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.

Heat Conduction

Author	M. Necati Özisik
Publisher	John Wiley & Sons, Inc. Somerset, New Jersey (1980)
Pages	687
Price	$28.00
Reviewer	Wilhelm G. Wolfer

This book deals with the solutions of the Fourier and Laplace equations as they apply to heat conduction in solids and stationary fluids. It begins with a beautifully concise introduction to the fundamentals of heat conduction: the derivation of Fourier's law, a short list of thermal conductivities, boundary conditions, dimensionless heat conduction parameters, a very clear exposition of homogeneous and inhomogeneous boundary value problems, and short paragraphs for each of the methods of solution to be treated in subsequent chapters. The methods covered include the separation of variables, integral transform techniques, the Laplace transform, approximate analytical methods, and the finite difference method for numerical solutions. This is a nearly complete coverage of standard methods of solution. However, finite element methods and the more recent development of the boundary integral and boundary element methods are not included.

With the exception of two chapters that cover about a hundred pages, the bulk of the book is devoted to analytical methods of solution. As a result, the actual problems solved are heat conduction in solids having the shape of slabs, plates, cylinders, and spheres or spherical shells.

The organization of each chapter is superb. Usually, a short introduction tells the reader in simple words what is to follow. The method of solution is then presented and subsequently illustrated with numerous applications. These are usually cast into a concisely stated problem followed by a detailed solution. These various "Examples," as they are referred to by the author, constitute an excellent teaching aid. In fact, it is often better to go first through these examples and then read up on the method of solution in general. Some of the problems treated in these examples appear again in later chapters where they are attacked with a different method of solution. Again, the reviewer found this of great didactic value. Some of the more elaborate mathematical details are relegated to appendixes called "Notes" at the end of the chapter rather than to the back of the book. Also, each chapter has its own list of references as well as more problems to be solved by the student.

The chapters dealing with the solution of cylindrical and spherical problems by analytical means contain solutions to rather sophisticated problems, such as heat conduction in a cylindrical sector or in a composite pipe. Naturally, these solutions are then expressed in terms of eigenfunction expansions employing Bessel functions, Legendre polynomials, and the like. Unfortunately, no numerical evaluations for these solutions are presented, and the reader is left to wonder what shape the temperature distribution might have, or how many terms are really required in this expansion to obtain a result with sufficient numerical accuracy. This, the reviewer feels, is the major shortcoming of the book.

The Duhamel's theorem, the Green's function method, and the Laplace transform are covered each in one chapter. However, these methods of solution are also employed in subsequent chapters, for example, when composite media are considered.

Three of the most valuable chapters for the practicing engineer or scientist are the ones on approximate numerical methods, on phase-change problems, and on nonlinear problems. Although these chapters are relatively short, they provide a very concise introduction and demonstration of what can be done with these approaches. The reviewer has repeatedly consulted Özisik's book ever since it has been on his shelves to apply the "integral method." This method applies a simple trial function to approximate a transient temperature distribution, and it can easily be evaluated with a programmable calculator.

The chapter on numerical methods of solution covers only the finite difference method. The treatment is brief, yet adequate for simple applications.

In the next two chapters, the author returns to his eminent field, the analytical methods, and shows how the "integral transform technique" provides the general framework to solve heat conduction problems in terms of eigenfunction expansions for homogeneous and composite solids.

The last chapter deals with heat conduction in anisotropic media in which the thermal conductivity must be specified as a symmetrical tensor. And here, some confusion arises with the index notation. For Cartesian coordinates, the indices are numbers on the space variables and on the conductivity tensor. However, when the heat conduction equations are written down in cylindrical or spherical coordinates, the number index disappears on the space variables, but it is retained on the conductivity tensor. Only later on will the uninitiated reader perhaps become aware that the conductivity tensor has a very different representation in each coordinate system. This possible confusion could have been avoided by a different index notation, e.g., k_{rr}, k_{rz}, etc., instead of k_{11}, k_{13}, etc.

Although the reviewer has not read everything with a magnifying glass nor checked every equation in this book, nevertheless, during his extensive use of the book, he has not found an error or misprint. This attests to the excellent editing and printing that went into this work. The book is of the highest quality both in content and presentation of the material, and it can be highly recommended as a textbook and as a reference for the practicing engineer and scientist.

It is unavoidable to compare this book with the classic work of Carslaw and Jaeger, *Conduction of Heat in Solids*. To a large extent both books cover the same material. However, there are differences. For one, the mathematical notation in the classic book is antiquated and unfamiliar to today's readers. Second, the book by Carslaw and Jaeger stresses mathematical rigor and elegance; whereas, Özisik adopts a didactic approach in presentation. As a result, if a student or engineer needs to solve a particular heat conduction problem, Özisik shows him the way to accomplish this. On the other hand, the classic work of Carslaw and Jaeger may serve in this context more as a compendium of analytical solutions, and it requires a certain amount of skill to discover and extract the particular one that solves the problem at hand.

As a last point, Özisik has included many problems and exercises, which are an indispensible aid in learning how to solve heat conduction problems. There are no exercises in Carslaw and Jaeger. In the final evaluation, the reviewer decided that he will want to have both books on his shelves.

Wilhelm G. Wolfer received a PhD in nuclear engineering from the University of Florida in Gainesville, worked at the Westinghouse Advanced Reactor Division on the development of the liquid-metal breeder reactor, and subsequently in the Metals and Ceramics Division of the Oak Ridge National Laboratory. He is currently a professor of nuclear engineering at the University of Wisconsin and is engaged in research of radiation damage to structural material and the development of fusion reactor technology.

Safety Aspects of Fuel Behaviour in Off-Normal and Accident Conditions

(Proceedings of a CSNI Specialists Meeting, Finland, September 1-4, 1980)

Publisher	OECD Nuclear Energy Agency with the cooperation of the International Atomic Energy Agency
Pages	657
Price	$28.00
Reviewer	A. R. Wazzan

This is the *third* specialists meeting on the "Safety Aspects of Fuel Behavior in Off-Normal and Accident Conditions" to be organized by the Organization for Economic Cooperation and Development Nuclear Energy Agency (Nuclear Safety Division) with the cooperation of the International Atomic Energy Agency. The first was held in France in 1973 and the second in Norway in 1976. The present meeting assumed particular importance because of the Three Mile Island-2 (TMI-2) accident. The meeting was hosted by the Technical Research Centre of Finland.

The proceedings of the conference held in Espoo, Finland, September 1980, provide a snapshot of the current status of knowledge and the kind of analytical and experimental programs in progress with regard to fuel element behavior and associated thermal-hydraulic conditions during transients and accidents in water-cooled power reactors. Many of the accident scenarios considered appear, to a large degree, motivated by the TMI-2 accident. The bulk of the papers was presented by authors working in European establishments, although there was some representation from Japan, Canada, India, Argentina, and the United States. There were four sessions of contributed papers, plus one session that consisted of a review paper on the largely "inferred" fuel element behavior during the TMI-2 accident.

The proceedings provide a series of modest-length papers together with a record of the discussions and a final summary panel. The papers mostly represent reports of current progress rather than long-lived reviews and evaluations on major original contributions.

Session I

As a result of the TMI-2 accident, due emphasis is now being placed on the understanding of thermal-hydraulic system effects during transients and small loss-of-coolant accidents (LOCAs). The session provided an opportunity for the interaction between specialists in thermal hydraulics and fuel element behavior. Papers presented in this session dealt mostly with specific typical events. Various core uncovery scenarios were investigated. Computations are performed with many computer codes, NCRCOOL-1, RELAP4, LOOP7, BRUSEK. For example, the RELAP4-MOD6 code is used to determine the response of the primary circuit to a small break transient with system pressure higher than accumulator pressure. Other studies included fuel element response to turbine trip caused by loss of condenser vacuum with and without scram, rupture of a main steam line, double-ended guillotine break in various positions, and a host of cold-leg break sizes. A limited number of experiments are performed in support of various aspects of these transients. Results vary with postulated modes of cooling and clad deformation. It appears much progress in the understanding of fuel element response to severe and modest transients has and can be further attained by closer cooperation between code developers and thermal-hydraulic experimentalists.

Session II

The second session included a dozen papers dealing with theoretical and experimental studies in Zircaloy deformation and rupture and aimed at the development of *universal rupture criteria* for Zircaloy cladding in light water reactors (LWRs). Out-of-pile tests involving single-rod geometry and multirod environment demonstrated the importance of temperature, pressure, heating rate, and azimuthal and axial temperature distributions to ballooning and rupture of Zircaloy clad under conditions typical of off-normal operation and accidents, e.g., LOCA, anticipated transient without scram, reactivity-initiated accidents (RIA), etc. Local