INFORMATION RETRIEVAL*

Gas absorption accompanied by an irreversible reaction of general order, Brian, P. L. T., **A.I.Ch.E. Journal, 10,** No. 1, p. 5 (January, 1964).

Key Words: Gas-5, Liquid-5, Reaction Rate-6, Reaction Order-6, Absorption-8, Mass Transfer-8, Reaction Kinetics-8, Diffusion-8, Mathematics-10, Computations-10, Finite-Differences-10, Penetration Theory-10.

Abstract: The penetration theory differential equations are solved numerically for gas absorption accompanied by an irreversible chemical reaction. Solutions are obtained for a number of combinations of *n* and *m*, the orders of the reaction kinetic equation with respect to the concentrations of the absorbing species and of the solute reactant, respectively. A generalized definition of the relative rate parameter is found to render the solution quite insensitive to *n* when the diffusivities are equal, and an empirical correlation describes the effect of *m*. The effect of the diffusivity ratio is also illustrated.

Viscosity *correlations* for nonpolar dense fluids, Starling, Kenneth E., and Rex T. Ellington, **A.I.Ch.E. Journal, 10,** No. 1, p. 11 (January, 1964).

Key Words: Viscosity-7, Density-6, Temperature-6, Correlation-9, Least-Square-10, Methane-8, Ethane-8, Propane-8, *n*-Butane-8, Isobutane-8, Ethylene-8, Nitrogen-8, Carbon Dioxide-8.

Abstract: Expressions for the coefficient of viscosity as a function of temperature and density are derived which describe behavior for the liquid, gas, and supercritical dense fluid regions of a number of nonpolar materials. Two expressions are derived from expressions in the Born and Green and Enskog theories; three others are derived from analyses of observed behavior for ethane, propane, and *n*-butane. Empirical constants in these equations were determined by an iterative, least-squares method. Standard deviations of the data calculated by use of one of these expressions are 0.87, 1.19, and 0.97% for ethane, propane, and *n*-butane, respectively. This equation also describes the viscosity of methane, isobutane, ethylene, nitrogen, and carbon dioxide within about 2%.

A new approach to the stability and control of nonlinear processes, Leathrum, J. F., E. F. Johnson, and L. Lapidus, **A.I.Ch.E. Journal, 10,** No. 1, p. 16 (January, 1964).

Key Words: Control-8, Stability-8, Reactors-9, Nonlinearity-7, Geometric-10, Oscillations-2, Integration-10, Computers-10, Disturbances-1.

Abstract: The method of Lyapunov was applied to the problem of assuring stability for nonlinear systems and also an acceptable level of control quality for large disturbances. Geometrical considerations have led to stability criteria which avoid the search for analytical functions. This technique involves constructing an approximate integral for the system by choosing alternate extremes in the magnitude of the state vector. A number of different types of physical systems are examined and the technique predicts the existence and stability of limit cycles.

The thermal conductivity of nonpolar substances in the dense gaseous and liquid regions, Stiel, Leonard I., and George Thodos, **A.I.Ch.E. Journal, 10,** No. 1, p. 26 (January, 1964).

Key Words: Correlation-8, Thermal Conductivity-8, Physical Properties-8, Fluids-9, Gases-9, Liquids-9, Dimensional Analysis-10, Residual Relationships-10.

Abstract: Thermal conductivities available in the literature for the gaseous and liquid states of 20 nonpolar substances, including inert gases, diatomic gases, carbon dioxide, and hydrocarbons of all types, were correlated with reduced density by the use of dimensional analysis and the residual relationship for thermal conductivity. A single generalized relationship was obtained for thermal conductivity and it is presented both graphically and analytically. The properties required for the calculation of thermal conductivity with the relationship are the molecular weight, the critical constants, and the density of the substance at the temperature and pressure considered.

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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); **58,** No. 7, p. 9 (July, 1962).

NOTE: Additional pages of information retrieval abstracts and key words in this issue are available on request.

The Thermodynamics of Gasification and Gas-Synthesis Reactions, N. V. Lavrov, V. V. Korobov, and V. I. Filippova, translated by G. H. Kinner, Pergamon Press, Macmillan Company, New York (1963). 116 pages. $6.50.

This is essentially a handbook of thermodynamic parameters relevant to the equilibrium constants of carbon gasification, methane conversion and dissociation in the gas phase, the Fisher-Tropsch reaction, and synthesis from the carbon monoxide-steam reaction. It contains a valuable compilation of such data for several hundred hydrocarbons. A brief outline is given of the statistical mechanical methods used to determine the parameters. As it is a handbook some vagaries in definition of symbols, lack of units and logarithms of dimensional quantities can be overlooked, since we all know what is intended. The calculation of equilibrium constants from a simple form using standard state-standard temperature enthalpies and entropies of formation, the more precise Ulikh's formula or, more accurate still, the tabulated values of thermodynamic potential Φ^* defined by $F_o = H_o^o - \Phi^* T$, is described. Values of ΔF_o could be tabulated instead of ΔH_o^o and Φ^*, but the use of Φ^* makes it easier to compare the more accurate values with first approximation values. Equilibrium degrees of conversion and gas composition are given for a number of reactions. The $C + H_2O = CO + H_2$ equilibrium is treated independently of the associated $CO + H_2O = CO_2 + H_2$ and $C + 2H_2 = CH_4$ reactions, which is probably unrealistic in practice and the same criticism will apply to several of the other systems considered, unless extremely specific catalysts are available. (There is no kinetic or catalytic information in the book.) It is an excellent handbook for all chemical engineers concerned with these synthesis reactions. L. G. Austin

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River Pollution, II: Causes and Effects, Louis Klein, Butterworths, London (1962). 456 pages. $14.95.

Klein's 1957 "Aspects of River Pollution" was well received and is currently being updated and reissued in three volumes of more convenient size. The first, on "Chemical Analysis," appeared in 1959. The present volume deals with pollution and polluted streams per se: the historical and legal background, the nature and sources of pollution, and the effects of pollution on uses of the stream, including its use as an environment for fish and other organisms. A final volume, not yet announced, will presumably be concerned with the treatment of municipal and industrial wastewaters in order to reduce and control pollution and standards for such control.

All of Klein's manuscripts demonstrate an efficient use of words. Much information is contained on each page, yet the writing is thoroughly lucid, and delightful to the reader. Compactness is achieved, though not at the expense of a brief literary gem to introduce each chapter and an apparently easy style of writing throughout. The author makes no attempt to minimize his feelings or to hide his innate wit when he describes overzealous regulatory activities of the government or callous disregard for civilized ethics by municipal or industrial polluters. The result is most enjoyable.

This book is, of course, British, which is particularly apparent in Klein's historical introduction and his review of legal aspects of river pollution. These two chapters are of relatively minor use to an American seeking quick answers to a technical question, but are excellent reading for anyone who will relax long enough to appreciate them. The remaining chapters are more tightly packed with technical information on pollution.

The nature and effects of pollution are carefully outlined and described as to sources, chemical types, physical types, physiological aspects, and biological effects. Industrial wastes are included in all of these phases, and are more specifically covered in the succeeding chapter, in parallel with sewage, as a cause of river pollution. Some of the aspects of industrial pollution are typically British, but nevertheless of interest in American practice.

The uses of river water are explored, including brief sections on conservation and possible substitute sources of water. Standards are discussed for the quality of water for drinking, groundwater recharge, industrial uses including boiler water and cooling water as well as a number of specific industries, agricultural and fishery use, waste transport, navigation, and recreation.

The second half of this volume covers more specifically the biochemical and physicochemical aspects of pollution, and biological aspects including separate chapters on fish and on other aquatic life forms. Klein has called upon coauthors for these subjects, each an expert in his field; the result is an exhaustive survey of current information. Toxic materials are well covered, as are other aspects of the aquatic environment.

Klein's book is well documented with literature citations throughout. Probably not suitable for a beginner's text, it is an excellent reference work for anyone who wishes more than a casual knowledge of stream pollution.

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Elements of Chemical Reactor Design and Operation, H. Kramers and K. R. Westerterp, Academic Press, Inc. (1963). 245 pages. $10.00.

This new text on reactor design merits the attention of both educators and those in industrial practice for its catholicity of coverage and its attention to those problems which are, at the same time, important for the student and indicative of current practice and application for the design engineer. It is most pleasing to note the successful combination of much of the recent and significant work in chemical-reaction engineering with a continuing sense of the importance of those practical and economic considerations involved in its effective utilization.

The subject material of the book includes analysis of batch, tubular flow, and stirred-tank reactors, and their operation. The discussion is extended to include reactor cascades, the cross-flow reactor model, and some applications to fixed-bed reactors. Nonisothermal and mixing effects in reactor design are treated in detail. A separate section is devoted to the topic of reactor optimization, including isothermal and nonisothermal systems, through discussion of some individual cases; applications of mathematical methods of optimization such as dynamic programming are introduced at the end of this section.

The authors are to be commended for their treatment of all these topics. Presentation throughout is clear and well organized; the subject material chosen for presentation from this large and rapidly developing field is well considered. The value of the book as a text is considerably enhanced by numerous illustrative examples, which are presented after almost every topic, and by the extensive citation of the literature of the field, including most papers of importance in reactor design and analysis.

The text is, thus, very well presented in general; a sole criticism is the omission of a subject index. An overall evaluation, however, must include some questions concerning material which is not presented. It is perhaps unfair to comment on the scope of a work such as this except when the scope is so limited that the material which is presented is adversely affected, or when the presentation is very well carried out and one desires to see the same authors discuss additional, advanced material. The latter comment applies here. The fluidized-bed reactor, for example, is not discussed in detail, and the recent work developing computational models of fixed-bed, catalytic reactors by means of stirred-tank networks is not mentioned at all. The important question of experimental reactors and the problems involved in obtaining reliable kinetic data suffers from condensation; this is unfortunate in the sense that inclusion of a topic in an appendix, as this is, may relegate it to secondary importance in the mind of a student. There are a number of additional points of this nature which might be included here, all dealing with various items which could be extended in scope of discussion. It may be the feeling of the authors that many of these systems, such as fluidized reactors, are not yet well enough characterized to allow treatment in the same manner as material which is presented. In view of the excellence of this book, one may only regret this decision.

The authors have succeeded in their stated attempt to bring forth some type of structure or system by which the problems of reactor design and operation may be treated through the use of methods which possess some generality.

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Liquid-Liquid Equilibriums, Alfred W. Francis, Interscience Publishers, New York (1963). 298 pages.

This excellent little book provides a concentrated treatment of the characteristics of liquid-liquid equilibriums in binary, ternary, and quaternary systems. The emphasis is on the manner in which these systems illustrate the principles governing the relationships between regions of solubility and insolubility, the shapes of miscibility gaps and solubility curves, the characteristics of equilibrium tie lines, and other properties. Francis himself has been responsible for developing much of what is known of the properties of these systems, and the book is profusely illustrated with examples, many of which are taken from the author's own extensive researches. Great care is taken to avoid using "typical" systems, no examples of which are known, to demonstrate the principles, and much of the text is devoted to correcting the misinformation which has developed from imaginative use by others of such "typical" systems rather than from direct knowledge.

The book will be most useful for students and chemists working with liquid-liquid systems and for engineers who must apply this information in the practice of liquid extraction. The author's long association with the petroleum industry is revealed on occasions, as when he lists as the principal commercial solvents only those

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