Chemical Processing Handbook

Edited by John J. McKetta, Marcel Dekker, New York, 1993, 972 pp., $225.00

This handbook is a compilation of articles written by industry experts: most contain process description and broad economics, and some have annual production figures. The editor's preface tells us that it "covers up-to-date processing operations in the chemical industry." It goes on to say that "Each of the processing articles contains information on plant design as well as significant chemical reactions" and that "...shortcut methods of calculation are included..." along with "nomographic methods..." Only in very few of the processing chapters are there anything like "shortcut design methods" or nomographs. The plant design is mostly qualitative in nature and, in many of the chapters, even the important chemical reactions are missing. Finally, most of the chapters are hopelessly out-of-date; they are, in fact, taken without revision directly from this same editor's *Encyclopedia of Chemical Processing and Design*, most of which was prepared prior to 1980.

The contents are heavily weighted toward the petroleum industry: 14 of the 34 chapters deal directly with petroleum or natural gas processing. These include "Alkylation," "Dehydrogenation," "Gas Processing," and "Petroleum Processing"; the bulk of the information contained in these articles can be found in standard sources such as Nelson's *Petroleum Refinery Engineering*. Many others are indirectly related: these include "Oxidation of Hydrocarbons," "Bromination and Bromine Compounds," "Amination," "Esterification," "Nitration," and "Oxidation of Aromatics." Essentially all deal with hydrocarbon processing; most of this material can be found in Groggins' *Unit Processes in Organic Synthesis* in greater detail. There is nothing specific to the inorganic chemical industry (aside from a brief section on chloralkali), pharmaceuticals, propellants, detergents, foods, paper, photography or ceramics to name a few.

This is not to say that none of the contributions is worthwhile. The chapter titled "Olefin Processes" is quite complete and highly readable. "Chlorination, Liquid Phase and Vapor Phase" is very comprehensive; chemical reactions, rates and selectivity are all well described. "Hydrogenation Catalysts," written by the group at IFP in France, contains a good discussion of the tradeoff considerations for the use of palladium-based catalysts. The chapter written by the group at UOP on isomerization has mechanisms, plant layouts, and economics not found elsewhere. "Polymerization" is a reasonable mix of simple theory, application and practice. As an example of the haphazard editing, however, this chapter includes work on emulsion polymerization, yet it is followed by a chapter titled "Polymerization, Emulsion." More discussion of polymerization occurs in the chapter titled "Chemicals from Petroleum." Another example is the chapter titled "Catalysis and Catalysts," which includes material on precious metals, but is followed by "Precious Metals Catalysis." Many of the other chapters include description both of the theory and practice of the catalysts used in the process considered.

The most important deficit is the outdated nature of most of the contributions; one runs into such phrases as "If the North Sea gas contains significant ethane..." and "Of technical importance is the preparation of DDT..." Technologies developed in the last ten or 15 years are almost entirely absent. There is not to be found any mention of the replacements for the Freons, nonlead antiknock agents for gasoline, waste treatment and recovery technologies. The chapter on Enzyme Processing was written in 1979, so that virtually an entire industry has been excluded.

On the positive side, the format is very readable, with excellent typesetting, figures and tables. But the contents are available in standard sources such as those mentioned, in addition to Shreve's *Chemical Process Industries*, so that this handbook is not recommended for any purpose.

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Physical Forces and the Mammalian Cell

Edited by J. A. Frangos, Academic Press, 1993, 400 pp.

Perhaps the most convenient entree for engineers into the world of mammalian cell biology, motivated by bioprocessing and health care applications, has been the study of effects of mechanical forces on cell function. Engineers are obviously well prepared to apply experimental devices and theoretical analyses for quantifying fluid mechanical forces on cells, whether attached to surfaces or free in suspension. Coupling these standard engineering methods to measurements of various cell functions, such as proliferation, protein production, adhesion, or merely maintenance of viability, allows generation of tremendous amounts of information for the numerous possible combinations of cell type, cell function, and mechanical environment. Indeed, so much information has accumulated during the roughly two decades of research in this area that the availability of a comprehensive summary and review is highly desirable.

This multiauthor volume provides a useful compendium of engineering studies of how mammalian cells are affected by mechanical forces, primarily those induced by moving fluids. In the context of this review for a chemical engineering journal, it is intriguing that only four of the 11 chapters are written by chemical engineers, although the editor is Professor John Frangos of the Department of Chemical Engineering at Pennsylvania State University. This probably reflects the fact that study of mechanical forces is not predominantly within the domain of chemical engineering—or even of engineering more broadly. Indeed, one of the positive features of this book is that it should alert our community to the excellent work going on in this particular aspect of biochemical and biomedical engineering by investigators from other disciplines. My own viewpoint is that chemical engineers remain uniquely well suited for quantitative research in cell biology, especially in its contemporary molecular approach, as regulation of cell function is ultimately chemical in nature. Even when mechanical forces are the original stimuli, it is my prejudice that these forces act by eventual translation into cellular biochemical processes. Thus, I believe that the crucial issue in studying effects of *mechanical* forces on cells is how they modulate *chemical* regulatory systems. A few relevant examples exist already, such as polymerization of cell cytoskeleton precursors and binding of substratum-bound ligands to cell adhesion receptors, in which mechanical forces appear to alter chemical reaction rates, presumably by modification of molecular interaction energies.

Despite the 1993 publication date of this book, it is yet too early for this molecular perspective to be prominent in a collection of research on mechanical force effects on cells. However, Professor Frangos has done an excellent job of organizing contributions from leading groups to cover the spectrum of current information in this area. It is, of course, typical for multiauthor volumes to be uneven in clarity and approach. Nonetheless, all 11 chapters are reasonably well written and technically sound, and should be found useful by anyone interested in this subject for summaries of the present state of understanding of various topics. A few of the chapters are especially noteworthy and highly recommended for their emphasis on offering authoritative insights, going beyond basic description. These include Chapter 2 on the role of the cytoskeleton in mechanochemical signal transduction by Don Ingber, Chapter 4 on mechanically-sensitive ion channels by Peter Davies, Chapter 5 by Frangos on cell secretion products under fluid shear conditions, Chapter 6 on shear stress effects on endothelial cell morphology by Bob Nerem, and interrelated Chapters 9 and 10 by Larry McIntire and Terry Papoutsakis, respectively, on fluid mechanical effects on cells in suspension and in bioreactors. (These chapters also have coauthors, but for the sake of brevity [and with sincere apologies to them] I have mentioned only the senior investigators.) Other helpful contributions include Chapter 1 by Roger Tran-Son-Tay on methods for measuring physical forces and Chapter 3 by Albert Banes on mechanical deformation of cells. The remaining chapters summarize information that may be beneficial for purposes of literature survey but do not, in my limited personal opinion, provide significant aid to increased conceptual understanding of their topics.

Along with the guide to special attractions listed above, it might be worthwhile to a potential buyer to offer a few additional, minor comments in order to sketch a fuller picture of what will be found in the book. Absent a true introductory chapter, the Preface by Editor Frangos spells out the motivation for the project, but it does not go further to relate the individual chapters within a global context nor does it frame the outstanding questions to be addressed. Chapter 1 on force measurement methods is variable in detail, showing great depth in some assays but very little in others, without apparent correlation to current utility. Chapter 2 advocates the intriguing and appealing theory known as "tensegrity," based on the analogy of Buckminster Fuller's geometric mechanics to cells. Chapter 4 lays out the evidence for "shear-activated" membrane channels very nicely and admits that the fundamental mechanism is still unknown. Chapter 5 contains one of the best discussions I have read examining concisely alternative mechanisms for shear stress regulation of intracellular processes. Chapter 6 is the epitome of what one looks for in an expert review, focusing on ongoing issues. Chapter 8, by Lowell Langille, on effects of blood flow on artery walls, contains the greatest degree of emphasis on *in vivo* physiology. Chapter 10 is extremely thorough in considering various possible mechanisms causing cell damage in bioreactors, including both suspension and surface-anchored cells. Finally, Chapter 11, by Paul Todd, on the influence of gravity on cells, is interesting, but fails to make a compelling argument for centrality, at least in the case of cells in culture as opposed to whole tissues.

It should be clear that I see this volume as a valuable addition to the library of anyone interested in mammalian cell function. I know that I will frequently refer to particular chapters in it when I need to recall information on some topics and to refresh insights on mechanical force effects on mammalian cells in either bioprocessing or health care technology applications.

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Microhydrodynamics: Principles and Selected Applications

By Sangtae Kim and Seppo J. Karrila, Butterworth-Heinemann, Boston, 1991, 507 + xxiii pp., $69.95.

In the briefest and broadest terms, this book can be regarded as addressing the linear relation between motions and forces that applies to low-Reynolds-number particulate flow. It does so with clarity of presentation, and with sufficient scope and depth to encompass the roles of an excellent advanced graduate text and of a timely and timeless reference for research.

Overview

Whether hydrodynamics represents the primary focus or one of several interacting phenomena, fundamental understanding and applications-oriented modeling of the mechanics of colloidal dispersions and noncolloidal suspensions, electrophoretic separations, filtration and membrane transport processes, sedimentation, coagulation, and site-specific reactions rely on hydrodynamic coefficients in the creeping-flow regime, at various levels of accuracy and of geometric detail. This information is usually utilized in one of two equivalent linear forms that relate the kinematical characterization of the motion of the particles relative to the surrounding fluid (linear and angular velocity, ambient rate of strain) to dynamical quantities (forces, torques, stresslets). Resistance relations regard the forces as being determined by