BOOK REVIEWS

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Nuclear Chemical Engineering (2nd ed.)

Authors	Manson Benedict, Thomas Pigford, and Hans Levi
Publisher	McGraw-Hill Book Company, New York (1981)
Pages	1008
Price	$39.95
Reviewer	Alfred Schneider

In the aftermath of World War II, the public perceived nuclear physics as having been the prime contributor to the successful development of the atomic bomb. *Chain reaction, critical mass, fission, transmutation*, and *radioactivity* became household words and the opinions of nuclear physicists were eagerly sought in political, industrial, and social councils. With the gradual lowering of the classification barriers, it became clear that engineers played a decisive role in the realization of a project that demanded the rapid development of entirely new technologies and safety standards. The contributions of chemical engineers were particularly vital in two essential projects: the production and separation of plutonium and the enrichment of uranium. This was possible because chemical engineering, originated and developed in the United States during the first half of the century, had reached a high level of sophistication, particularly in the industrial realization of complex processes involving mass and energy transfer.

The publication in 1957 of *Nuclear Chemical Engineering* by M. Benedict and T. Pigford contributed significantly to the understanding of the fundamental as well as the technical aspects of nuclear energy. The book became an important text for students preparing for a nuclear engineering career as well as a reference for the experienced practitioner interested in better understanding the scientific bases of his endeavors.

The second edition of *Nuclear Chemical Engineering*, with H. Levi as an added coauthor, had been eagerly awaited. The authors' aim remained unchanged: to describe the materials of special importance in nuclear reactors and the processes that have been developed to concentrate, purify, separate, and safely store these materials. The rapid development of nuclear fission energy, the phasing out of earlier concepts, the emergence of new problems, the availability of powerful computational machines, and the further declassification of many early reports—all contributed to making this edition an essentially new book.

The first chapter introduces nuclear fission, identifies the materials important in nuclear technology, and shows the relation between reactors and the associated fuel cycle operations.

Chapter 2 is devoted to nuclear reactions, including an excellent quantitative treatment of the production and decay of nuclides during and following reactor operations.

Chapter 3 describes the fuel cycle for several reactor types with typical material balances and introduces the procedures used for in-core management of light water reactor fuel.

Chapter 4 treats in detail the principles and applications of solvent extraction, a separation technology widely used in the production of nuclear feed materials and in the reprocessing of spent fuel.

Separate chapters (5 through 9) systematically cover the chemical elements of special interest: uranium, thorium, zirconium and hafnium, fission products, plutonium, and other actinide elements.

The properties of irradiated fuel and other reactor materials are treated in Chap. 8.

Chapter 10, "Fuel Reprocessing," reflecting a narrowing of technical alternatives, is devoted largely to PUREX and similar solvent extraction processes. Only a brief review of the large number of processes that had been vigorously developed during previous decades is given in a section on the history of reprocessing. This chapter also contains a good introduction to criticality safety, an important but highly specialized subject.

Chapter 11, "Radioactive Waste Management," defines various radioactive wastes and surveys the technologies either in use or being developed for their management. It is noteworthy that this subject was not addressed in the first edition, an indication of the low level of concern with waste management during the earlier period of nuclear energy development.

The remaining three chapters, devoted to the separation of isotopes, treat the theories, engineering designs, and industrial applications of these processes in an excellent and balanced manner. Many details pertaining to uranium enrichment are still classified, but the authors succeed in developing meaningful descriptions and analyses from the fractional information published in the open literature.

Four appendixes contain tables of fundamental physical constants, conversion factors, properties of the nuclides, and radioactivity concentration limits for selected radionuclides. Extensive lists of references and problems follow each chapter.

This book has been found to be an excellent text for fuel cycle courses at the senior undergraduate and at the graduate levels. Most of the material is pertinent to the present nuclear industry, the clarity of presentation is outstanding, and good judgment is evident throughout in the selection of references from the vast literature in this field. The design and operational details that are provided for selected plants (e.g., the Barnwell Nuclear Fuel Plant for commercial fuel reprocessing, the French high-level waste Marcoule Vitrification Plant, the Savannah River heavy water plant, a gaseous diffusion uranium enrichment plant based on the published characteristics of a French barrier material) are particularly useful in design courses devoted to nuclear fuel cycle facilities. This reviewer missed a chapter on the chemical engineering aspects of the design and operation of nuclear power reactors (e.g., water treatments, chemical controls, hydrogen recombiners, metal-water reactions, decontamination, fission gas containment, radiation-induced reactions, etc.).

Nuclear Chemical Engineering should be of interest to a much wider group of readers than its title might imply and will certainly become a classical treatise on important aspects of nuclear energy.

Alfred Schneider, who received a PhD in chemical engineering from the Polytechnic Institute of New York, is a professor of nuclear engineering at the Georgia Institute of Technology and a past chairman, Nuclear Engineering Division, American Institute of Chemical Engineers. He has been active for 27 years in research, technical management, and education in the nuclear fuel cycle and energy conversion areas and has served as consultant to the New York State Energy Research and Development Authority, Allied General Nuclear Services, the U.S. Department of Energy, and Electric Power Research Institute.

Particle Physics and Introduction to Field Theory
(Contemporary Concepts in Physics, Vol. 1)

Author	T. D. Lee
Publisher	Harwood Academic Publishers, New York (1981)
Pages	865
Price	\$59.50 cloth bound; \$19.50 paper bound
Reviewer	Howard Grotch

This book provides a much needed contemporary addition to the long list of texts dealing with various aspects of quantum field theory and particle physics. Written by one of the most eminent theoretical physicists of our time (Nobel laureate with C. N. Yang in 1957), this is the first of a number of volumes dealing with topics at the forefront of physics research.

In the early sections of the book, Lee introduces the spin 0, spin 1/2, and spin 1 fields. He does this systematically by first discussing the classical mechanics of finite systems. After developing the Feynman rules and applying them to basic processes in quantum electrodynamics, he then devotes a sizable chapter to solitons, a topic that has been very much in vogue in recent years. Since this subject has not been discussed in texts on field theory or particle physics, it is refreshing to see a comprehensive, yet understandable, treatment, which begins with the early history of the subject. This topic completes Part I of the book, which deals primarily with field theory.

Part II of the book, which far exceeds Part I in length, deals with many aspects of particle physics. It is broken into three subsections, the first of which is a short chapter on order-of-magnitude estimates. It gives the strengths of the four fundamental interactions, discusses various lengths in physics, and considers a number of processes at high energies.

Part IIA contains eight chapters, all of which treat symmetry principles in particle physics. Many of the topics, such as isospin, SU_3, and the discrete symmetries P, C, T, are treated in standard texts, but Lee updates these topics and explains them in an interesting way.

Part IIB comprises more than half of the book. It consists of a wealth of information on interactions in particle physics. In particular, emphasis is placed on strong and weak interactions. For the former, there is a timely discussion of the problem of quark confinement and an extensive chapter on quantum chromodynamics, the field theory used to describe strong interactions. Lee's own research on color dia-electrics is treated in this section. Chapter 19 develops the path-integration method and uses this to generate Feynman rules. There is a great deal of material on the quark model of hadrons and the use of the quark-parton model to analyze high-energy scattering. This includes a discussion of the Massachusetts Institute of Technology and Stanford Linear Accelerator Center bag models. There are several chapters devoted to weak interactions. This includes the phenomenology of weak processes as well as gauge theories that unify weak and electromagnetic interactions. Chapter 24 discusses chiral symmetry. The brief concluding chapter provides some interesting comments on the present status of particle physics and future directions.

Interspersed throughout the book are suggested exercises of varying degrees of difficulty. A serious reader intent on mastering the material should attempt these exercises.

Generally, the equations in the text are well presented and the balance between mathematics and explanation is good. The only criticism I have concerns notation. Lee uses an imaginary fourth component for his four vectors. Others in this field also use this, but I believe it is more standard to use real components and to utilize a metric tensor and covariant and contravariant vectors.

Although I enjoyed reading this book and would certainly recommend it to both students and faculty in the field of high-energy physics, much of the book is probably too far removed from the area of nuclear technology to be of practical use. However, those who are interested in keeping abreast of this exciting field of physics will find that their effort is justly rewarded.

Howard Grotch is a professor of physics at The Pennsylvania State University at University Park, Pennsylvania. He is a theoretical physicist whose research encompasses a variety of topics in atomic and elementary particle physics. He is also a coauthor of a textbook, Physics for Science and Engineering.