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Fluid flow through woven screens, Armour, James C., and Joseph N. Cannon, **AIChE Journal, 14,** No. 3, p. 415 (May, 1968).

Key Words: A. Correlation-2, 8, Pressure Drop-7, 8, Flow-8, Screen-9, Plain Square Weave-0, Full Twill Weave-0, Fourdrinier Weave-0, Plain Dutch Weave-0, Twilled Dutch Weave-0, Water-9, Helium-9, Nitrogen-9, Flow Rate-6, Laminar-0, Turbulent-0, Newtonian-0, Friction Factor-8, Reynolds Number-8.

Abstract: A packed bed model has been adopted to develop a general correlation applicable to the flow of Newtonian fluids through all types of woven metal screens. Both of the main theoretical approaches to studying pressure drop in packed systems have been used by visualizing the screen as a collection of submerged objects with surface area to unit volume ratio a for laminar flow, and as a bundle of tubes of diameter D for turbulent flow. In the usual manner viscous and inertial energy losses are added to give an expression for the total pressure loss. Rearrangement of the general equation to the form of a friction factor yields a unique definition of the Reynolds number for screens $N_{Re} = \rho u/\mu a^2 D$. Procedures are described for collection of pressure drop-velocity data for the flow of nitrogen and helium through plain square, full twill, fourdrinier, plain dutch, and twilled dutch weaves. The data are used to derive a viscous resistance coefficient $\alpha = 8.61$ and an inertial resistance coefficient $\beta = 0.52$. The validity of the correlation equation is tested by using additional data from the literature. The correlation successfully predicts pressure drop for a Reynolds number range of 0.1 to 1,000, void fractions from 0.35 to 0.76, screen pore diameters from 5 to 550 μ, mesh sizes from 30 to 2,400 wires/in., and surface area to unit volume ratios from 1,200 to 29,000 ft.$^{-1}$.

Mechanism of interfacial mass transfer in membrane transport, Kaufmann, Thomas G., and Edward F. Leonard, **AIChE Journal, 14,** No. 3, p. 421 (May, 1968).

Key Words: A. Mass Transfer-7, 8, Dialysis-8, Diffusion-8, Sugar-9, Resistance-8, Membrane-9, Cellophane-9, Dialyzer-8, 10, Sherwood Number-7, 8, Reynolds Number-6, Schmidt Number-6, Distance-6, Eddy Diffusivity-7, Testing-8.

Abstract: Dialysis of binary aqueous solutions of several sugars through a cellophane membrane was studied in a stirred, batch dialyzer. Sherwood numbers describing mass transfer resistance in the fluid adjacent to the membrane were determined as a function of the corresponding Reynolds and Schmidt numbers. The results establish a reproducible environment for membrane testing in which a known, controllable and small interfacial resistance is placed in series with that of the membrane. The results also are shown to support, for this geometry, the postulation of a third-power relationship between eddy diffusivity and dimensionless distance from the phase boundary as well as the Sherwood-Ryan nondimensionalization of this distance.

Density and pressure fluctuations in gas fluidized beds, Winter, Olaf, **AIChE Journal, 14,** No. 3, p. 426 (May, 1968).

Key Words: A. Fluidization-8, Density-8, Pressure-8, Bubble Diameter-2, 7, 9, Density Fluctuations-9, Pressure Fluctuations-9, Frequency Distributions-9, Fluidized Bed-10, Reactor-10, Photocell-10, Conductivity Cell-10, Geiger-Mueller Counter-10, Strontium^{90}-10, Statistics-10, Design-4, Model-4, Particle Size-6, Gas Velocity-6, Horizontal Screens-6, Bed Height-6, Distance from Air Distribution Plate-6, Intensity of Density Fluctuations-2, 7, Intensity of Pressure Fluctuations-2, 7, Degree of Freedom of Probability Distribution-1, 7, Air-1, Glass Beads-1, Light Rays-1, β-rays-1, Characteristic Numbers-2, Gas-5, Solid-5.

Abstract: A Bench scale size fluidization system was constructed for the purpose of conducting experiments to determine density and pressure fluctuations in gas fluidized beds. Density fluctuations and bubble sizes were measured with a photocell device and β-ray absorption. Pressure fluctuations were determined with a conductivity cell. The frequency distributions of the density and pressure fluctuations and bubble sizes were determined as functions of several variables. They could be described by dimensionless coefficients and χ^2-distributions with different degrees of freedom. Such variables as distance from the gas distribution plate, bed height, particle size, gas flow rate, and internal screens were considered.

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have been tabulated but this is expecting too much of what is already a monumental piece of work.

In spite of the shortcomings of this new edition, which have been pointed out, it is my opinion that this book is still the best in its field and most scientists and engineers whose work involves vapour-liquid equilibrium will surely wish to add this new edition to their library.

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Mathematical Modeling in Chemical Engineering, Roger G. E. Franks, John Wiley and Sons, Inc., New York, 285 pages, $10.95.

The title of this book quite accurately describes what it is about; and since the word "model" causes nearly every engineer and scientist to salivate, this book ought to be a best seller. However, some poor editing may make it worthwhile delaying purchase until the second, and hopefully corrected, printing rolls off the presses.

Quite often one hears an engineering professor exclaim that his students can't integrate, quite apart from the problem of having them properly formulate a mathematical equation which should be integrated! In the Preface to this book, Dr. Franks essentially tosses aside the first problem, namely, solving differential equations. To quote, "The recent development of macrocomputer languages, such as digital simulation programs, eliminates the need for many of the mathematical procedures that discourage the average engineer from adopting the analytical approach. Having removed the complexities of problem solution by the simple expedient of substituting computerized methods, a more serious deficiency is revealed, namely, that of problem formulation."

However, before going into the details of formulating models, three chapters are devoted to digital simulation languages which are designed to handle systems of nonlinear differential and algebraic equations. In particular, two are described in some detail, MIDAS and MIMIC. These systems are a collection of mathematical subroutines similar, or analogous, to the units in an analog computer. With these languages, the scaling problem of analog computers disappears. (This reviewer had hopes of introducing some of the book's material in a course in process dynamics and control, but the possibility of doing this faded considerably when the computing center here

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Prediction of drag reduction with a viscoelastic model, Patterson, G. K., and J. L. Zakin, **AIChE Journal, 14,** No. 3, p. 434 (May, 1968).

Key Words: A. Reduction-7, 8, Drag-7, 9, Polymers-6, 9, Solutions-9, Flow-8, 9, Laminar-0, Turbulent-0, Viscoelastic Model-10, Damping-6, Momentum Transfer-8, Heat Transfer-8, Mass Transfer-8, Diameter-6, Pipe-9, Degradation-6, Velocity-6, Fluids-9, Viscoelastic-0.

Abstract: A viscoelastic model was developed which demonstrates that drag reduction may be predicted without the assumption of a reduction of turbulence intensity. The reduction in the turbulent-momentum-transfer rate calculated at the same turbulent intensity suggests that turbulent heat and mass transfer may be reduced in the same manner in viscoelastic fluids without a decrease in turbulence intensity. This has serious implications in the design of heat exchangers and reactors involving viscoelastic fluids in turbulent flow.

Similarity type solutions of turbulent boundary layers for momentum and energy, Telles, A. S., and A. E. Dukler, **AIChE Journal, 14,** No. 3, p. 440 (May, 1968).

Key Words: A. Fluid Mechanics-8, Heat Transfer-8, Turbulent Boundary Layers-9, Velocity Distributions-9, Similarity Transformation-10, Small Perturbation Expansion-10, Drag-4, Heat Transfer Coefficient-4, Wall Law-4, Wake Law-4.

Abstract: A small perturbation type solution for the turbulent boundary layer is presented and the conditions of similarity under which such a solution is valid is explored. The Law of the Wall is shown to be the zeroth order solution to the momentum equations. The first-order solution generates a correction to this wall law similar to Coles' Wake Law.

Effect of suspension density on crystal size distribution, Larson, M. A., D. C. Timm, and P. R. Wolff, **AIChE Journal, 14,** No. 3, p. 448 (May, 1968).

Key Words: A. Suspension-9, Density-6, Size-7, Crystals-9, Crystallizers-8, 9, Nucleation-7, Growth-7.

Abstract: The effects of suspension density on crystal size distribution was studied. If the crystals present in suspension are not a source of nuclei, larger crystals will be obtained in the presence of higher suspension densities. If the rate of new particle formation is proportional to the amount of crystals present, the crystal size obtained will not be changed by the suspension density level. There was evidence of nucleation rate dependency on the quantity of suspended crystals.

Effect of nucleation kinetics on the dynamic behavior of a continuous crystallizer, Timm, Delmar C., and Maurice A. Larson, **AIChE Journal, 14,** No. 3, p. 452 (May, 1968).

Key Words: A. Kinetics-6,8, Nucleation-6,8, Crystallizer-8, 9, Size-7, Crystals-9, Growth-6, Performance-7, Mathematical Model-8, Alum-9, Sodium Chloride-9, Ammonium Sulfate-9. B. Density-6, Size-7, Crystals-9, Nucleation-7, Growth-7.

Abstract: The nucleation kinetics of alum, sodium chloride and ammonium sulfate were related to the growth kinetics using steady state data obtained at various degrees of supersaturation. These materials were then crystallized under unsteady state conditions in a mixed suspension mixed product removal crystallizer and the transient size distributions were determined.

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reported that it had begun to program MIMIC on the IBM 7044. But now with the new CDC 6400, it will be at least a year before MIMIC will be incorporated).

The formulation of mathematical models begins in Chapter 4 and the mathematical complexity of the problems grows as one proceeds through the book. Thus, the first problems involve ordinary nonlinear differential and algebraic equations with time as the independent variable. Then these are extended to cases involving multistage systems. Next, systems are treated where the ordinary nonlinear differential equations have either distance or geometric length as the independent variable. Finally, systems described by partial differential equations are taken up.

One of the most appealing features of the book is the extremely broad coverage of problems which arise in chemical engineering, such as multicomponent vapor-liquid equilibrium, reaction kinetics, fluid flow, staged operations, distributed systems, partial differential equations, and process control. Under each of these topics, a number of examples are developed. The physical principles behind each are briefly discussed and the equations for the system are formulated. Then the equations are set up in a block diagram form that is suitable for solution by one of the simulation languages. In some of the examples, special iterative techniques are required. These are, to some extent, discussed.

At the end of each chapter, a number of references are presented. These are quite comprehensive and up to date and would be very helpful to someone new in the field.

Turning now to the debit side, it appears that some of the examples are overly complex, especially for a book which seeks to be instructive. Evidently, the intent is to show that one should not feel inhibited in modeling. However, in a few cases, the models turn out to be somewhat overwhelming. Some of the iterative and convergence problems which occasionally arise in the book could be better discussed, perhaps with some numerical examples to give the reader a feel for these problems. In short, one gets the impression that even with a simulation language at hand, there may still be some flies in the ointment.

The editing work is the main disappointment. The book has many errors and undefined symbols. For a reader already well versed in the fundamentals of the topics covered, these

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Mass transfer to falling films. I. Application of the surface stretch model to uniform wave motion, Howard, D. W., and E. N. Lightfoot, **AIChE Journal, 14,** No. 3, p. 458 (May, 1968).

Key Words: A. Velocity Profiles-1, Surface Stretch Model-1, 10, Stanton Number-2, Mass Transfer Rate-2, Prediction-4, Gas Absorption-4, 7, 8, Liquids-5, Ripples-6, Films-9, Rippling-0, Liquid-0. B. Prediction-8, Gas Absorption-9, Surface Stretch Model-10.

Abstract: A method is developed for predicting rates of gas absorption into laminar rippling films in terms of the surface velocities. The description is an extension of the surface-stretch model of mass transfer (1) and is therefore useful for cases of high Peclet number. The description can be used with any of the presently known hydrodynamic models of rippling films and with any future models which may be developed, provided they satisfy two relatively nonrestrictive conditions: (1) the ripples are of a two dimensional nature, being of constant thickness in the direction normal to their direction of propagation, and having no velocity components in this transverse direction; and (2) the ripples propagate at constant celerity and with constant shape. It can be used for both traveling and standing waves and can be extended do describe the effects of high net-mass transfer rates and combined diffusion and chemical reaction.

Optimal control of a distillation column, Brosilow, C. B., and K. R. Handley, **AIChE Journal, 14,** No. 3, p. 467 (May, 1968).

Key Words: A. Control-8, Feedback-10, Optimization-8, Distillation-9, Rectification-9, Algorithms-10, Pilot Plant-0.

Abstract: Optimal feedback control has been implemented on a fifteen tray pilot scale rectifying column. The results show that excellent control is obtained in spite of major upsets in the feed flow rate and for large changes in the controller set point. Design and implementation costs for the optimal control system should be competitive with those for standard control systems.

Catalytic dehydrogenation of Cyclohexane: a transport controlled model, Graham, R. R., F. C. Vidaurri, Jr., and A. J. Gully, **AIChE Journal, 14,** No. 3, p. 473 (May, 1968).

Key Words: A. Kinetics-8, Catalysis-4, 8, Modeling-8, Reaction Rate-7, 8, Equilibrium-8, 9, Cyclohexane-1, 8, Hydrogen-2, 5, Benzene-2, Temperature-6, Pressure-6, Reynolds Number-6, Differential Reactor-10, Platinum-on-Alumina-4, 5, Mass Transfer-9, Heat Transfer-9, Diffusion-9.

Abstract: Experimental data and a mathematical model for the dehydrogenation of cyclohexane on a platinum-on-alumina catalyst in the presence of excess hydrogen are presented. Differential rate data were obtained, using a fixed bed flow reactor, over a temperature range of 400 to 500°C, a pressure range of 21.3 to 41.8 atm. at modified Reynold's numbers of 20 to 65. Cyclohexane concentration was varied from 16 to 25 mole %. In the development of the basic model, complete transport control of the overall reaction rate with equilibrium at the fluid external surface interface is assumed. The average deviation between experimentally determined and basic model calculated rates was 5.65%.

Modification of the model by replacing the equilibrium assumption by a crude surface rate expression resulted in a reduction in average deviation to 4.3% and the maximum deviation was reduced from 22 to 12%.

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are not tremendous problems, just annoyances. In some instances, two different symbols are used for the same thing on the same page; in others, the same symbol is used for two different things on the same page. In view of this, the Nomenclature given at the end of each chapter is often misleading or incorrect. In one particular kinetics problem, fourteen reactions are postulated to occur; these are then meshed together diagramatically. The example would have been easier to follow had the equations been numbered.

The author has aimed this book at "the undergraduate and graduate chemical engineer, as well as the practicing process engineer." He presumes that the reader already possesses background in the fundamentals of transport phenomena, kinetics, and vapor-liquid equilibrium. Certainly a good bit of it could be understood by seniors, at least with some explanation by an instructor. On the other hand, many schools probably would not build a course around it. Some sections surely could be integrated into existing courses. Problems are presented at the end of each chapter and these could be used for instruction.

As I read through the book, the question of do the Models work continually arose in my mind. It would have been very interesting to see some of the solutions produced by the computer. Undoubtedly, many of the examples came out of problems which the author tackled in his work in the Engineering Computation and Analysis Engineering Department of E. I. du Pont de Nemours and Company, Inc.

Although the mission of the book clearly was not to prove that the models work, an occasional proof might have added some flavor to the book and would also convince the reader that the whole business of model building might be worthwhile.

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ADDENDUM

In the paper "Turbulent Flow in Concentric Annuli" by Curtis W. Clump and Daniel Kwasnoski (Vol. 14, No. 1., pp. 164-168), the following acknowledgement should be noted:

The authors appreciate the contributions of Dr. R. A. Wolffe who put forth the original ideas for the work and aided immeasurably in its early stages. The use of the computing facility at the Homer Research Laboratory of the Bethlehem Steel Corporation is gratefully acknowledged.