interesting mix of reactions and processes that illustrate the diversity of chemical reactions that employ the types of catalysts mentioned above.

The book closes with three appendices that deal with membranes, monoliths, and reactors. These three short presentations provide brief introductions to continuous-flow devices. There is nothing new in these sections that have not been presented in detail in many texts on reaction engineering.

Overall, I find this book to be a useful source of information concerning heterogeneous catalysis for fine chemicals. The presentation by Prof. Tundo is timely, since the number and complexity of reactions peformed by heterogeneous catalysts is burgeoning, and it concisely organizes many useful organic syntheses into a single reference.

Mark E. Davis
Chemical Engineering Dept.
California Institute of Technology
Pasadena, CA 91125

Advances in Heat Transfer: Bioengineering Heat Transfer

Edited By Y. I. Chao, J. P. Hartnett, and T. F. Irvine, Jr., Academic Press, 443 pp., 1992

The stated intent of this monograph, published as Volume 22 in the well-known Advances in Heat Transfer series, is "to present the fundamentals and applications of heat and mass transfer in biomedical systems." This is a broad and ambitious undertaking, and it is not surprising that the editors have decided to limit the work to an in-depth and detailed treatment of the analysis, description, and measurement of temperature distributions in biological tissue. The result is an excellent review of a narrow part of the wide spectrum of heat-transfer topics one encounters in biomedical systems and certainly among biological heat-transfer problems amenable to an engineering approach. The absence of any significant consideration of mass-transfer effects, surface convection transfer, radiative heat exchange mechanisms, or regulatory phenomena may disappoint readers expecting a fuller treatment as the title and intent would imply. For researchers desiring an exhaustive treatment of the range of techniques used in developing microscopic temperature distributions in tissue, it is an excellent summary.

The volume consists of four chapters, each written by a recognized authority on the subject. The first is an interesting and concise history by Professor John Chato of the University of Illinois of the major developments in the aspects of bioheat transfer in tissues, covering the period from the contemporaries of Galileo to the present. The second chapter, by Professor Caleb Charny of the Cooper Union, summarizes the development of the microscopic thermal energy balance in tissue (the bioheat equation) and its various solution techniques, beginning with a lucid description of the pioneering work of Pennes in 1948. Successive advances and modifications discussed include the Wulff continuum model, which added an anisotropic blood flow term to the existing perfusion and conduction models, the Klinger continuum model in 1974 which introduced spatial averaging techniques, and the Chen and Holmes contribution in 1980, which used two conduction and two convection terms in the energy balance. Countercurrent treatments, notably those of Keller and Seiler and of Mitchell and Myers, are discussed. A recent work by Weinbaum and Jiji which introduces morphological detail in the intermediate tissue layer is also presented.

The longest chapter, (190 pages with 231 references) by Professor Kenneth Diller of the University of Texas at Austin, is devoted to the application of the bioheat equation to describe effects arising at low and high temperatures, such as found in cryosurgery, tumor hyperthermia therapy, laser surgery, freezing of tissue for preservation, cryoinjury, and burns. This is an excellent chapter with many examples of how classical mathematical analysis techniques can be employed along with various forms of the microscopic thermal energy balance to produce useful results concerning local heat fluxes and temperature distributions in a wide variety of geometries.

The last section, prepared by Professor Jonathan Valvano of the University of Texas at Austin, is perhaps the most generally useful for researchers, including those needing to employ temperature measurement techniques in other applications. Dr. Valvano presents the theory, mechanisms, a discussion of instrumentation techniques, and error analysis for the most significant technologies used in bioheat transfer, including thermistors, thermocouples, and thermal imaging techniques.

In summary, this volume is an excellent resource for those with an interest in the measurement and characterization of temperature distributions and heat fluxes in biological tissue. Those interested in bioengineering heat-transfer subjects such as environmental exchange, artificial organ design, thermoregulation, and macroscopic problems still await a definitive work.

Richard C. Seagrave
Chemical Engineering Dept.
Iowa State University
of Science and Technology
Ames, IA 50011

Fluidization Engineering

By Kaizo Kunii and Octave Levenspiel, Butterworth-Heinemann Publisher, 491 pp., 2nd. Ed., $145 (hard cover), 1991

Fluidization in a broad sense covers a variety of fluid-particle systems in which the particles are in a moving state. It is an important operation in industry encompassing many chemical, petrochemical, metallurgical, energy and environmental process systems. For example, in the chemical industry today, significant amounts of products or intermediate products are in granular form. These products routinely undergo a variety of fluid-particle interactions, chemically or nonchemically, in the transport processes. Thus, an understanding of fluidization phenomena is essential to the successful operation of these systems.

Since its first edition in 1968, Kunii and Levenspiel's *Fluidization Engineering* has been widely adopted as the principal textbook for classroom teaching of fluidization throughout the world. It has also become a standard, important reference book for experienced practitioners in their research. It highlighted the major breakthrough by several pioneers in the 1960s on the flow structure around the bubble culminating in the authors' bubbling bed model and fluidized bed reactor analyses. Despite the notoriously complex flow structure in fluidized beds, the approach adopted in their book describing fluidization behavior was uniquely simple; yet it contained inherent concepts of this complexity, essential to characterizing the fluid and particle flows