BOOKS

Liquid Extraction (2 ed.), Robert E. Trey-bal, McGraw-Hill, New York (1963). 621 pages. $16.50. *(Continued from November, 1963, issue)*

Stagewise calculation methods for multicomponent systems have been extended. An interesting and useful chapter on laboratory and small-scale extraction has been added; experimental and calculation methods are described for batchwise simulation of continuous, countercurrent extraction.

In the chapter on stagewise contact equipment, new correlations on performance and power requirements are given and new equipment developments are discussed. In the chapter on continuous contacting equipment, new correlations of performance and flooding are presented; equipment utilizing mechanical agitation such as rotating agitators and liquid pulsing are discussed. In reporting performance data the author has exercised critical judgment in selecting the material because in the last ten years huge quantities of such data have been reported in the literature.

A new chapter on some aspects of extractor economics has been added. The chapter on liquid-extraction processes has been shortened: flow sheets and detailed process descriptions have been eliminated. A brief survey of the many fields where liquid extraction is now used routinely is presented. As the author points out, when the first edition was published commercial extraction processes were relatively rare; now they are routinely used in all areas of chemical processing. Many volumes could be written in describing details of the many current applications.

The new extraction volume by Professor Treybal is a welcome and valuable addition to chemical engineering literature.

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Analysis of Nonlinear Control Systems, Dunstan Graham and Duane McRuer, Wiley, New York, London (1961). 482 pages. $9.75.

Although many books dealing with almost every aspect of control systems theory have been published during the last decade, there has been a curious lack of concern by textbook writers for the problems connected with nonlinear control systems. The two or three books that did appear were limited in scope and not very useful as textbooks—at least in the opinion of this reviewer. The present volume has changed this

NOTATION

D_{AB}, D_{Ai} = binary bulk diffusion co-efficients, that is for species A and B, sq. cm./sec.

D_{kA} = Knudsen diffusion coefficient for species A, sq. cm./sec.

D_{mA} = mean bulk diffusion coefficient for species A, sq. cm./sec.

D_{eA} = effective diffusion coefficient for species A, sq. cm./sec.

G = molecular flux with respect to fixed coordinates, molec./(sec.) (sq. cm.)

k = Boltzmann constant

m = molecular mass

n = molecular concentration, molec./cc.

p = partial pressure

r = capillary radius

T = temperature—°K.

u = axial velocity with respect to fixed coordinates, cm./sec.

$\bar{v}$ = average molecular velocity

y = mole fraction

δ = correction factor

Ξ = $\dfrac{1}{G_A}\displaystyle\sum_{i=A}^{\nu} G_i$

ν = number of diffusing species in the system

Subscripts

i = property of species i

k = Knudsen diffusivity

AB, Ai = binary bulk diffusivity of species A and i or A and B

m = Hsu and Bird (2) mean diffusivity

e = effective diffusivity

LITERATURE CITED

1. Scott, D. S., and F. A. L. Dullien, A.I.Ch.E. Journal, 8, 113 (1962).
2. Hsu, H. W., and R. B. Bird, ibid., 6, 516 (1960).
3. Carman, P. C., "Flow of Gases Through Porous Media," Academic Press, New York (1956).
4. Evans, R. B., G. M. Watson, and E. A. Mason, J. Chem. Phys., 36, 1894 (1962).
5. Ibid., 35, 2076 (1961).
6. Butt, J. B., Can. J. Chem. Eng., 41, 130 (1963).

situation to a considerable extent. Its scope is considerably wider than that of its predecessors, and it is also clearly and logically written so that it can easily be followed as a text.

The describing function is given the greatest attention and, is treated in considerable detail in four of the ten chapters. Since the describing-function method is probably one of the simplest and most convenient techniques for analyzing and synthesizing nonlinear control systems, it does not seem unreasonable to devote almost half of the book to a thorough treatment of it. The authors derive the describing function for a large number of commonly encountered nonlinearities and present curves not only for the fundamental but also some harmonic outputs. There is also a chapter on the describing function of nonlinear elements excited by random functions with Gaussian distribution.

Phase-plane methods, particularly as applied to piecewise linear systems and switched systems, take up most of the remainder of the book. Here again the treatment is quite thorough and a number of specific results, such as the phase-plane equation for typical linear systems, are worked out in complete detail. There is also a chapter on optimum-switched systems and a short section on Liapunov's second method with two rather interesting examples.

Although at the time of its publication the book was probably the best text available on the subject of nonlinear control, it does have a number of shortcomings. One of the most important of these is the rather brief treatment of Liapunov's second method. This method has received a great deal of attention in recent years and a number of fairly useful results have been developed that should certainly be included in the next book written about nonlinear control systems. Also, despite the fact that almost half of the book deals with describing functions, a number of important topics, such as the effect of two or more inputs, the closed-loop response and the inverse describing function problem, are completely absent. Some of the simpler analytic methods for solving nonlinear equations as well as a discussion of adaptive systems and their peculiar problems are also missing. Finally, the usefulness of the book as a text is reduced by the complete lack of problems.

However, the advantages of the book outweigh the shortcomings, and it should be especially useful to the student seeking an introduction to the subject of nonlinear control.

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A Course in Process Design, Thomas K. Sherwood, Massachusetts Institute of Technology Press, Cambridge, Mass. (1963). 256 pages. $6.00.

This book is one of the results of the Ford Foundation grant to Massachusetts Institute of Technology for a study of improved methods in engineering education. Its main purpose is to illustrate the types of process-design problems which are especially suited to an undergraduate design course in the senior year. It achieves its purpose by analyzing nine processes or cases selected to cover a wide range of processes. Most of the problems are slanted toward chemical engineering, but at least two of them and probably four are equally suitable for mechanical engineering students.

There are ten chapters and an appendix. The first chapter includes a discussion of the principles and philosophy of design and some general remarks on the design method with examples. The following nine chapters are devoted to the detailed analysis of nine design problems. The chapter headings reveal the wide range of coverage of subjects such as the liquefaction of methane, the desulfurization of petroleum naphtha, gas transmission line, the use of thermocouples for refrigeration, water desalination by hydrate formation, fresh water from sea water, solvent recovery, pigment washing and the production of hydrogen by steam reforming of methane and butane.

The appendix describes a short-cut method of optimizing a quantity, such as a cost, which is a function of several variables. The method has certain limitations on its generality but there are many practicable cases where it is applicable and involves less labor than conventional methods.

Design problems of this general type have been used in the senior design course in many schools, and the annual student chapter contest problem of American Institute of Chemical Engineers which is now in its 30th edition is closely related. Nevertheless, this book is unique in its assemblage of a variety of very carefully worked out cases with each step and assumption clearly explained. Each chapter shows the results of the thought and effort that has gone into presenting each problem in a clear and logical manner. All the material has been well organized so that it is easy to follow and comprehend.

All engineering teachers who are concerned with process design (and this should include practically all process-engineering teachers since design is the very essence of engineering) should find this book a very useful guide in the development of their own design problems for undergraduates. As a textbook illustrating typical undergraduate problems in process design, it should prove useful to students working on design problems even though their own problem is quite different in content. This is true because the general methods of approach to the problems and many of the procedures are common to most process-design problems.

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