Book Reviews

The Detection of Fissionable Materials by Nondestructive Means. By Rudolph Sher and Samuel Untermyer II. American Nuclear Society (1980). 296 pp. $49.00.

This is a compact book in which a variety of diverse aspects of a very broad field is examined. Following an introductory chapter, which explains the necessity of developing techniques for detecting fissile materials nondestructively and describes both nondestructive and destructive techniques briefly, the book contains seven additional chapters, which can be grouped into three parts. Part 1 (Chaps. 2, 3, and 4) gives nuclear properties of fissionable isotopes and discusses the detector systems and interrogation sources commonly employed in nondestructive assay (NDA) systems. Part 2 (Chaps. 5 and 6) covers the development of passive and active NDA methods. Part 3 (Chaps. 7 and 8) covers two additional topics--spiking of fissionable materials and statistical analysis of assay systems--and is somewhat different from the preceding two in that Chap. 7 is derived almost totally from a single reference and Chap. 8 is material submitted by a separate author (John Jaech of Exxon Nuclear Company, Inc.).

The topics within Part 1 are well presented, providing the reader with an adequate topical overview. This section serves as a review for those persons already familiar with radiation detectors and sources, or as a primer for nonspecialists in the field. Since the treatment of the topics within these chapters is quite brief, it is suggested that for a thorough understanding more rigorous texts on fundamental atomic and nuclear physics and radiation detection be consulted. Fortunately, the authors have included several such texts among their references.

Several tables given in Part 1 provide a condensation of information of particular interest to NDA specialists. Examples are a table that lists the properties of photoneutron sources and another table that gives spectral characteristics of moderator configurations for 14-MeV neutron sources. Because it provides specialized information as well as an overview of the physical principles involved, Part 1 serves as a handbook for those working in the NDA field.

In Part 2, descriptions of active and passive NDA systems, their principles of operation, and their relative advantages and disadvantages are well summarized within a short space. An extensive list of instruments is reviewed. In addition to those instruments and methodologies designed specifically for the assay of nuclear fuel and waste, closely related instruments such as health physics survey meters, portal monitors, portable search units, and whole-body counters are discussed, though only briefly. Despite this appearance of breadth, however, there are some notable omissions of instruments and techniques that have been documented in the current literature. For example, the book does not discuss the technique of assaying the residual fuel in fuel cladding waste by measuring gamma rays produced by fission product decay. Also there is very little discussion of instrument development work in countries other than the U.S.; for example, no mention is made of European installations that use 14-MeV neutron sources for the assay of waste and scrap. Also, there is at least one instance in which a device that is currently well developed for commercial applications is described only in terms of an outdated, prototypic model. The instrument so noted is the Segmented Gamma Scanner. The reader, therefore, should heed the authors' warning that it is not their intent to describe all instruments and techniques currently in use or under development, and, rather, should regard the NDA methodologies presented as being representative, but by no means a catalog, of all ongoing work.

In Chap. 7, the use of radioactive spiking is discussed in the context of detecting and locating fissionable materials, but not of making quantitative measurements. A comparison of gamma and neutron spikants is made and the effects of spikants on the usefulness of NDA devices is discussed.

In the concluding chapter, a brief but excellent explanation of a simple statistical model applied to NDA systems is presented along with specific examples.

The book's one Appendix gives a helpful summary of the nuclear properties of heavy elements important in NDA applications. This information, like that in Part 1, is of general help to NDA specialists.

A total of 155 references is given. Most of these are up-to-date, and almost all refer to reports, journal proceedings, and other readily obtainable documents. Many of the referenced publications have received broad dissemination, and will therefore be familiar to the reader who is a specialist in nondestructive detection. Information extracted from these references appears to be accurate and correctly presented.

As a general observation, the figures and tables, which are generously located throughout this book, are excellent from both the high quality of production and from the depth of information presented. The opposite, unfortunately, is true of the photographs, which are of substandard quality, and detract from the appearance of the contents. A minor, but confusing typesetting error was noted in two of the figures; the captions of Figs. 4-6 and 4-7 (p. 95) are interchanged.

The authors' intent, as stated in the Preface, is to summarize the most common nondestructive methods. They feel that a unification of the extensive, but fragmented information contained in reports, journal articles, and other such publications is badly needed, and this reviewer agrees. In meeting the stated intent, the book succeeds. Its primary shortcoming, however, is that it attempts to cover too broad a scope within too few pages. The treatment of many topics is too brief to be of practical help other than to provide the reader with a superficial familiarization and sufficient references through which a more in-depth understanding can be pursued. However, in a field in which the literature is comprised almost entirely of specialized reports, a book that summarizes the information and directs the reader to the appropriate documents performs a valuable service. In final consideration, therefore, of its assets and deficiencies, this book is recommended to those working in the NDA field.

Edward D. Blakeman

Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tennessee 37830

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About the Reviewer: Edward Blakeman is a member of the staff of the Instrumentation and Controls Division of Oak Ridge National Laboratory, where he is engaged in the development of nondestructive active-neutron methods for the analysis of spent nuclear fuel and of nuclear wastes. Mr. Blakeman's academic training was at the universities of Kentucky and Virginia. He came to Oak Ridge following a period at the Duke Power Company.

Numerical Heat Transfer and Fluid Flow. By Suhas V. Patankar. Hemisphere Publishing Corporation, Washington, D.C. (1980).

This book is essentially devoted to presenting what the author considers to be effective, practical, and recommendable methods for solving the set of continuity, momentum, and energy (or diffusion) equations commonly encountered in the problems of fluid flow, heat, or mass transfer. Emphasis is placed not on surveying or comparing various available techniques relevant to the subject, but on describing a carefully selected and rather restricted family of methods that the author has adopted and developed through his many years of successful computational experience in this field.

The book is well written and quite readable. The key to the simplicity of the presentation lies mainly in the author's ability to devise a unified and straightforward treatment of this rather broad and complex subject. The author points out that most of the relevant equations including the equations of continuity, momentum, energy, the turbulent kinetic energy and the conservation of a chemical species, etc. can be represented by a single generalized differential equation provided that proper meanings are assigned to the dependent variables and other symbols such as the diffusion coefficient and the source term. Main attention is then focused exclusively on constructing a general numerical method for solving this single differential equation containing an unsteady term, a convective term, a diffusion term, and a source term.

A notable feature of the book is that the description of the numerical technique is made in most cases by breaking up the generalized equation into simpler cases and illustrations are given by using very elementary examples such as one- or two-dimensional heat transfer in the Cartesian coordinates. For example, by using the simple example of steady-state, one-dimensional heat conduction containing a source term, the author was able to establish, by physical observations alone, the so-called "four basic rules" that form the guiding principles for the development of the numerical methods throughout the book. These rules are shown, whenever applicable, to predict certain crucial criteria that are well known through pure mathematical analyses.

Perhaps one of the most favorable features of the numerical technique developed in this book is that its mathematical formulation stresses the physical significance associated with it. The discretization of the differential equation, for example, is based on the idea of control volume formulation that lends itself to an easy physical interpretation. Also, in treating the equation containing both the convective and diffusion terms with a given velocity field, these two terms are combined to form a total flux, J, and, by proper reasoning, the discretized equation is finally derived in such a way that the dependent variable at a grid point of interest is related to those at the surrounding neighboring grid points through coefficients that are sole functions of the mass flow rate through the control volume surface, the directional conductance, and the grid Peclet numbers. This approach is certainly advantageous since it enables the user to gain a better understanding of the underlying physical principles that is often desirable for interpreting the computational results, thus providing adequate guidance toward obtaining physically meaningful solutions.

Although the book devotes considerable space to discussing the linearization of the source terms, the reader may still find it difficult to understand completely how to handle them properly, particularly under complex situations where several source terms of different functional relationships are present in the same equation. There are also somewhat questionable statements in the chapter discussing the solution of the momentum equation for obtaining the velocity field. It is stated that the real difficulty in the calculation of the velocity field lies in the unknown pressure field and that the way to determine the pressure field seems rather obscure. The main emphasis in this chapter is directed toward finding the pressure field such that the velocity field calculated from the momentum equation satisfies the continuity equation. Relatively minor attention is paid to emphasizing the importance for the pressure field to also satisfy the appropriate equation of state simultaneously. It should also be pointed out that since the book concentrates mainly on computational methods, relatively complex phenomena such as two-phase, supersonic, or open-channel flow, and the mathematical modeling of turbulence or combustion are virtually left untouched.

The book is comprised of nine chapters, the first three are devoted mostly to introductory and preparatory materials including the concept of "one-way" and "two-way" coordinates and their connections with the standard mathematical terminologies such as parabolic, elliptic, or hyperbolic. The main development of the numerical technique is presented in Chaps. 4, 5, and 6. At the end of Chaps. 2 through 6 there are exercise problems designed to further understanding of the materials presented in those chapters. Thorough discussions of such topics as the iterative scheme for solving coupled nonlinear equations and the source-term linearization are given in Chap. 7, together with some suggestions for computer program preparations and testing. Chapter 8 outlines some procedures for taking advantage of a one-way space coordinate and also points out the similarity between the finite-element method and the method developed in the book. The last chapter can be deemed a collection of some illustrative examples mostly taken from the author's and his coworkers' published papers. They include topics such as developing flow in a curved pipe, combined convection in a horizontal tube, melting around a vertical pipe, turbulent flow, and heat transfer in internally finned tubes and a deflected turbulent jet. Discussions are brief and they are mostly demonstrative