, Axial-0, Isothermal-0, Annulus-9, Conduits-9, Annular-0, Curves-9, 8, Flow Curves-9, 8, Motion-9, Calculating-8, Viscosity-2, 9, 7, Flow Rate-1, 6, Pressure Drop-1, 6, Polymer Solutions-9.

Abstract: The equation of motion is solved for steady axial laminar isothermal flow of an Ellis model fluid in a conduit of annular cross section. Tables are presented which may be used to obtain flow curves for annular flow of fluids whose Ellis parameters are known. The Ellis fluid predictions are compared with experimental data on dilute polymer solutions flowing in annuli. Ellis fluid predictions of flow curves are also compared to those predicted by the generalized Newtonian fluid and the power law fluid.

A theory of withdrawal of cylinders from liquid baths, White, David A., and John A. Tallmadge, **A.I.Ch.E. Journal, 12,** No. 2, p. 333 (March, 1966).

Key Words: A. Entrainment-8, 4, Films-9, Liquids-9, Cylinders-9, 10, Oils-9, Withdrawal-10, 8, 9, 4, Theory-8, Predicting-8, 4, Calculating-8, 4, Flux-2, 9, 7, Quantity-2, 9, 7, Radius-1, 6, Viscosity-1, 6, Surface Tension-1, 6, Goucher Number-1, 6, Capillary Number-1, 6, Rate-1, 6, Speed-1, 6, Theoretical-0, Experimental-0.

Abstract: A theory of the amount of liquid entrained by cylinders upon withdrawal from liquid baths is derived for a wide range of cylinder radii. The theory is based on matching curvatures for static and dynamic menisci. Predicted values are expressed as the effect of the dimensionless wire radius (Goucher number) and dimensionless withdrawal speed (capillary number) on the dimensionless flux. The theory is verified experimentally. Deviations, which are noted at high capillary numbers, indicate that the theory is a plug flow or low-speed theory.

Binary physical adsorption of argon and nitrogen on fixed beds of activated silica gel, Camp, David T., and Lawrence N. Canjar, **A.I.Ch.E. Journal, 12,** No. 2, p. 339 (March, 1966).

Key Words: A. Mass Transfer-8, 9, Adsorption-8, 9, Gases-1, 9, Mixtures-1, Argon-1, 2, Nitrogen-1, 2, Binary-0, Fixed Beds-9, Silica Gel-5, Activated-0, Velocity-6, Concentration-6, Length-6, Rate-7, 2, Amount-7, Diffusion-6, Internal Mass Transfer-6, Calculating-8, Diffusion Coefficient-2.

Abstract: Physical adsorption of binary mixtures of argon and nitrogen on fixed beds of silica gel is studied for various gas concentrations, gas velocities, and bed lengths. Possible factors controlling the rate of mass tranfer are considered. Data are correlated with integrated diffusion and integrated kinetic models and with differential rate expressions.

Bubble shapes in nucleate boiling, Johnson, M. A., Jr., Javier de la Pena, and R. B. Mesler, **A.I.Ch.E. Journal, 12,** No. 2, p. 344 (March, 1966).

Key Words: A. Analyzing-8, Examining-8, Measuring-8, Shapes-9, 8, 7, Bubbles-9, Water-9, Nucleate Boiling-4, Heat Transfer-4, Photography-10, High Speed-0, Rate-6, Growth-9, 6, Size-6, Contact Diameter-6, Delay Time-6, Surface Tension-6, Inertia-6.

Abstract: An explanation of the differently shaped bubbles observed growing on a surface during nucleate boiling of water is presented. Measurements of bubble dimensions and growth rates obtained by high-speed photography are analyzed. The relative importance of the inertial and surface tension forces is computed and the differences in shapes among bubbles are explained on the basis of the relative importance of these forces. It is also reported that delay time, contact diameter, rate of growth, and size of the bubble at departure are important factors closely related to bubble shape.

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one is faced with a nonlinear partial differential equation, one can find in concurrent form standard techniques, worked out examples, explicit literature citations, and helpful hints. The writing is generally clear, interesting and helpful; the author has clearly taken great care with proofreading and preparation of the index. An enormous amount of painstaking effort has gone into collecting together and interpreting a wide variety of subject material in a rapidly moving field. The author is to be congratulated for his successful execution of a difficult assignment.

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University of Wisconsin

Chemical Reaction Engineering. Proceedings of the Third European Symposium, J. Hoogschagen, Editor, Pergamon Press, New York (1965). vi 326 pages, $20.00.

It is always difficult to review a book such as the present one, which is a collection of papers presented at a symposium. Anyone working in this field is certainly cognizant of the existence of the first two Chemical Reaction Engineering Symposia and this one is of the same type. The papers are concerned with recent research performed by the authors and so are not meant to constitute current reviews in the various areas. The exception to this is the "final review" by van Krevelen in which he again shows his great skill in giving an organized, overall view of how the papers presented at the meeting fit into present knowledge in chemical reaction engineering.

The theme of the meeting was "Confrontation of Science and Practice in Process Development" and the volume contains many examples of the application of chemical reaction engineering to real industrial problems. The First and Second Symposia both contributed many distinctively new and novel approaches to problems (possibly because of a backlog of work), but this aspect is somewhat lacking in the Third. This was probably within the framework of the theme, but perhaps a meeting more balanced between new ideas and reflections on applications would be desirable.

Rather than attempt the impossible task of reviewing each paper, a discussion of the contents will be given. There are six sessions. The first is

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