BIOSEPARATIONS: Downstream Processing for Biotechnology

by Paul A. Better, E. L. Cussler, Wei-Shou Hu
John Wiley & Sons, New York, 368 pages, $39.95 (1988)

Reviewed by
Murray Moo-Young
University of Waterloo

In the broad field of biotechnology, any new book with the words "bioseparations" and "downstream processing" in its title will attract much attention since these are the current trendy, fashionable areas of biotechnology. Somewhat surprisingly, this is probably the first book devoted entirely to this area, which is partly due to the difficulty in handling it for a multidisciplinary audience indigenous to biotechnology. Whereas Volume II of the multi-volume work, *Comprehensive Biotechnology* (Pergamon Press) is a major reference, this book is a primer on the subject matter. As such, it is a good teaching text and is well worth its list price of $39.95.

The authors, comprising a group of experts with both industrial and academic experience, have developed an effective pedagogical strategy in which typical bioseparations are viewed as an idealized four-step process according to a so-called RIPP organization: Removal of insolubles, Isolation of product, Purification and Polishing. The book helps to bridge the gap between the usually separate, parallel evolving cultures of the life sciences and engineering in this area by providing material for "scientists with no background in engineering" and "engineers with no background in biology." Inevitably, this ambitious approach to satisfy such a wide audience results in sections (*e.g.*, filtration, drying) which are rather rudimentary for chemical engineering graduates (which is the usual level at which biotechnology is taught in chemical engineering departments), while the same sections are too advanced for the life science undergraduates. Regardless, the authors are to be commended for providing in one place "an introduction to the separation and purification of biochemicals."

After an overview introductory chapter, the book is divided into four parts which cover a total of twelve chapters, and ends with two appendices. It is of interest to note the section titles and number of pages allocated to these topics: Overview (11), Filtration and Ultrafiltration (35), Centrifugation (21), Cell Disruption (21), Extraction (47), Adsorption (37), Elution Chromatography (39), Precipitation (17), Ultrafiltration and Electrophoresis (35), Crystallization (35), Drying (29), Auxiliary Operations (12), Characteristics of Biological Materials (5), and Limits of the Continuum Approximations (5). Possibly, a disproportionate amount of space is given to the classical methods of liquid extraction (which is primarily for relatively small molecules in "new" biotechnology terms) at the expense of other aspects (*e.g.*, isoelectric focusing) and recent innovations.

For example, it could be argued that there are a number of other topics or subtopics that should have been covered in a book of this type. Among these are the following: supercritical fluid extraction (its use is increasing); relevant process control and CAD/CAM; multi-unit integration strategies; bioreactor/downstream processing interfacing optimization, bioseparations in microgravity environments (prospects of biomanufacturing on a future space platform are of practical interest); development of new polymeric and composite materials for membrane separations and chromatography column packings; effect of surfactants on membrane separation performance; equipment innovations such as the use of Taylor vortices to reduce polarization effects in membrane separations; the implications of solid-state fermentations to downstream processing economics; materials of construction of the various bioseparation devices. Presumably, the authors could excuse these omissions on the basis of their philosophy that "mixing, like life, is incomplete..."!

The subject matter is given quantitative testament as a series of unit operations (typical of chemical engineering) in terms of mass and energy balance and kinetics of the processes involved. Fundamental concepts are presented clearly. Where correlations derivable from first principles are not possible, the authors draw attention to the traditional usefulness of dimensional analysis for complex flow systems, *e.g.*, the analysis and design of cell disruption devices (Chapter 4). Each chapter contains several illustrative examples and at the end, practice problems with answers (which should please students and practitioners alike) are given. Curiously, some of the problem statements are given in mixed S.I. and British units (*e.g.*, kg, ft) and probably reflects the immediate real-world industry situations addressed. Line diagrams, some with three-dimensional cut-away views, are used to depict clearly the mechanical features and physical functions of various equipment. As a teaching tool, this technique is more effective than photographs.

As suggested by the authors, the book appears to be suitable as a one-semester course for senior undergraduate chemical engineering students and first-year science graduates (including those from chemistry, microbiology, food science). The book should also be useful in industry where calculations in downstream processing are required in research, development, design, and plant operations. The book is sufficiently robust to withstand many hours of use. It has a good subject index, but unfortunately no author index. More discriminating students (and others) would have welcomed some references to the research literature, especially in view of the advances being made in this area. However, this is a minor criticism. Despite the omissions mentioned earlier, the book has something in it for almost everyone interested in bioseparations, a term synonymously now used with downstream processing in biotechnology. ❐