# BOOKS

**Advanced Process Control** by W. H. Ray McGraw-Hill Book Co., 376 pages, $33.50 (1980).

This book is intended as a text for a second-level course in process control for advanced undergraduate or graduate students. It is also suitable for self-study by engineers in industry. In view of the author's well-deserved reputation as a leading researcher in advanced control and estimation techniques, it is not surprising that the book emphasizes modern control theory. The mathematical prerequisites for the book are quite modest: elementary matrix analysis and an introduction to ordinary differential equations.

The contents of the book are as follows. The short introductory chapter discusses the incentives for using advanced control concepts and introduces the dynamic models that are considered in the book. Chapter 2 describes the hardware associated with a typical computer control scheme. This chapter is intended to provide the reader with an appreciation for the effort and equipment required to implement computer control schemes.

The third chapter, "Control of lumped Parameter Systems," is chiefly concerned with the design of optimal feedback control systems for linear and nonlinear state-space models. Noninteracting control schemes and the Relative Gain Array are also considered. Multivariable frequency domain techniques such as the Inverse Nyquist Array Method are only mentioned in passing.

Control strategies for distributed parameter systems are considered in Chapter 4. Several lumping techniques for converting first- and second-order partial differential equations (PDE) into ordinary differential equations (ODE) are described including the method of characteristics, modal analysis, and the method of weighted residuals. The thorough treatment of optimal control policies for PDE models in this chapter is a distinctive feature of this book. Chapter 4 concludes with a discussion of time delay compensation techniques and optimal control policies for time-delay systems.

State estimation techniques for both lumped parameter and distributed parameter systems is the subject of Chapter 5. Emphasis is placed on optimal state estimation techniques such as the Kalman filter. An introduction to stochastic control theory is also included. The author has wisely decided to present the basic features of state estimation rather than rigorous derivations involving advanced statistics. Consequently, only a rudimentary knowledge of statistics is required.

The final chapter consists of four detailed case studies which illustrate the application of the advanced control and estimation techniques described in the preceding chapters. The case studies include two pilot-scale experimental units, a double effect evaporator and a heated ingot, and two simulation studies, a sidestream distillation and a continuous steel casting operation.

The book is concise and well written and has a surprisingly small number of typographical errors. The large number of physical examples and the Case Studies in Chapter 6 are effectively used to demonstrate key features in designing advanced control systems. The chief shortcoming of this book is the omission of material on sampled-data control systems and digital control algorithms. In view of the widespread interest and application of digital control, it would seem appropriate to devote a signifiant portion of a second-level course to the design and analysis of digital control systems. The book does not include material on two other topics which are currently receiving widespread attention: adaptive control and predictive control techniques.

Despite these omissions, this book is easily the best available text on advanced process control.

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**Gas Tables: International Version Second Edition (SI Units)** Joseph H. Keenan, Jing Chao, and Joseph Kaye, John Wiley and Sons, New York, New York, 1983, 211 pp., $37.95.

The book represents a companion volume of the second edition of *Gas Tables* in English units published by the same authors in 1980. The coverage of both books is the same and indeed Tables 24 through 59 are identical. These tables present the polytropic functions and compressible flow functions for gases. The main independent variables in these tables are the Mach number, the exponent for a polytropic process and the pressure ratio and these variables are independent of the choice of units. The book contains a detailed description of the sources of data. A rather extensive description of the methods used to calculate the values presented in the various tables is given. The ideal gas thermodynamic properties are calculated by employing the methods of statistical mechanics. For diatomic molecules this includes translational, rotational, vibrational, electronic and anharmonicity terms. The explicit equations for the partition function are given. The book includes 21 examples which serve to illustrate the use of many of the tables. These examples are presented in detail and should provide enough information to allow a novice to use the Tables in a very short time. Tables 30 to 53 cover the one-dimensional compressible flow functions. These tables contain the functions useful in many engineering problems in the one-dimensional flow of a perfect gas with constant specific heat and molecular weight. In particular, the book introduces the Fanno line and the Raleigh line and treats their use.

While the book has been prepared primarily for mechanical engineers, it is of value to any engineer needing properties of gases under static or flowing conditions. The book also contains some physical constants and conversion factors. As the trend of the future is towards international conformity in the use of SI units, perhaps this version is the more appropriate one for inclusion in a university or company library.

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**Flow Phenomena in Porous Media,** by Robert A. Greenkorn, published by Marcell Dekker (1983), 560 pages, $75.00.

If you are serious about this area, this is a book that you must buy. I had already purchased my copy, and my students were using it before I was asked to write this review.

This is a field of broad appeal extending considerably beyond chemical engineering. Yet relatively few books have been written attempting to summarize work in the area. I was delighted to see Professor Greenkorn take the time from his busy schedule as vice president and associate provost of Purdue University to share with us his point of view.

And his point of view, formed from more than 25 years of personal experience in the area, is unique. Consider, for example, the last three chapters dealing with applications in petroleum engineering, in groundwater hydrology and in soils science. These areas represent different phases in the long-term and continuing research program of Professor Greenkorn and his students.

It is relatively easy to find fault with a book of this character. Some explanations and derivations could be clearer. A list of notation would have helped. While the use of a Hele-Shaw model to study single-phase flow in porous media is straightforward, a convincing explanation of why a Hele-Shaw model can be used to study the stability of a displacement of one phase by another is not given in Chapter 4.

To focus on such details is to miss the important point. We are very fortunate that Professor Greenkorn has taken this opportunity to share his experience with us. For the rather nominal consulting fee of $75.00 we can have his advice at our fingertips for the rest of our lives.

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**Catalytic Reactor Design,** by M. Orhan Tarhan. McGraw-Hill, 1983. 372 pages. $36.95

This text provides an introduction to process engineering aspects of heterogeneous catalytic reactor design, including computer solutions of design equations. It is not and does not purport to be a comprehensive reference on catalytic kinetics, nor does it spend a great deal of time on derivations of reactor design equations. It resembles, and in fact is based on, a set of notes for an industrial short course.

The book begins with three short chapters on reactor classification and design methodology, numerical methods for solving differential equations, and catalytic kinetic models. The next six chapters deal with the design of fixed-bed gas reactors, gas-liquid fixed-bed reactors (including trickle-bed reactors and fixed-bed bubble reactors), and suspended-bed reactors. Fluidized beds are not treated. The book concludes with three short qualitative chapters on laboratory and pilot plant reactor design, reactor safety and stability, and mechanical design of commercial reactors.

The author has had extensive experience in industrial reactor design, and writes in clear and straightforward expository prose. For each reactor type discussed, transport correlations are summarized, design equations are derived, and their solutions are outlined in examples based on commercially important processes. Fortran programs are presented which solve the design equations for adiabatic and nonadiabatic fixed-bed reactors and plug flow and backmixed trickle bed reactors.

There is no other book on the market that does quite the same thing that this one does, although it is less unique in dealing with the practical aspects of catalytic reactor design than the Preface implies. One reference that comes to mind is Satterfield's *Heterogeneous Catalysis in Practice*, an outstanding compendium of practical details of industrial catalysis, principally in areas only sketchily covered in this book such as catalyst selection, preparation, and characterization; another is Rase's two-volume set, *Chemical Reactor Design for Process Plants*, which provides a wealth of information on the practice of industrial reaction engineering.

Who should buy this book? In the Preface, the author states that he intended it for seniors and graduate students in chemical engineering and for industrial chemical engineers. Unfortunately, although it is written at a level accessible to seniors, I cannot see a role for it in the undergraduate curriculum—it fails to cover too many of the basics, and it has no problems that can be used for homework assignments. It might be used in a graduate course on catalytic reaction engineering, but only as a supplement to a text oriented more toward fundamentals (e.g. Carberry's *Chemical and Catalytic Reaction Engineering*) and others that provide more extensive coverage of industrial catalysis (e.g. the previously mentioned work of Satterfield) and catalytic chemistry (e.g. *Chemistry of Catalytic Processes* by Gates, Katzer, and Schuit.)

On the positive side, the book would undoubtedly be a worthwhile addition to the library of an industrial process engineer who wishes a series of short and readable reviews of design techniques for the types of reactors covered, and a good, albeit incomplete, compilation of references. In addition, course instructors who have traditionally relied on the time-honored A → B reaction to illustrate design methodology will find the book to be an excellent source of examples based on real process data.

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