BOOK REVIEWS

Pore Size Engineering in Zeolites

By E. F. Vansant, John Wiley & Sons, Chichester, 1990, 148 pp., $59.95

The main goal of this book is to review the modification techniques that can be applied to vary the porosity and pore size of zeolites. Although the text contains some information that has not resulted directly from Professor Vansant's laboratory, the book more accurately can be described as a review of the Vansant work. The topic and coverage are very narrow and are therefore most likely useful for mainly those working directly within the area.

The book contains three chapters. Chapter 1 briefly introduces zeolites. (It contains only four pages.) Chapter 2 deals with pore size engineering of zeolites. Three topics are addressed: (i) modification by cation exchange, (ii) modification by a pre-adsorption of polar molecules, and (iii) modification of the zeolite framework. Topics (i) and (ii) are covered in a superficial way and most of the chapter is involved with topic (iii). Zeolite reactions with silane, disilane, and B_2H_6 to modify pore size and porosity by depositing silicon or boron oxides are discussed in detail. This portion is the main thesis of the text. Finally, the chapter ends by describing the impregnation of zeolites with inorganic acids and salts, for example, H_3BO_3, NaH_2PO_2, and $Na_4P_2O_7$. Chapter 3 deals with the possible applications, in which modified zeolites may find use. They are: (i) the encapsulation of gases and (ii) the separation of gases. Item (ii) is a well-known use of zeolites, and modification of the pore size and/or porosity is for the fine tuning of sorbent specificities. Topic (i) is interesting and is illustrated by attempts to encapsulate Kr and Xe; ^{85}Kr is radioactive and may be stored safely if immobilized in solid form.

Since there are many zeolite structures that are known, one may wonder about the motivation for modifying a given zeolite as opposed to using a different zeolite structure. First, only a very limited number of zeolites are available in large quantities. (Fortunately, this text concentrates on mordenite which is available at commercial scale.) Thus, fine tuning of the pore architecture imparts a broader range of sorption capabilities onto a given zeolite. Second, the application of encapsulation is a fine example of how zeolite modification may find a utility that is not possible in a practical sense without modification procedures.

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Robust Process Control

By Manfred Morari and Evanghelos Zafiriou, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1989, 488 pp., $55.00

This book exemplifies the process by which basic research results find their way into engineering practice and education. It takes a deft hand to bridge that gap while retaining the texture and rigor of an active research field. In this case, the effort succeeds because the authors focus on an important technological problem, the development of process control systems that account for model uncertainty, with a coherent presentation of applicable theory. In my view, the book is a landmark in process control that may eventually alter the way control systems are conceived and analyzed.

The role of this book perhaps can be understood best in the context of the recent history of process control. Control research by chemical engineers was a dying field in the early to mid 70's. The sophisticated linear theory of that era simply was not having an impact on control practice. This point was made in several contemporaneous critiques written by industrial and academic workers (which, incidently, may also have scared away the funding agencies and a generation of graduate students). In retrospect, one can now say that the problem then was not the lack of sophistication by either academics or industrial practioners. Rather, the limiting factors for control performance were not fully understood. As a result of subsequent research, we now understand better the roles of model uncertainty, control constraints and adverse dynamical characteristics.

Uncertain models, of course, are not the exclusive domain of chemical engineers. Robust control theory was developed during the 1980's as an interdisciplinary field focusing on the explicit and quantitative treatment of model uncertainty. This line of research exploited several remarkable advances, including the parameterization of stable control systems (known as internal model control in the chemical engineering community), singular value and structured singular value analysis, and the notion of specifying performance with respect to a class of inputs signals. The last point is quite significant: it marks the difference between the older style methods of evaluating performance by case study and the newer systematic methods like H_∞.

This new understanding has dramatically changed how researchers conceptualize the design of the basic feedback control loop. This book attempts to consolidate this view for a broader community that includes a sophisticated industrial audience, graduate students, and academics. The authors are well-suited to the task having made substantial contributions to the research literature. Several other books and monographs have appeared that attempt to do the similar things, but they are generally written for audiences with a background in linear systems theory rather than process control.

The book is broken into five parts. The first presents a theory in the context of internal model control for the robust design of single variable control systems. It is a comprehensive treatment, discussing different performance measures, two-degree-of-freedom design, and control of unstable processes. The reader will gain some nice insights into "perfect" control, and how model uncertainty, time-delay, and right half-plane zeros conspire against it. Chapter 6 then quantitatively interprets in this new light existing process control technologies, such as PID, feedforward, and cascade control.

Parts II–IV of the book extend these developments to sampled data and multivariable systems. The mathematical level is somewhat higher, particularly in the discussion of multivariable control. The level is on the order of a first-year graduate course in engineering mathematics with a strong component of linear algebra. While this is not done unnecessarily, the presentation might have benefitted from a somewhat more relaxed approach. But this is quibbling, the interested reader will find the effort worthwhile.

Chapter 14 presents an interesting discussion of decentralized control. Several measures of "interaction" are used widely in process control practice. This chapter demonstrates some of the relationships among them, firmly grounding these more or less empirical techniques in the framework of robust control analysis. This is a valuable synthesis of new and old technologies that is not widely available outside of the research literature.

The final part is a case study presenting the analysis of multivariable control for a high-purity distillation column. A complete model for the column is included as an appendix.

This book represents more than just another research monograph or an updated book on process control. The authors attempt to reformulate the basic problems of process control using the advances that have occurred in robust control theory over the past decade. They give new insights into conventional techniques for process control and show the fundamental place that model uncertainty occupies in determining achievable control performance. Of course, this is not the end of the story. The role of constraints, nonlinearity, and discrete events are topics not covered in this book and, in fact, continue to be challenging research problems. But within its declared scope, the book does an excellent job of synthesizing available results for robust process control.

The book could be used independently as a guide to this area of process control or as a book to supplement a graduate course in process control. In my opinion, Part I is must reading for anyone involved with control theory, no matter what discipline. The book would not be suitable as a stand-alone text for a first course in control, since it lacks coverage of other topics, nor does it contain end-of-chapter exercises. However, I don't think it will be too long before the structure of this book becomes the framework for basic control education.

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Basic Bioreactor Design

By Klaas van't Riet and Johannes Tramper, Marcel Dekker, Inc., New York, 472 pp., $135.00 ($55.00 for orders of 5 or more copies, for classroom use only)

According to the authors, this book is based on the course material of the graduate school in biochemical engineering at Wageningen Agricultural University. Part of it originated from earlier lectures given by K. van't Riet, J. J. Hiejnen, and N. W. F. Kossen in a biochemical engineering course at Delft Technical University. Its intention is to be used as a textbook for graduate students as well as a handbook of fermenter design and engineering.

The book has many positive features. The topic of bioreaction engineering is covered appropriately. In addition to topics such as balances, yield, kinetics, mass transfer, and heat transfer, it includes separate chapters on stability, shear, mixing, and foam. The expertise of the authors and their contributions to biochemical engineering are reflected in such chapters as the one on shear, which is the most current and extensive treatment of this topic in a biochemical engineering textbook.

The treatment covers the topics that one would expect in a traditional bioreactor design course that has been developed over a period of years. The prior employment of one of the authors with Gist Brocades N.V. gives the book an element of practical biochemical engineering. Relevant principles and current industrial methods for process engineering are emphasized. The book does not treat modern cell engineering topics; and genetics, plasmid, and mutation do not appear in the subject index. It does not cover reaction engineering at the cellular level, nor does it include any specialized treatment of the environmental biochemical engineering topics of bioremediation and wastewater treatment.

There are a number of good references at the end of each chapter; however, there is no attempt to include all of the important references. The references contain many contributions of the authors and their coworkers.

One of the features of an excellent textbook is an assortment of good homework problems. This book has some example problems, but there are no homework problems. Despite this shortcoming, it can be used effectively as one of the textbooks for a biochemical engineering course. Many faculty will find material from this new book useful as they attempt to cover this rapidly developing field of chemical engineering. Those who are responsible for commercialization of biotechnology will find it to be an excellent addition to a personal or corporate library.

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