BOOK REVIEWS

Bioreactor Design Fundamentals

By N. G. McDuffie, Butterworth-Heinemann, Stoneham, MA, 1991, 137 pp., $42.95

Several books on biochemical engineering topics have recently emerged. Among these McDuffie's text is unique in terms of the succinctness with which the broad topic of bioreactor design is presented. The goal of this monograph, according to the author, was to provide a unified coverage and condensation of applications of biological kinetics and thermodynamics related to biological reactor design. The need for such coverage evolved from the author's experience in teaching courses in bioengineering.

The material is divided into seven chapters. The introductory chapter gives a brief overview of models that are used for describing the kinetics in bioreactors. Chapter 2 gives an overview of thermodynamics and stoichiometry as foundation to discuss material and energy balances, and phase and reaction equilibria. Enzyme kinetics in the next section describes some fundamental rate laws, the classical enzyme inhibition models, and the effect of pH and temperature on the reaction rates. The section concludes with a brief excursion into the kinetics of polymer hydrolysis. After a brief chapter on fundamentals of mass transfer, the kinetics of cellular multiplication is illustrated. Typical growth phases of a cell culture are described. The Monod kinetics is explained, and yield coefficients are introduced to relate cell growth to substrate consumption and product formation. Some examples of how inhibitory effects can be treated are given before concluding with a classification of mixed cultures. The design equations for plug-flow and stirred-tank bioreactors are introduced in the chapter on enzyme reactors, which also shows how concepts of heterogeneous catalysis are applicable to immobilized enzyme systems. The book concludes with a chapter on cell culture bioreactors that illustrates the application of the developed rate equations in designing the basic reactor types. Concepts used for scaling up bioreactors are described at the end.

The presentation of the material is very clear and simplified to the backbone of essential concepts. Details are deliberately omitted, but helpful references can be found throughout the text so that interested readers can quickly find more comprehensive treatments of the presented topics. I found reading the book very enjoyable, as it gives a quick overview of the subject and impressively shows how much simplification can be afforded in presenting the topic without losing essential concepts. This is certainly a reflection of the author's extensive experience in teaching the material. The book should be useful as an introductory text for both biologists and engineers. It can show biologists that an engineering analysis of growth phenomena is not essentially complicated. And for chemical engineers it illustrates that bioreactors are just another type of reactors that can be approached with the common engineering tools.

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Crystal Growth from Melts: Applications to Growth of Groups 1 and 2 Crystals

By B. N. Roy, Wiley, New York, 1992, 322 pp.

This is not a book on the general aspects of melt crystallization; rather, it addresses the crystallization of specific classes of substances from melts of metal salts. The objectives of the book are "..... to present the major ideas and the important principles of high-temperature crystal growth."

The book attempts a general overview of phenomena important in crystallization and coverage of results specific to the crystallization of alkaline-earth metal salts from melts. The overview of general principles is too brief to be of significant value. On the other hand, the treatment of alkaline-earth metal salts is superb, and anyone interested in these substances would do well to have this book; coverage is complete and there is extensive documentation of the presented material. Below are my reasons for the disparate views of the two thrusts of the text.

Crystallization Phenomena. Chapters 1 through 8 address fundamentals of crystallization; in almost every instance, the coverage is skimpy and the order in which some material is presented is less than optimal. For example, not until an overview of crystallization methods is presented, is crystal growth divided into growth from the gas phase, from solutions, and from the molten state; earlier subdivision would seem more appropriate. The material in the early chapters is overly repetitive—for example, much of the introductory material from Chapter 1 is repeated in Chapter 2—and the sparse use of graphics makes following the descriptive material more difficult than it should be. For a book that focuses on experimental results, there are surprisingly few illustrations of apparatus, as is done with the schematic representation of a Czochralski crystal-pulling furnace.

Chapter 3 is an exception to the format of the first eight chapters: it provides an excellent compilation of solubility data for alkaline-earth salts. Even here, however, the descriptive material is overly sparse as fundamental thermodynamic relationships involving solute-solvent behavior are insufficiently illustrated. The section intended to accomplish that, "Thermochemical Calculations," is slightly less than one page in length.

Crystallization of Alkaline-Earth Metal Salts. Beginning with Chapter 9, the focus shifts to specifics associated with crystallization of alkaline-earth salts from different melts. It is with this material that the *raison d'être* for the book becomes apparent. Here and in subse-