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Height of a liquid film in a horizontal concurrent gas-liquid flow, Cohen, Leonard S., and Thomas J. Hanratty, **A.I.Ch.E. Journal, 12,** No. 2, p. 290 (March, 1966).

Key Words: A. Calculating-8, Thickness-2, 7, Height-2, 7, Dimensionless-0, Liquid Film-9, Film Flow-8, 4, 9, Fluid Flow-8, 4, 9, Concurrent-0, Two-phase-0, Reynolds Number-6, Waves-6, Viscosity-6, Velocity-6, 9, Liquid-9, Gas-9, Correlating-8, Data-1, 9.

Abstract: Results of a study of the height of liquid films flowing concurrently with an air stream in a horizontal channel are presented. With the assumption that three-dimensional waves exist at the gas-liquid interface, the effect of liquid Reynolds number on the dimensionless film height is examined.

Transmethylation reactions of monomethyl and dimethylamine over montmorillonite in a flow system, Restelli, Edward F., Jr., and James Coull, **A.I.Ch.E. Journal, 12,** No. 2, p. 292 (March, 1966).

Key Words: A. Kinetics-8, 7, Rate-8, 7, 2, Methylation-9, 8, 4, Transmethylation-9, 8, 4, Monomethylamine-1, Dimethylamine-2, Ammonia-2, Catalysts-10, 9, Montmorillonite K-106-10, 9, Differential Reactor-10, Adsorption-6, Pore Diffusion-6, Bulk Diffusion-6, Initial-0, Size-6, Temperature-6, Mass Velocity-6, Helium-5, Calculating-8, 4, Velocity Constants-2, Arrhenius Equations-2, Freundlich Isotherm-10, Langmuir-Hinglewood Rate Equation-10. B. Kinetics-8, Rate-8, Methylation-9, 8, 4, Transmethylation-9, 8, 4, Dimethylamine-1, Trimethylamine-2, Monomethylamine-2, Montmorillonite K-106-10, Catalysts-10, Differential Reactor-10, Helium-5.

Abstract: The transmethylation reactions of monomethylamine and dimethylamine are investigated under steady state conditions in a flow system. A differential reactor is employed with montmorillonite as the catalyst. The effects of pore diffusion on the rate of reaction are checked experimentally. The controlling phenomena of the reactions are determined by applying the Freundlich and Langmuir adsorption isotherms to the experimental results in the form of initial reaction rate vs. average partial pressure of the reactant at constant temperature. Velocity constants and Arrhenius equations for these controlling processes are also determined.

Direct contact heat transfer with change of phase: Spray-column studies of a three-phase heat exchanger, Sideman, Samuel, and Yehuda Gat, **A.I.Ch.E. Journal, 12,** No. 2, p. 296 (March, 1966).

Key Words: A. Effectiveness-8, Operation-8, Description-8, Heat Transfer-8, 9, Three-Phase Heat Exchanger-9, 10, Heat Exchanger-9, 10 ,Three-Phase-0, Multiphase-0, Direct Contact-0, 10, Spray Column-9, 10, Vaporization-4, 9, 8, Pentane-1, 2, Water-5, Calculating-8, Heat Transfer Coefficient-2, 7, 9, Flow Rate-6, Temperature-6, Height-6, 7, Holdup Ratio-6, 7, Volumetric-0.

Abstract: Heat transfer characteristics are presented for a perforated plate-spray column in which a volatile dispersed phase evaporates while rising in the continuous, counterflowing, immiscible phase. Optimal column heights, volumetric heat transfer coefficients, holdup ratios, and foam heights are reported as a function of flow rate and temperature approach for a pentane-water system. Comparison with related studies is presented.

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Thermodynamics of Multicomponent Systems, Bruce H. Sage, Reinhold Publishing Corporation, New York (1965). 366 pages.

This book follows the approach of an earlier treatment by the author on single-component thermodynamics. The objective is to extend and apply the concepts of Gibbs to practical systems. The extensive experimental studies of properties of hydrocarbon mixtures, carried out in the author's laboratory, are used to illustrate the derived relationships. No attempt is made to relate the behavior of multicomponent systems to theories of molecular interaction. Rather, the approach, like that of Gibbs, is to present and examine the restrictions placed on the properties of mixtures by rigorous application of the first and second laws of thermodynamics.

The first chapter gives definitions of terms. The care with which the boundaries of the thermodynamic system are considered is a preview of the importance attached to irreversibilities. Changes in the form of energy as it is transferred through the boundary between the system and the surroundings is later used to establish the extent of irreversibility.

Chapter 2 describes the volumetric and phase characteristics of fluids in hydrocarbon systems. Following this, Chapters 3 to 10 present thermodynamic relationships for multicomponent systems, first for the restraint of constant composition and later for the general case. This section constitutes about one-half of the book and considers in detail expressions for the partial entropy, enthalpy, and free energy of a component in a homogeneous fluid. Partial quantities are illustrated using graphical techniques with experimental volume vs. composition data.

The evaluation of fugacities from partial volume data is the objective of Chapter 10. With this background general equations are derived for the phase equilibrium constant in terms of volumetric data in Chapter 11. Seldom is sufficient information at hand to use these derived relationships. Hence the author has wisely included a chapter which describes how an equation of state may be used to calculate the fugacity and partial quantities for a component in a mixture. The equations presented are based upon the Benedict-Rubin-Webb equation of state. Detailed equations are given for single-component systems but unfortunately only a qualitative description is included for mixtures.

The final three chapters are devoted to special topics. The use of the Gibbs-Duhem type of equation to calculate

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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.

J. M. Smith
University of California

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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