INFORMATION RETRIEVAL*

Key Words: Catalysis-I, Conditions-I, Surfaces-I, Temperature-I, Pressure-I, Partial-, Heterogeneous-H, Reactions-H, Particles-H, Pellets-H, Reaction Mechanics-H, Methods-J, Numerical-, Graphs-, Techniques-J, Models-J.

Abstract: Numerical and graphical methods are presented for estimating the temperatures and partial pressures at the surfaces of catalyst particles for gaseous reactions in flow systems. The errors resulting in the interpretation of catalytic reaction rate data where surface conditions are assumed to be those of the ambient gas stream are presented. A numerical method of evaluating the reaction model using nonisothermal surface conditions is indicated.

Reference: Yoshida, Fumitake, D. Ramaswami, and O. A. Hougen, **A.I.Ch.E. Journal, 8,** No. 1, p. 5 (March, 1962).

Key Words: Transferring-I, Heat Transfer-I, Radiating-I, Fluxes-H, Thermal-H, Radiations-H, Heat Transfer-H, Local-, Transport-H, Surfaces-H, Temperature-F, Emissivity-F, Heat Transfer-G.

Abstract: An analysis of radiant interchange is made which takes account of possible surface variations in incident radiation flux, heat transfer, and leaving radiant flux. This represents a generalization of standard calculation methods which postulate that the radiant fluxes and heat transfer are uniformly distributed on a surface. Consideration is given to pairs of simply arranged surfaces having different emissivities and arbitrarily different surface temperatures. Local and overall heat transfer results are compared with those predictd by standard calculation procedures.

Reference: Sparrow, E. M., **A.I.Ch.E. Journal, 8,** No. 1, p. 12 (March, 1962).

Key Words: Flow-I, Fluid Flow-I, Pressure Drop-I, Predicting-I, Forecasting-I, Fluids-H, Gases-H, Liquids-H, Phases-H, Heat Transfer-H, Trichlorofluoromethane-A, Chlorinated Hydrocarbons-A, Fluorinated Hydrocarbons-A, Halogenated Hydrocarbons-A, Hydrogen-A, Tubes-J, Pipes-J.

Abstract: Data on pressure drop in two-phase, single-component fluid flow, both with and without heat transfer, are presented in terms of the Lockhart and Martinelli correlation parameters. The fluids used were trichloromonofluoromethane and hydrogen. The results are compared with the correlation curve recommended by Martinelli and Nelson, and reasons for deviations are discussed. A method is proposed for predicting roughly the total pressure drop in tubes containing steady state, two-phase, single-component fluid flow with appreciable vaporization.

Reference: Hatch, M. R., and R. B. Jacobs, **A.I.Ch.E. Journal, 8,** No. 1, p. 18 (March, 1962).

Key Words: Fluid Flow-I, Flow-I, Velocity-I, Profiles-I, Annular-I, Friction-H, Factors-H, Correlations-H, Pressure Drop-H, Reynolds Number-H, Drag-H, Boundaries-H, Water-A, Liquids-A, Fluids-A, Tubes-J, Pipes-J, Cylinders-J, Concentric-J.

Abstract: Main stream velocity profiles have been obtained by means of impact probes for the steady, isothermal flow of water in three smooth, concentric annuli having widely different diameter ratios. The point of maximum local velocity has been determined, thus permitting the ratio of skin frictions of the inner and outer boundaries to be calculated. Previously published data on pressure drop have been used to obtain separate friction factor correlations for the two surfaces. Attention has been centered on the transition range, where the position of maximum velocity is a function of both the diameter ratio and the Reynolds number.

Reference: Rothfus, R. R., and E. J. Croop, **A.I.Ch.E. Journal, 8,** No. 1, p. 26 (March, 1962).

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* For details on the use of these key words and the A.I.Ch.E. Information Retrieval Program, see **Chem. Eng. Progr., 57,** No. 5, p. 55 (May, 1961), No. 6, p. 73 (June, 1961).

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conference deals with units and recommends that all future publications use the units bar and kilobar for pressure. One atm. = 0.987 bars).

Of special note is the paper by Professor Vereshchagin of the Institute for High Pressure Research of the Union of Soviet Socialist Republics which reviews the progress made in this area in the Union of Soviet Socialist Republics.

In order to give a better idea of the content of the various papers presented at this conference the following list of titles is given: High Pressure Apparatus, Diamond Cells for X-Ray Diffraction Studies under High Pressure, Optical Studies at High Pressure, The Upper Three-Phase Region in the System SiO_2-H_2O, Mobility of Vacancies and Interstitials at High Pressures, Some Observations on the Morphology and Physical Characteristics of Synthetic Diamond, The Thermodynamics of Activated Processes at High Pressures, The Synthesis of the Cubic Form of Boron Nitride, The Effect of Hydrostatic Pressure on the F.C.C. ⇄ B.C.C. Reactions in Iron-Base Alloys, The Effect of High Pressures on Transformation Rates, Research and Development on the Effects of High Pressure and Temperature on Various Elements and Binary Alloys, State of Matter at High Pressure, Resistance and Thermal Gap Measurements to 400,000 Atmospheres, Recent Geochemical Research at High Pressures, Melting and Other Phase Transformations at High Pressure, Some Experiments at High Pressures and Low Temperatures, The Pressure Variation of the Elastic Constants of Sodium, Properties of Semiconductors at High Pressures, An Accurate Determination of the Equation of State by Ultrasonic Measurements, Effect of Pressure on EMF of Thermocouples, Effect of Hydrostatic Pressure up to 8,000 Atm. on the Self-Diffusion Rate in Silver Single Crystals, Effects of Pressure on Magnetic Interactions in Metals, The Volume Dependence of the Cohesive Energy from Shock Wave Compression Measurements in Solids, Nuclear Magnetic Resonance in Solids and Liquids Under Pressure, Investigations (In U.S.S.R.) in the Area of the Physics of High Pressures, Some Fixed Points on the High Pressure Scale, and Large Pressure Units.

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The Optimal Design of Chemical Reactors: A Study in Dynamic Programming, Rutherford Aris, Academic Press, Inc., New York (1961). 191 pages. $7.00.

Problems associated with optimization and optimal design of chemical reactor systems have been receiving increasing attention in recent literature. Quite often the results have been somewhat disappointing in that only relatively restricted systems are considered, and the inclusion of more general situations results in mathematical formulations of appalling complexity.

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INFORMATION RETRIEVAL

Key Words: Heat Transfer-I, Transferring-I, Turbulence-I, Flow-I, Fluid Flow-I, Bubbling-I, Surfaces-H, Bubbles-H, Transport-H, Boiling-H, Injection-H, Steam-A, Water-E, Rates-F, Flow-F, Temperature-F, Velocity-F, Size-G, Shapes-G, Heat Transfer-G, Coefficients-G.

Abstract: Turbulent heat transfer coefficients have been measured at the surface of single bubbles formed by injecting steam into a subcooled water stream at atmospheric pressure. Depending upon the steam flow rate (0.4 to 1.5 g./min.), the water temperature (80° to 180°F.), and the water velocity (0.9 to 7.2 ft./min.), the bubbles ranged from small, smooth, ellipsoidal bubbles, similar to those observed in highly subcooled nucleate boiling, to larger, irregular bubbles which oscillated in size.

Reference: Bankoff, S. G., and J. P. Mason, **A.I.Ch.E. Journal, 8,** No. 1, p. 30 (March, 1962).

Key Words: Transferring-H, Transport-H, Heat Transfer-H, Mass Transfer-H, Flow-H, Fluid Flow-H, Fluids-I, Gases-I, Spheres-J, Vaporization-I, Turbulence-I, Air-I, Water-I, Drag-I, Friction-I, Factors-, Analogs-I.

Abstract: The transfer of mass, heat, and momentum past a single sphere has been experimentally investigated. The data resulting from the vaporization of water into a turbulent air stream are used to check the analogy between heat and mass transfer. The total and form drag of the sphere were determined, but the extension of the analogy to momentum transfer can not be tested on account of the difficulty in obtaining significant values for the friction factor due to shear drag.

Reference: Yen, Yin-chao, and George Thodos, **A.I.Ch.E. Journal, 8,** No. 1, p. 34 (March, 1962).

Key Words: Diffusion-H, Transport-H, Rates-H, Mass Transfer-H, Gases-I, Fluids-I, Mixtures-I, Ternary-, Countercurrent-I, Hydrogen-I, Nitrogen-I, Carbon Dioxide-I, Oxides (Inorganic)-I, Cells-J, Diffusion-, Interactions-I, Predictions-I.

Abstract: Equimolal countercurrent diffusion runs have been made in a two bulb diffusion cell using the system H_2, N_2, CO_2. The initial bulb compositions were chosen so that various types of ternary interactions occurred. The results are compared with those predicted by the Maxwell-Stefan equations.

Reference: Duncan, J. B., and H. L. Toor, **A.I.Ch.E. Journal, 8,** No. 1, p. 38 (March, 1962).

Key Words: Rates-H, Reactions-H, Reaction Kinetics-H, Kinetics-H, Chemical-, Dehydration-I, Isothermal-I, Heterogeneous-I, Catalysis-I, Adsorption-I, Ethanol-A, Alcohols-A, Diethyl Ether-A, Ethers-A, Ethanol-B, Alcohols-B, Diethyl Ether-B, Ethers-B, Water-B, Ethylene-B, Alumina-D, Recycling-J, Reactors-J, Differential-, Temperature-F.

Abstract: The isothermal rate of a heterogeneously catalyzed gas reaction has been measured by a new method involving a differential reactor incorporated into a recycling system. The kinetics of the dehydration of ethanol and diethyl ether over alumina have been studied and a mechanism is proposed. The values and the temperature dependence of all pertinent rate and adsorption constants are reported.

Reference: Butt, John B., Harding Bliss, and C. A. Walker, **A.I.Ch.E Journal, 8,** No. 1, p. 42 (March, 1962).

Key Words: Reduction (Chemical)-I, Rates-I, Reactions-I, Kinetics-I, reaction Kinetics-I, Reaction Mechanics-I, Porosity-H, Properties (Characteristics)-H, Solids-H, Physical Properties-H, Heterogeneous-H, Diffusion-H, Iron Oxides-A, Oxides (Inorganic)-A, Hydrogen-A, Carbon Monoxide-A, Iron-B, Metals-B, Temperature-F, Pressure-F, Rates-G, Pellets-J, Spheres-J, Particles-J.

Abstract: A study has been made to determine the rate controlling step in the reduction of iron oxide with hydrogen and carbon monoxide. For the reduction of porous hematite pellets and bars, it was found that the reduction rate is controlled by the counterdiffusion of reactant gas and product gas between the reaction zone and the main gas stream. Reduction rates were studied at system pressures of one and two atmospheres, and temperatures between 700 and 1200°C.

Reference: Kawasaki, Edwin, Jack Sanscrainte, and Thomas J. Walsh, **A.I.Ch.E. Journal, 8,** No. 1, p. 48 (March, 1962).

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Professor Aris has produced, in the reviewer's opinion, a work which provides a substantial definition and approach to the problem of optimality—as applied to reactor design explicity and, indeed, by inference to a far wider range of problems of chemical engineering interest.

The application of dynamic programing methods to an optimal design problem brings some considerable order into the process of determination of optimal policies, in the case of both multistage and continuous systems. In specific application to reactor systems, it is convenient to quote Professor Aris:

"... whatever transformation may be effected in the first stage of an R-stage process, the remaining stages must use an optimal (R—1)-stage policy with respect to the state resulting from the first stage, if there is to be any chance of optimizing the complete process. Moreover, by systematically varying the operating conditions in the first stage and always using the optimal (R—1)-stage policy for the remaining stages, we shall eventually find the optimal policy for all R stages."

Essentially the principles embodied in this statement form the basis of the method, and they can be applied with good effect through the use of digital computers to an amazing array of reactors and reactions systems.

The material is first presented in general form: an introduction to the basic methods of dynamic programing as applied to discrete and continuous processes. In the sections immediately following are discussed mathematical models for various reactor types and the variables involved, both those controlling the reactor operation (policy) and those to be optimized (objective function). Specific cases of optimal design and policy are investigated in chapters on continuous stirred-tank reactors, multibed adiabatic reactors, and the tubular reactor for a variety of operating restrictions and first-order reaction systems. General methods are developed for the more complex cases. The book is concluded with a discussion of the optimal operation of existing reactors.

The mathematics involved in this discussion is not complex, but one should not assume that the topic is easily understood immediately. The inclusion of an excellent review of the literature of the field is a substantial aid for additional reading; the system of nomenclature employed is involved and quite confusing in spots—certainly a few of the specific applications could have been treated in more simple terms without fear of loss of generality.

Of the importance and application of dynamic programing methods to these problems of optimal design there is no question. Those unfamiliar with the methods will find a considerable amount of thought necessary preliminary to their understanding; the reward is commensurate with the effort.

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