Periodic arrays of cylinders and spheres do appear; among networks, only the square lattice; among fractal structures, the Sierpinski gasket, fractal foam, and Menger sponge.

A sample from the text that relates Darcy permeability to Stokes flow in spatially periodic networks of passages by the loop form of Kirchhoff's laws (not always the most efficient representation, although this is not mentioned) is indicative:

"The basic graph is defined as the set of vertices $V\Gamma_b$ linked by the set of [nonequivalent] edges $E\Gamma_b$ . . . . The local graph Γ_ℓ is obtained by identifying the homologous vertices of the basic graph . . . When an arbitrary orientation is given to the local graph, it can be completely described by its incidence matrix $\mathbf{D}_\ell$ . . . . extend to the local graph whose component J_j represents the algebraic flow rate . . . . on edge j of the flow rate vector (m_ℓ components) $\mathbf{J}_\ell$ . . . . The components of the pressure difference vector $\mathbf{P}_\ell$ are equal to the pressure differences between the vertices . . . . The $m_\ell \times m_\ell$ diagonal conductance matrix $\mathbf{M}_\ell$ is defined . . . . The m_ℓ relationships . . . for the pressure generator can be expressed as $G_\ell = \mathcal{R}_\ell \cdot \overline{\nabla}\, \bar{p}$ where $\mathcal{R}_\ell$ is a $m_\ell \times 3$ matrix . . . defined on the edge space and on the three-dimensional Euclidean space . . . . Ohm's law between the vertices can be written as $\mathbf{P}_\ell = \mu \mathbf{M}_\ell \cdot \mathbf{J}_\ell + \mathbf{G}_\ell$ . . . . The conservation of the fluid at each vertex can be written in a simple form by using the incidence matrix $\mathbf{D}_\ell$: $\mathbf{D}_\ell \cdot \mathbf{J}_\ell = 0$ . . . . Let ξ_Q be a cycle vector of the local graph; then Kirchhoff's law [for loops] can be expressed as $\xi_Q \cdot \mathbf{P}_\ell = 0$. . . . Let $\mathbf{C}_\ell$ denote the matrix whose ith column is the ith basis cycle vector. The [last] can be summed up as $\mathbf{C}_\ell^t \cdot \mathbf{P}_\ell = 0$. Now let's solve . . . for $\mathbf{J}_\ell$ and $\mathbf{P}_\ell$ . . . . Choose a spanning tree in the local graph Γ_ℓ . . . . The edge space $E\Gamma_\ell$ can be split as $E_T + E_N$, where E_T is the subspace spanned by the tree edges and E_N is that spanned by the chords . . . ."

And so on. The result $\mathbf{J}_\ell = -\mu^{-1}\mathbf{C}_\ell \cdot (\mathbf{C}_\ell^t \cdot \mathbf{M}_\ell \cdot \mathbf{C}_\ell)^{-1} \cdot \mathbf{C}_\ell^t \cdot \mathbf{G}_\ell$ is arrived at a page later and Darcy permeability the page after that. An equivalent formula, for the average impedance and hence the equivalent conductance of unbounded regular, or symmetrical, networks, was worked out more simply by R. M. Foster and published in 1949. It is not cited.

The author states that "the major purpose of this book is to present transport phenomena through heterogeneous systems using a unified and modern framework, where the emphasis is on . . . a rigorous mathematical treatment," and he dreamed that it "would be at the same time an elementary introduction, a graduate textbook, and a reference book." In most parts, the approach is reportorial, not interpretive nor analytical, much less didactic. The reader is frequently referred to papers for details and, at other junctures, is told "(so-and-so) was able to show that," "it can be shown that," "it is easily shown that," "it is now a simple matter for the reader to . . . ," "it is left as an exercise," etc.

Before teaching again recently the biannual course on the science of porous media that H. T. Davis and I, with help from others, have developed at Minnesota, I read the backbone parts of Adler's book and skimmed the rest, taking notes as I went. That course draws first-year graduate students, a few seniors, a sprinkling of second-year graduate students, and various auditors. The match was such that no presentation from the book found a place in the course, although the book did loom as a useful reference for the two students who were PhD candidates in early stages of researches on the physics of liquid flow and of dispersion processes in actual porous media. Now I have been through the book again, and have come to the following view. The science of porous media has shaped up over the past two decades. This book is in major respects a transect through a portion of the theoretical underpinnings of the science. But it often misses plain versions of basics, uncomplicated developments of consequences, and instructive examples of applications. It is antithetic to the dictum that in science the ultimate in sophistication is simplicity. It dwells on mathematical formalisms, or rigorous mathematical treatments, that have interested or occupied the author in his quest for a unified, modern development of transport phenomena through heterogeneous systems. It is neither an elementary introduction nor a graduate textbook. As a research monograph and reference work, it will be valuable to a rather sparse audience.

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Carbon Adsorption for Pollution Control

By Nicholas P. Cheremisinoff and Paul N. Cheremisinoff, Prentice Hall, Englewood Cliffs, NJ, 1993, 216 pp., $57.00

This is a rudimentary book, apparently intended as a "how-to" manual on design and selection of activated carbon adsorption equipment for removing gaseous and aqueous pollutants. Although generally informative, the text is written at a needlessly elementary level, clearly below that appropriate to typical bachelor-level chemical engineers.

The presentation leaves much to be desired. A number of descriptive passages are reiterated several times in the book. Even figures are repeated (for example, Figures 1.8 and 4.1, 1.7 and 4.3, 3.18 and 6.10). There are a good number of typographical errors (e.g., in Tables 4.4 and 4.5). The sources of the figures and tables in the text are not cited; in fact, the entire text is devoid of references. The 30-page appendix is largely irrelevant, listing physical properties of hydrocarbons, such as critical constants and heats of combustion, which bear no relation to adsorption.

There are features of the book that are unique. The process flowsheets and schematics of equipment may find use by practitioners. The tables on "retentivity" (amount adsorbed) for different organic vapors by carbon would constitute another serviceable feature of the book if the corresponding partial pressures or concentrations were given. A practicing engineer would be better off obtaining more meaningful and useful information for the organics in question directly from the manufacturers of activated carbons. Nonetheless, the tables presented here could provide a qualitative estimate of the relative amounts adsorbed for different organic compounds.

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Applied Optimal Control and Estimation

By Frank L. Lewis, Prentice Hall and Texas Instruments, Englewood Cliffs, NJ, 1992, 624 pp.

This book, subtitled *Digital Design and Implementation*, has as its stated goal "to bring to the individual researcher and engineer working at a PC all the power of modern control theory for design, simulation, and actual controls implementation." To accomplish this, it devotes a certain amount of space to discussing implementation of the optimal control and estimation algorithms on fixed-point processors, particularly on the Texas Instruments TMS320 C25 DSP (digital signal processor), and even provides examples written in assembly language. I found myself skipping these sections, which only make up a small part of the book anyway, while enjoying the review of optimal control and estimation theory. The author already has in his record successful books on the theory of both of these topics. In this book, he does an excellent job of providing clear and mathematically less demanding expositions of these topics. His deep understanding of the theory has allowed him to provide derivations of control and estimation laws that clearly convey the concepts behind the derivation, without getting bogged down in unnecessarily elaborate proofs. The author does not hesitate to sacrifice some mathematical rigor in order to keep the material accessible to those more interested in the results and their implications than the mathematics. This is exactly where the value of the book lies.

This book has five parts and ten chapters. Part I, Introduction, has two chapters. The first includes a history of automatic control, which is concise and well written with about 50 references that include many seminal papers. Such histories in introduction sections of control books usually serve little more than cosmetic purposes, but I caught myself reading this one with pleasure. The second chapter provides a review of linear system theory. The author uses both frequency and time domain approaches, depending on the subject. The section that covers both nonminimum phase systems, as well as the concepts of reachability (controllability) and observability, is particularly well written. The author says that "the meat of the book does not appear until Chapter 3," but I would recommend Part I to all first-year graduate students interested in process control. It provides a brief and readable review of basic material necessary to read most of today's control literature. Part II with two chapters covers optimal control of continuous systems. Chapter 3 does an excellent job of covering the standard linear quadratic regulator (LQR) problem with state feedback. Chapter 4 deals with output feedback design, but the techniques used are not of much interest to process control. Part III with three chapters covers digital control. Chapter 5 covers the basics, including discretization of continuous controllers, and represents a change of pace. The same material can, of course, be found in several books on digital systems, but it is convenient to have it in the same reference with material on optimal control and estimation. Chapter 6 discusses implementation aspects on a digital signal processor. I found the brief section on windup interesting in that it discusses antiwindup compensation in terms of observer dynamics. Chapter 7 covers several techniques for direct digital controller design, including the discrete versions of Chapters 3 and 4. Too many disparate techniques are thrown together in the same chapter, however. Part IV consists of a single chapter that attempts to cover the basics of robust control. There is really no connection to preceding material though. Part V with two chapters deals with the use of state observers. Chapter 9 is an excellent review of optimal state estimation. In the space of about 50 pages (if one excludes the material on DSP implementation), the author covers all the basics and goes through enough derivations to get the reader comfortable with the computation of propagation of means and covariances. I wish though that the author spent more than the one and a half pages on nonwhite process noise. Although the basic concept of augmenting the state space model to deal with colored noise is introduced, no further discussion on step-like (persistent) disturbances is given. Chapter 10, the final chapter, covers linear quadratic gaussian (LQG) design, including a discussion of the separation principle and the LQG/LTR (loop transfer recovery) design procedure. The book also includes several appendices, two of which are very good reviews of linear algebra and random processes material. Finally, it should be pointed out that throughout the book as well as in Appendix A, Fortran code is given for design computations and system simulation. I am not sure that this is such a good idea though, given the several packages that exist for control design that do not require the user to program in Fortran. The author mentions some of these packages and even uses them to perform some computations, but does not give examples of their use.

The book is meant as a textbook for a first-year graduate control course. However, I would not recommend it as the textbook for a graduate-level course on process control, as it does not touch on topics of importance to process control applications, like decentralized control and model-predictive control (with the exception of a one-page example introducing receding horizon control). Also, although the book is full of examples of the control of physical systems, none of them comes from chemical engineering. Still, the book can be an excellent supplemental text in a course that utilizes concepts from optimal control and estimation. The current directions of research on model-predictive control point more and more toward the need for such a background. The book's applied favor makes it a better choice for chemical engineering students than more theoretical books on these subjects.

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Inorganic Materials

By D. W. Bruce and D. O'Hare, Wiley, New York, 1992, 543 pp.

Duncan Bruce and Dermont O'Hare have assembled a volume devoted to inorganic materials. As stated in the preface, although there is an increasing interest in materials chemistry and more specifically in inorganic materials, few texts are available which cover this area. The editors have chosen a multiauthor format of mostly younger researchers since "their energy, enthusiasm and relatively new entry in these areas would provide new perspectives."

Each chapter is devoted to a different class of materials. Entries include molecular inorganic superconductors, inorganic magnetic materials, metal-containing materials for nonlinear optics, intercalation compounds, biogenic materials, clays, polymeric coordination complexes, metal-containing liquid crystals, and precursors for electronic ma-