BOOK REVIEWS

Engineering Properties of Foods
(Food Science and Technology Series, Vol. 19)

Edited by M. A. Rao and S. S. H. Rizvi, Marcel Dekker, Inc., New York, 1968, 416 pp., $69.75 in U.S. and Canada, and $83.50 in all other countries

The editors have done an excellent job of coordinating the contributions of nine authors into a book useful for researchers, students, and practicing engineers in the multidisciplinary fields of Food Science and Technology. Readership may include agricultural, biochemical, chemical, food and mechanical engineers; food scientists and technologists; bio-, cereal and oil chemists; and biotechnologists.

The book primarily provides the definitions and theoretical background of each engineering property and methods employed in determining the property. The accuracy of these techniques is evaluated, and a value of the property for various foods is compiled reasonably. The ability to predict properties is emphasized, since extensive compilation is available elsewhere in reference books. These sources are provided in the bibliography, which is quite extensive and current.

The properties discussed include rheological properties of solid and fluid foods, thermal, colligative and mass transfer properties, thermodynamic properties related to dehydration, and dielectric properties useful in applications of microwaves for thawing and sterilization. The text is structured such that the key properties are discussed in separate chapters as follows:

Chapter 1: Rheological Properties of Fluid Foods. The flow properties of foods, with behavior ranging from Newtonian to time-dependent viscoelastic fluids, are determined as related to a variety of purposes. These include quality control, structural understanding, process engineering applications, and correlation with sensory evaluation. Characteristic models of the various rheological behaviors and the foods that fall within these classifications are discussed. Fundamental, empirical and imitative experimental methods are described. The engineering aspects of the flow of foods in piping and heat transfer systems are presented in context with sterilization processes. The rheology of doughs and the importance of rheological behavior in food extrusion are not discussed; however, appropriate references are given.

Chapter 2: Thermal Properties of Foods. The thermal properties and preferred methods of measurement are discussed. Sources of data are presented along with predictive techniques. The emphasis is on estimation techniques and establishing criteria for the applicability of specific thermal property data. Thermal conductivity, specific heat, thermal diffusivity, enthalpy, and surface heat transfer coefficients are discussed considering their importance in the design of thermal transport processes. Considered to be of less importance for design considerations, and hence not presented, are heats of adsorption, respiration, and phase transitions; coefficient of thermal expansion, dielectric constant, emissivity and absorptivity.

Chapter 3: Mass Transfer Properties of Foods. The theory of mass transfer processes is discussed briefly, with emphasis on properties important to foods. The direction is toward quantitative analysis of the various processes, thus phase equilibria, diffusion within a phase and interphase transport are discussed. Selected literature values of the appropriate properties are tabulated. Also included are important applications such as moisture transfer, diffusion of solutes, diffusion of aroma compounds, extraction, distillation and gas absorption, crystallization and packaging, pertinent to food systems. The author points out when "ideal" assumptions are valid and useful.

Chapter 4: Thermodynamic Properties of Foods in Dehydration. This chapter is good particularly for its insight into many aspects pertinent to this field. Thermodynamic properties are used to relate moisture to partial pressure in the analysis of transport phenomena to determine optimal moisture content for stable product storage and to yield theoretical minimum energy requirements. The microstructure of food materials, and interpretation of phenomenological effects at water-food interfaces are also discussed. The fundamental thermodynamic functions are described, with discussion of their origins and the assumptions made in their measurement. Practical aspects are discussed. Emphasis is on the mechanism of transport, kinetics, energy requirements and the defining of descriptors as organoleptic and nutritive values, as well as the obvious physicochemical properties.

Chapter 5: Rheological Properties of Solid Foods. The emphasis here is the role of rheological properties in the manufacture, quality control and product development of foods. The objective is to relate mechanical tests to texture, flavor and appearance, i.e., acceptability. Fundamental tests are discussed relative to modulus of elasticity, Poisson's ratio, relaxation time, shear modulus, etc. Empirical and imitative tests are discussed relative to puncture force, extrusion energy, etc. Both dynamic and quasistatic testing are discussed. Rheological modeling as viscoelastic materials using Hookean solid elements (springs) and Newtonian fluid elements (dash pots) with moduli of viscoelastic elements as functions of time is evaluated.

Chapter 6: Physicochemical and Engineering Properties of Food in Reverse Osmosis and Ultrafiltration. This chapter stresses membrane food processing, with illustrations of the fundamental principles associated with food concentration and factionation. Transport equations are presented for two models; (i) the water-preferential sorption model and (ii) the surface force-pore flow model. The appropriateness of each process and its ability to quantitatively predict performance data are evaluated. Their use for design of membrane module systems and membranes with desired pore structues, with particular concerns for the reduction of membrane fouling problems, is presented.

Chapter 7: Electrical Properties of Foods. The importance of electrical properties in the coupling and distribution of energy, i.e., heating characteristics, in high-frequency food processing is stressed. Analysis of conductive and/or radiative energy transfer from an electromagnetic field as in microwave heating and radio frequency processing is presented. The differences in the electrical and thermal response of foods to different frequency fields are discussed as related to chemical composition, physical struc-

ture, geometry and mechanism of energy transfer. Another topic is the relationship of major electrical properties of interest in thermal processing to the physicochemical basis of their dielectric behavior at high frequencies. The hindering of dipole rotation due to possible interactions of undissolved protein, lipid and ash content with free water and salts is illustrated. Predictions of dielectric behavior with models in terms of temperature, chemical composition and physical structure effects is discussed. Time-temperature profiles, integrated lethality, and nutrient retention levels are estimated, their accuracy evaluated and applicability and limitations assessed. Success is reported for various geometries for Newtonian and non-Newtonian fluids.

This text is expansive in its coverage of pertinent subjects. However more emphasis could have been directed to extrusion, supercritical fluid extraction, and packaging, as related to storage and food-package interactions. Also, the editors indicate in the preface that this book will be useful in teaching a senior level undergraduate or graduate level course. I concur with them if one uses this text as a teaching aid, not as the primary text, since there are no examples or homework problems.

Overall, I am pleased with this book. It is a valuable addition to my personal library; the references are current and directed to research in the pertinent areas.

R. J. Fisher
Biotechnology and Engineering Groups
Food Science and Mechanical
Engineering Departments
University of Delaware
Newark, DE 19716

Hydrometallurgical Extraction and Reclamation

By E. Jackson, Ellis Horwood Limited, Halsted Press, Chichester, 1986, 266 pp., $41.95

This book is intended primarily as an introductory text on hydrometallurgical extraction and reclamation for first-degree students in metallurgy, minerals extraction, materials processing and reclamation, and applied science. For some time there has been an acute need for a comprehensive, up-to-date, introductory text on hydrometallurgy; therefore, it will be welcomed by students and instructors alike. Although it will be of limited use to those working in the field of hydrometallurgy, it might be of interest to engineers from related disciplines seeking an introduction to this area. The extensive list of references provided at the end of each chapter and the final bibliography will be of particular interest to the latter group of readers.

Material is arranged to reflect the order in which the unit processes of hydrometallurgy are usually performed. The first chapter defines mineral reserves and resources, briefly discusses the importance of secondary materials, and considers the advantages of hydrometallurgical processing. The second chapter then covers the leaching of ores, concentrates and secondary materials, considering thermodynamic, electrochemical and kinetic principles, along with leaching methods and processes used in practice. The third chapter is devoted to separation, purification and enrichment processes used for treating pregnant leach and waste solutions, discussing the principles and practice of ion exchange, carbon adsorption, solvent extraction and liquid membrane processes. Precipitation processes used for purification, such as the precipitation of hydroxides and sulphides, are considered in a separate chapter, along with reductive processes such as cementation and hydrogen reduction, and precipitation methods used for recovery from waste streams. The final chapter discusses electrowinning and electrorefining, in both aqueous and molten salt media.

In general, the approach used is appropriate for the intended readers. Although it is assumed that the reader has a good grasp of basic chemistry and thermodynamics, the fundamental principles of each unit process are discussed at some length. There are occasional typographical errors that could cause confusion and the treatment of electrochemistry is rather weak. The causes and effects of galvanic interactions are muddled, and although the polarization of electrochemical reactions is discussed in the chapter of electrolytic processes at the end of the book, polarization is ignored when discussing the kinetics of electrochemical processes such as leaching and cementation. Elsewhere, however, the fundamentals are explained clearly and effectively to demonstrate the relationship between basic science and engineering applications.

The fundamental principles of each unit process are usually illustrated with practical examples. Although a text of this nature cannot be expected to be exhaustive, the examples cited do not always reflect current commercial practice. Leaching, for example, is discussed largely in terms of processes for copper and uranium, several of which were experimental or are no longer used. While this is quite understandable, given the fluctuating financial situation of the minerals industry, it is surprising that no mention is made of the leaching of zinc calcine and zinc sulphide concentrates, given the commercial importance of these processes. At times, as in the section on hydrogen reduction practice, the practical examples given are too broad, covering the whole of a commercial operation rather than the unit process under consideration, which could be confusing to a student. It might have been more effective, if individual unit processes were described succinctly and the book had a final chapter analyzing representative flowsheets.

It is commendable to include hydrometallurgical processes for treating secondary materials and recovering metals from waste solutions and effluents; students should be aware that the versatility of hydrometallurgical processes makes them ideal for these applications, which are certain to increase in importance in the future. Overall, this is a sound, well-written and very readable book that should be considered seriously by anyone teaching hydrometallurgy at the undergraduate level.

F. M. Doyle
University of California
Dept. of Materials Science and
Mineral Engineering
Hearst Mining Buiding
Berkeley, CA 94720

Drying of Solids

Edited by Arun S. Mujumdar, John Wiley & Sons, 1986, 342 plus xi pp., $39.95

DRYING OF SOLIDS is not a general text dealing with industrial drying principles and/or equipment design, operation and performance as the title might suggest. The subtitle, Recent International Developments, is more accurate. This book is a collection of 44, unreviewed, research and tutorial papers contributed from 18 countries with Canada, France, Japan, India and USSR being the primary sources. Thirty-six of the titles were listed in the initial program of the Fourth International Drying Symposium, Kyoto, Japan, 9–12 July 1984, with 17 of these titles ultimately being presented at that symposium and published in the Proceed-