BOOK REVIEWS

Fermentation and Biochemical Engineering Handbook

HENRY C. VOGEL, ED.

Noyes Publications, Park Ridge, NJ, 1983, 439 pp., $64.00

This book is intended for the practicing engineer and was primarily written by engineers at equipment supply companies. As such it has a minimum of theoretical developments or research references and an emphasis on equipment description and trouble shooting during plant operations. The first chapter provides a background on microbiology to aid the reader who is not particularly versed in this area. Three chapters are then devoted to fermentation pilot plants, the design of fermenters, and agitation. Downstream processing is then treated from a unit operations approach with chapters on filtration, solvent extraction, ion exchange, evaporation, crystallization, and adiabatic and non-adiabatic drying. The final three chapters deal with the production of sterile water, equipment and processes for sterile formulation and with instrumentation and control of fermentation processes.

The review of microbiology (including genetic engineering) provided in Chapter 1 is appropriate and useful, but it would be too brief for the engineer who does not have some previous background in biochemistry or microbiology. The discussion of the industrial pilot plant covered a number of useful topics including media formulation, material and energy balances, instrumentation and control, as well as scale-up and pilot equipment sizing. The chapter on Fermentation Design by Allan Soderberg is one of the highlights of the book. He authoritatively discusses fermentation plant layout, the technical aspects of continuous versus batch sterilization, fermentor cooling, fermenter aeration including the relative merits of mechanical agitation and that from gas flow, and troubleshooting on contamination problems. The chapter on mixing provides general background information on mixing with some limited examples on mixing in fermentors. Between Chapters 3 and 4

there are some discrepancies on the basis for fermentation vessel scale-up. Soderberg seems to imply that gas superficial velocity should remain constant, while Oldshue (Ch. 4) implies that increased size results in increased superficial gas velocity. Overall the first four chapters provide the engineer with an appreciation of many of the practical problems in fermentation design and operation.

The portion of the book covering unit operations (Ch. 5–12) is rather disappointing because so little of the material presented is keyed to fermentation or bioprocesses. This is particularly unfortunate because there are few good treatments of industrial-scale downstream processing of biological materials available. Much of the discussion presented is available in handbooks such as Perry's. The chapter on filtration does not treat the very important subject of air sterilization by filtration. Also, in the discussion of solid–liquid separations such as that of cell-broth, no mention is made of the newer techniques using membrane filters. In contrast to the chapter on solvent extraction, that covering ion-exchange does have some discussion of the recovery of biological products such as amino acids. No mention is made of methods such as affinity chromatography, immunoadsorption, or preparative-scale HPLC. The chapter on evaporation devotes only two of its fifty pages to evaporative processes for heat-sensitive materials. A useful discussion of crystallizer equipment is provided in Chapter 9 with a few pages devoted to fermentation products. Precipitation by addition of a liquid agent (e.g., isopropanol to an aqueous fermentation broth to recover an antibiotic) is not covered at all, yet it is often employed in practice. The discussion of size control could have been more detailed because of its obvious importance in the production of many biologicals. All of the chapters in this section provide a useful introduction to equipment types and typically provide a list of manufacturers of such equipment.

Chapters 13 and 14 provide an excellent introduction to the design of systems to provide sterile pyrogen free water and to systems to produce sterile bulk pharmaceuticals or fill vials in a sterile manner. As such, these technologies are rather unique to biochemical engineering and are quite appropriate in this book. The final chapter on instrumentation and control deals quite specifically with fermentation systems including available sensors, categories of control, examples of fermentation control strategies and system configurations. It was obviously written for this biochemical engineering handbook and should be of use to those engineers first encountering control of fermenters. One wishes some of the other chapters had also been written specifically towards fermentation processes and products.

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Biotechnology, Chemical Feedstocks and Energy Utilization

(A Report from the FAST Programme of the Commission of the European Communities)

D. F. GIBBS AND M. E. GREENHALGH

Frances Printer (Publishers), London, 1983, 116 p., $22.50

This publication is a report of a study carried out for the Commission of the European Communities as part of the FAST Program (Forecasting and Assessment in the Field of Science and Technology). The aim of the study was to identify the fundamental issues and inherent problems affecting biotechnology, and formulating strategic options for its most effective use in the European Community during the next 30 years. Particular emphasis was placed on chemical feedstocks. Technical, economic, environmental, social, and political factors were examined, and considerable attention was given to an overall energy balance.

The report begins by considering the current energy situation and likely future trends in energy supply and demand in Europe. The European petrochemical industry was then examined in terms of projected production and consumption. Thereafter, various options were considered that are likely to be available over the next few decades to enable the chemical industry to fulfill its role. The use of coal and the impact that it might have on the viability of new biotechnology processes was evaluated.

It was concluded that biomass feed materials for a new biotechnology in Western Europe would probably have to be waste material from agriculture and forestry activities and domestic/municipal sources. This would arise from the unavailability of additional land suitable for the primary production of biomass. Obviously, this will severely limit the potential for large-scale biotechnology in this geographical area,

although it was suggested that new bioprocesses would be appropriate for some localities and regions.

Only a cursory review was given of the status of biotechnology research in Europe and possible future innovations. However, an interesting list of potential biologically derived products was presented. These included not only the usual oxygenated hydrocarbons and organic acids, but also ethylene, polymeric materials, and others that obviously will require a significant amount of research and development. Several important research areas were identified in microbiology, biochemistry, and process technology. New educational needs were also outlined and an emphasis on multidisciplinary approaches was encouraged. It was concluded that biotechnology would assume an important, but not critical role in the European Communities during the next 30 years. Recommendations for developing this type of technology were primarily aimed at providing additional governmental support for research and develop ment.

The book is relatively short (103 pages of text) and easy to read except that all the tables and figures are inconveniently placed at the end of the text. It is lacking in technical detail, but it presents an interesting commentary on the decision-making process of a large, multi-national, governmental body.

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Biotechnology

A Textbook of Industrial Microbiology

WULF CRUEGER AND ANNELIESE CRUEGER

Translated by Caroline Haessly; Translation edited by Thomas D. Brock; Science Tech, Inc., Madison, WI 53705; 1984, 308 pp., $28.50

The final goal of research programs in biotechnology is to translate the results obtained in laboratories to large-scale industrial process. Therefore, a need exists for those people who are interested in biotechnology to understand the well-established principles and methods that have been successfully applied to large-scale processes. With this understanding, the limiting factors in current processes can be determined and novel processes initiated. *Biotechnology* is a textbook that attempts to fulfill this need.

This volume was originally written in German. Its contents can be divided into two parts. The first six chapters, accounting for one-third of the book, discuss the general principles and methods used in industrial microbiology. After a brief introduction, the topics covered are: (1) screening of new metabolites, (2) strain development, (3) substrates for industrial fermentation, (4) methods for large-scale fermentation, and (5) product recovery. The rest of the book describes the application of these principles and methods to the industrial production of various microbial metabolites, including primary metabolites (i.e., organic feedstocks, organic acids, amino acids, nucleotides, vitamins, and polysaccharides) and secondary metabolites (i.e., antibiotics and ergot alkaloids). Chapters describing microbial transformation, sewage treatment, bacterial leaching, single cell protein, and microbial enzymes are also included.

Much space (40 pages) is devoted to strain development, which is the strong part of this book. The mechanisms of DNA repair and mutagenesis are well explained. This chapter gives a clear picture of the strategies and approaches in improving microbial strains; it includes classical mutation methods as well as modern techniques such as *in vivo* and *in*

vitro DNA recombination. The importance of the regulation of microbial metabolism is also stressed here, however, the control mechanisms are poorly described. This renders only a vague idea of how deregulation occurs at the molecular level.

Almost the same amount of space is given to methods of large-scale fermentation. As an introduction to the engineering aspect of biotechnology, this chapter covers important concepts in growth kinetics, fermentor systems, mixing, mass transfer, and sterilization. There are however some minor problems in this section. In using the equations for continuous culture, some assumptions are made that should have been incorporated into the text. The discussion of fermentor systems could have been clearer. The unit of the volumetric air flow rate in the Michel and Miller correlation is L/min, not vvm. There is no discussion of continuous culture other than the basic chemostat. In the subsequent chapter, product recovery is covered only briefly.

The second part of this book covers the application of industrial microbiology methods to the production of individual microbial metabolites or to other bioprocesses. In each chapter, the history of the production of specific microbial products is presented followed by the description of the biosynthetic pathway, regulation of this pathway and the strains used. Current and promising processes are presented and compared. The authors also make useful comments on each process from the point of view of large-scale production. The application of biological and engineering methods to optimize specific bioprocesses is vividly illustrated in these chapters. It is most valuable that new or potential processes that are made possible by genetic engineering techniques are described when they exist. Thus one can appreciate the role that genetic engineering plays in revolutionizing bioprocesses.

The format of this book was carefully planned. The authors should be congratulated for keeping each chapter consistent in style. The translation is good and the book is very readable. There are a few errors introduced by typesetting; however, they do not cause confusion. This book is abundantly illustrated with clear figures and tables, but being so concise, does not discuss many subjects in depth. Those who are interested in more advanced information will have to read additional material. Fortunately, the reference lists in this book are extensive and updated for the English edition.

In general, this affordable book is concise, up-to-date, and comprehensive. It has a good mingling of physiology and processes and is an excellent book for people who need an overview of industrial microbiology.

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