first, and the same ten chapters appear. But the content has been vastly expanded and updated. The new volume contains more than one and a half times as many pages and, because of a larger page size, nearly twice the material. The extensions involve pedagogical improvements, through explanations that are more thorough, and additions of a great amount of material of basic importance, that was unavailable in 1947 when the first edition was prepared. Moreover, the new translation is excellent; it is much better than the first, which itself was reasonably good. In the new volume, particularly in early chapters, one must search carefully to find unusual English phrases (typical examples being "completely stabilized flow" instead of "fully developed flow" and "inflammation" instead of "explosion"). The editor and publisher are to be congratulated for bringing forth so readable a translation so soon after the appearance of the Russian publication.

The content reflects the interests of the author. A number of the concepts and some associated terminology are unique. The theme of transfer processes involving chemical kinetics is developed with heterogeneous reactions emphasized more than homogeneous reactions, low-speed flow much more than high-speed flow, approximate methods more than exact calculations, limiting regimes such as diffusion-controlled and kinetic-controlled behaviour more than intermediate cases, qualitative concepts such as ignition, extinction and oscillatory reactors more than detailed studies of concrete systems, theory more than experiment. Yet, there is good coverage even of most topics that are not emphasized. Because of the peculiar arrangement of material, it is difficult to find specific items in the volume; for example, discussions of carbon combustion are scattered in at least four widely separated sections. However, the excellent index helps to mitigate this difficulty. Upon starting a chapter, the reader gains little knowledge of his destination. Only after wading through detailed derivations does he discover where he has been led. The road is long but traversed gradually enough for the most backward reader to follow, if he has sufficient patience. In retrospect one finds a marked coherence to the volume, not only within chapters but often between chapters. Were Dostoevsky a technologist, I think that he would write a book like this. Even remarks and opinions that are earthy occasionally occur. The effort required to study the book will be well spent because of the improved insight that will ensue. While it is not an elementary textbook, the volume is quite instructive to the mature reader.

It may be of interest to indicate, without detailed critical comment, some highlights of the second edition. A thorough exposition and defense are presented for the author's "method of the equiaccessible surface", wherein transport and reaction are separated for the purpose of simplifying the analysis of heterogeneous kinetics. The specific techniques described can prove quite helpful to those concerned with calculating transport processes for complicated systems with heterogeneous reactions. A thorough presentation is given of the method of Laplace transforms for solving diffusion problems with various boundary conditions. Concepts concerning Stephan flow are updated on the basis of results from the near-equilibrium molecular theory of gases. All of the essential results of the exact kinetic theory for diffusion and thermal diffusion of multicomponent ideal gas mixtures are derived from the exceedingly useful elementary viewpoint of momentum conservation applied separately to each of the mutually interacting species. Analyses are given for concentration fields in both laminar and turbulent boundary layers with high Schmidt numbers. The complete basis of combustion theory is set forth succintly, with minimum computation and maximum insight. Thorough expositions are given for thermal explosion theory and for flame propagation theory with both one-step and complex kinetics. Steady-state and transient theories are developed for ignition and extinction of heterogeneous reactions. On the basis of phase-plane analyses, critical conditions are derived for the occurrence of both chemical kinetic oscillations and relaxation oscillations in a variety of closed and steady-flow reacting systems. It can be seen from this list that the book will interest those who specialize in heat and mass transfer, in combustion and in chemical engineering.

FORMAN A. WILLIAMS

Variational Principles in Heat Transfer, M. A. BIOT, 185 pp. Clarendon Press: Oxford University Press, 1970.

WHEN teaching heat and mass transfer to graduate students, instructors have often wished to have some convenient monograph on variational methods to which students can be directed. Variational methods have never occupied in heat transfer the significent role they have in classical mechanics, and it is probable that a student's introduction to variational methods comes from study in classical mechanics. This is desirable for readers who pick up this book, because Dr. Biot plunges immediately into the fundamental variational principle in heat conduction with a style and notation familiar in Lagrangian mechanics. The text is based upon about twenty papers by Dr. Biot, cited about 50 times in the 180 pages of text. Persons familiar with the original papers will find a useful reordering of the material; following the fundamental variational principle, successive chapters treat the theory of linear systems (including orthogonality and normal coordinates), operational formulation, associated fields, non-linear systems, convective heat transfer, boundary-layer heat transfer and complementary principles. An appendix sketches treatment of related subjects,including mass transport and irreversible thermodynamics. Despite the all-embracing "heat transfer" in the title, radiation is considered only peripherally.

An attraction of variational principles in physical sciences is that they provide convenient vehicles for approximate analysis, where approximations for, say, temperature distributions are written down so as to represent anticipated characteristic features of a solution in terms of a small number of parameters which take the role of generalized coordinates. Approximate solutions can be achieved quite quickly. A disadvantage is that the accuracy of such an approximate solution does not lend itself to investigation in a formal way.

The book is a personal monograph in the Oxford Mathematical Monograph series. It is concerned principally with

the mode of formulation, giving only a few examples of application and certainly no exercises suggested for the reader. The few examples of application will not dazzle the reader with their speed in comparison with better-known alternative methods of solution, and the comparison is handicapped by lack of explicit reference to the alternatives, e.g. to appropriate asymptotic solutions for small and large Prandtl number for Chapter 7; and some confusions may arise e.g. the Prandtl number in equation (6.5) on p. 135 is the reciprocal of that normally used. Persons who wish for guidance in techniques of application as well as an introduction to principles will not find it in this book. Dr. Biot has not attempted to mention all the literature in the field: for example, in the discussion of solutions for ducted flow, pp. 140–141, no mention is made of Sparrow and Siegel's work; and while finite-element methods are mentioned on p. 59 and again on p. 149, no references are cited to encourage the reader to investigate more deeply. The author index is unusual. Dr. Biot has modestly omitted there mention of his own works, but he has included names which are mentioned in the text but for which no specific works are cited, e.g. Dirac, Euler, Laplace and Reynolds.

Readers with an appropriate background will find that this book provides a unified perspective and even, perhaps, some inspiration. Instructors of graduate courses will need to provide some additional background and references in addition to suitable exercises. Technologists faced with solving problems will probably continue to make very infrequent use of variational methods.

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