ple: membrane separations are covered in four chapters, and instrumentation and process control of fermentors are covered in two chapters each. There is a good balance of the academic (twenty-four contributors) and industrial perspectives (twenty contributors). Due to the large number of topics being addressed, one should not expect an in-depth coverage of each. Most chapters are written for a nonspecialist and provide adequate information about principles, applications in bioprocessing, equipment, and scale-up, and include enough references to serve as a starting point for self study. References in most chapters are up-to-date through 1983, and a glossary of terms and index is included.

One may question the subject matter or emphasis in some chapters. For example, chapters on immobilization of cells and enzymes emphasize immobilization techniques, and not reactor design and performance. In Section 2, while those unit operations chosen are of interest, rarely used operations such as supercritical gas extraction are included while some very commonly used operations such as crystallization, decolorization, adsorption-desorption, and drying are not. Each unit operation is also treated separately, with no discussion about process synthesis or integration of the unit operations to make the most efficient and economical process. This is an area of great importance to bioprocess engineers, since there are many ways to isolate a product to desired purity. Also, some discussion about the special considerations in bioprocess development, such as: maintaining biological activity during processing, variability of bioreactions compared to chemical reactions, separating large molecular weight compounds with only slight differences in structure, and processing problems caused by contamination would have been useful. Simultaneous fermentation and partial recovery (fermentation coupled with solvent extraction or adsorption) to improve fermentation by removing inhibitory products is another area of interest. Some discussion about the different types of assays used for product control and yield determinations also would have been useful to bioprocess engineers. Clearly, not all topics can be covered in a single book, and as the editors point out, ongoing trends and progress will be covered in supplementary volumes and in Pergamon's review journal Biotechnology Advances.

On the whole, I think the editors and contributors have done a good job. This book provides a broad introduction to, and an overview of, bioprocess engineering to students and practicing engineers with limited experience. Experienced bioprocess engineers will also find it to be very useful to fill in the gaps in their backgrounds. This book will serve as an excellent reference source, which will be, no doubt, used frequently.

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Volume 3—The Practice of Biotechnology: Current Commodity Products

Edited by Harvey W. Blanch, Stephen Drew, and Daniel I. C. Wang, 1136 pp.

The third volume of "Comprehensive Biotechnology" addresses the application of biotechnology to a wide range of commercial products: health care products, food and beverage products, industrial chemicals, biochemicals, and fuels. For this large undertaking, an approach similar to the Kirk-Othmer Encyclopedia of Chemical Technology was utilized. Various expert authors summarized the historical, current, and future directions of biotechnology as applied to the products of their expertise.

The first section of the book surveys applications to healthcare products, ranging from more mature, developed products such as penicillin to products from recombinant DNA. It is commendable that the majority of the authors are from industry, and are actually responsible for reduction to commercial practice. It is not surprising, then, that the degree of technical detail and economics disclosed is proportional to the product's age. Particularly noteworthy is the section on penicillins by R. W. Swartz, which is significant in that it discusses and reflects on the relative impacts that various disciplines (Microbiology, Biochemical Engineering, Chemical Engineering, etc.) can have on overall process economics. Although written specifically for penicillin, the "lessons learned" can be translated to almost any application of biotechnology.

The second section discusses food and beverage products. The range and variety of products discussed, from beer, whiskey, cheese, and bakers yeast technology to manufacture of amino acids is fascinating. Historically, these technologies developed independently, with their own nomenclature and approach. Therefore, it is interesting to read about the products with terms explained in a contemporary, scientific language.

The third and final section surveys industrial chemicals, biochemicals, and fuels. The products discussed are quite diverse. Industrial chemicals include acetic acid, acetone, ethanol, and butanol. It was interesting to note that the majority of these sections were written from the academic community, since, as the editor noted in the introduction, previous biological routes to these products were supplanted by the success of the petroleum based industry. The rise of petroleum prices has brought renewed interest in the biological routes. Several sections are devoted to manufacture of enzymes, the best of which discuss starch and glucose conversion. The survey of microbial polysaccharides is also noteworthy.

It is somewhat of a dilemma that the book's strong point could also be viewed as a weakness. The strong point is its comprehensiveness and scope of biotechnology. Given the enormous scope of its charter, the book is, in general, successful. By nature of its format and variety of authors, the detail, impact, and quality of the sections is uneven. There were serious omissions—such as an expanded discussion of vitamins (B12, Riboflavin, etc.) that are also products of biotechnology and important industrial commodities. There was also a missed opportunity to further expand the multidisciplinary approach. The third section in particular could have benefited from expanded discussion on the impact that molecular biology can have on enzyme specificity and yield, and that biochemical and chemical engineering can have on process economics through advances in reaction and separation technology. The large scope and volume of material also result in a high cost.

In summary, the series would make a valuable addition to an academic or industrial reference library. The wide scope of material and large number of refer-

ences make it a good starting point in addressing almost any area of biotechnology. The field of biotechnology is a moving target. While you might not hit a "bull's eye" on a topic, the large scope almost ensures hitting the target.

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Volume 4—The Practice of Biotechnology: Specialty Products and Service Activities

Edited by Campbell W. Robinson and John A. Howell, 1165 pp.

This volume essentially consists of three large sections written by an international group of well-known specialists. The first section consists of a diversity of technical papers on applications areas in biotechnology ranging from biomedical, chemotherapeutic, agriculture biopulping, enhanced oil recovery to mineral processing. The second section focuses on contributions from U.S., Canadian, Japanese and European specialists on government regulations on biotechnology and topics include patents, biohazards, and new drug regulation. The third section consists of technical papers on waste management and pollution control using biotechnology.

This volume is well organized; it would be useful for most biotechnologists in industry, and should likewise provide universities with a good up-to-date general reference of biotechnology applications. The subject index and the well written introductions by the editors to each of the three sections will guide the readers to valuable information. Most of the papers contain an up-to-date list of references.

As a specialist in the industrial fermentation area, I have reviewed a number of papers in this volume that might be useful for industrial biotechnologists. These include the papers on microbial growth rate measurement, analysis of fermentation gases, laboratory and equipment design for containment, as well as the overview papers on government regulation of recombinant DNA manufacturing and papers concerning regulations for new drug products. The majority of these papers are well written.

This volume is truly a comprehensive coverage of biotechnology applications and should be a valuable resource for the practicing biotechnologist.

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Thermodynamic and Transport Properties of Coal Liquids (An Exxon Monograph)

By C. Tsonopoulos, J. L. Heidman, and S.-C. Hwang, John Wiley & Sons, 1986, 214 p. $49.95

Over the years, various technologies have been developed to produce synthetic fuels from coal. The design and operation of coal conversion processes require data on thermodynamic and transport properties. However, the required data are not available for most properties at the conditions of interest. Current design calculations for coal conversion processes are based primarily on data and correlation methods for petroleum liquids, which rarely represent coal-derived liquids. The production of coal liquids is conducted at high temperatures, and the liquids generated differ substantially in nature from petroleum crudes. In this book the authors demonstrate the potential applications of methods developed for petroleum liquids, with slight modifications, to coal liquids at coal liquefaction conditions.

The book consists of ten distinct chapters. The first chapter presents a terse summary of the unique character of coal-derived liquids relative to petroleum fluids and key model compounds for coal liquids. The basic data needs for design calculations of coal liquefaction processes are reviewed in Chapter 2. Chapter 3 outlines methods for characterization of coal liquids. Chapters 4–9 examine the properties of interest with emphasis on elevated temperatures: vapor pressure (4), vapor-liquid equilibria (5), thermal properties (6), density (7), surface tension (8), and transport properties (9). Correlation methods used currently in the petroleum industry are applied in these chapters to the prediction of the properties of coal liquids. The text concludes with a discussion in Chapter 10 on future needs for experimental data and theoretical study, followed by two brief appendices in which inspection data for EDS coal liquids are summarized.

Two alternative approaches to properties correlation are explored: one based on boiling point and specific gravity and the other on critical properties and acentric factor. Extensive calculations are given to illustrate how well such classical methods for petroleum fluids can be extended to highly aromatic coal liquids. Unfortunately, with the exception of vapor pressure and vapor-liquid equilibria (VLE), experimental data for many of the properties of interest are nearly nonexistent at elevated temperatures. The lack of adequate data leads to inconclusive results in the development and testing of the correlations for such properties.

As the authors freely admit, the scope of the book is limited. No introduction to the theory behind the correlations nor detailed description of the coal liquefaction processes cited is presented. It is assumed that the reader is familiar with introductory thermodynamics and is referred elsewhere for details on coal liquefaction process design. Content is confined to the development of a classical framework for the estimation of the thermodynamic and transport properties of coal liquids. Within that framework, two-parameter (boiling point and specific gravity) characterization is pursued to its point of failure. No review is provided of the multiparameter correlations developed more recently to better model the complex behavior of coal liquids. Similarly, in the study of VLE data, the authors have restricted discussion to use of the Joffe-Zudkevitch modification of the Redlich-Kwong equation of state. No review is included of alternate solubility and VLE models for coal liquids. Throughout the text, attention is focused primarily on the large database for EDS and SRC-II liquids derived from key bituminous and subbituminous coals to the exclusion of more recent data.

The monograph is written with admirable clarity and meticulous detail. By way of documentation, the authors have gone out of their way to consolidate the bulk of the early literature on the thermodynamics of coal liquids into a single source for future reference. The result is a treatise on applied thermodynamics of uncommon value in industrial practice. The authors should be congratulated for their contributions in this book.

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