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REVIEWS

Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena, Volume I. By YA. B. ZEL'DOVICH and YU. P. RAIZER. (Translation edited by W. D. Hayes and R. F. Probstein) Academic Press, 1966. 464 pp. £7. 4*s*.

Introduction to Physical Gas Dynamics. By W. G. VINCENTI and C. H. KRUGER. Wiley, 1966. 538 pp. £5. 2*s*.

The wealth of knowledge uncovered by a decade's intensive study of the physical processes governing fluid behaviour at high speeds and temperatures has presented a formidable problem of assimilation to students and practitioners alike. The appearance of these books and Hayes and Probstein's second edition of *Hypersonic Flow Theory* (see accompanying review) changes the picture substantially. This reviewer predicts that the current group of books will enjoy the same widespread use and success as achieved by the Princeton Series on *High Speed Aerodynamics and Jet Propulsion* in the 1950's and Durand's *Aerodynamic Theory* in the preceding two decades. The reason for making such a claim is simple. Heretofore, the individual encountering high temperature gas dynamic phenomena has had to become thoroughly acquainted with the substance of fields other than fluid mechanics; kinetic theory, statistical mechanics, physical chemistry, and radiative energy transfer. Each of these other disciplines evolved somewhat autonomously with its own preferred journals for communicating new research results and its own textbooks designed to meet the needs of specialists. With the appearance of these two books by Vincenti and Kruger and by Zel'dovich and Raizer, workers now have ready access to material on the portions of each field which are relevant to fluid mechanics.

Volume I of the translation reviewed here includes about half of the original Russian text by Zel'dovich and Raizer. A second volume, containing translation of the final six chapters, is expected early in 1968. Chapter I covers in slightly over 100 pages the elements of classical gas dynamics and theory of shock waves. Active researchers will already be well acquainted with this material. For teaching at the first year graduate level, however, this introduction is sufficiently thorough to make the book a fine text for a course leading on into hypersonic aerodynamics or reacting flows. Chapters II and III bring in the necessary quantum and statistical mechanics for treating problems involving thermal radiation from gases and a little on the characteristics of plasmas. The fourth chapter offers a rather sketchy summary of the theory and use of a few different types of shock tubes. One would be sorely taxed to build or even try to operate one on the basis of the material given. Chapter V treats atomic theory and atomic and molecular spectroscopy in considerable depth. Added in this revised edition is a section on breakdown in a gas due to laser beam heating. Non-equilibrium phenomena and the theory of rate processes constitutes the subject of the sixth and final chapter of this volume. The usefulness of the book is enhanced by an

extensive bibliography, an appendix giving often used physical constants, properties, and formulae, and a good subject index.

As to the translation itself, we are fortunate in having the work undertaken by two scholars who not only know the subject matter intimately but who also write clearly and accurately in the English language. Thus, the English version is free of many of the annoying and sometimes ambiguous literal translations of Russian constructions or idiomatic expressions that one encounters in some translated works. The figures, captions, and tables are attractively laid out and are located next to the text discussing them.

Vincenti and Kruger's *Introduction to Physical Gas Dynamics* is an outgrowth of several years' experience in teaching a graduate-level course on the subject to students who have previously learned compressible fluid mechanics. The first six chapters, beginning with kinetic theory and ending with steady flow through shock waves and in nozzles, cover chemical thermodynamics, statistical mechanics, and equilibrium gas properties. The authors place major stress on conveying a sense of the physical processes occurring so that the student gains some sense of the limits of validity for the expressions derived. Admirable restraint is used in discussing gas properties; the nonsensical distinction between real and ideal gases is happily absent from the pages of this book.

The pattern of alternating between a presentation of basic concepts and their application to flows proceeds with non-equilibrium chemistry (chapters 7 and 8), transport phenomena (chapters 9 and 10) and finally radiation (chapters 11 and 12). The clarity of writing and logical development of the subject matter makes this book quite usable in an unusual way. If an individual only vaguely familiar with physical gas dynamics has a particular problem, say with the possible role of bulk viscosity in fluid flow, he can enter the text (via the Index) on p. 411 and see how this phenomenon acts. If he can't understand the mechanism or what the bulk viscosity coefficient describes, references to earlier explanatory material guide him back to earlier sections. These in turn have their antecedents identified. Thus, the person seeking help can read only what he needs, rather than being compelled to study the whole book in order to understand one problem. For the student, on the other hand, who is likely to follow the front-to-back route, problem exercises are provided at each important stage in the development of the subject as a check on comprehension.

With much subject matter in common, *Physics of Shock Waves and High Temperature Hydrodynamic Phenomena* and *Introduction to Physical Gas Dynamics* nevertheless complement each other. Zel'dovich and Raizer's book has much more material on radiation transport than does Vincenti and Kruger's, while the latter provides more physical insight into the phenomena treated. Advanced students and active workers in the field will doubtless find themselves referring to both books quite regularly.

WAYLAND C. GRIFFITH

Hypersonic Flow Theory. Volume I: Inviscid Flows. Second Edition. By WALLACE D. HAYES and RONALD F. PROBSTEIN. Academic Press, 1966. 602 pp. $16.00 or £6. 12*s*.

The second edition of *Hypersonic Flow Theory* is being prepared in two volumes: the first volume treats inviscid flows; the second volume, which is still in preparation, will cover viscous and rarefied flows.

A listing of chapter headings best indicates the range of material covered in the first volume:

I. General Considerations
II. Small-Disturbance Theory
III. Newtonian Theory
IV. Constant-Density Solutions
V. The Theory of Thin Shock Layers
VI. Numerical Methods for Blunt-Body Flows
VII. Other Methods for Locally-Supersonic Flows

Although this table of contents is essentially identical with the corresponding part for the first edition, the text has been updated and expanded. Indicative of the former, half of the 380 references cited in the text were published in 1960 or later. Many of these references are from the Russian literature.

Additional material on asymmetric-, conical-, and three-dimensional flows has been provided. Extensions to include effects of non-equilibrium flows are also indicated. The treatment of hypersonic similarity has been broadened in scope. Particular attention has been given to providing a more penetrating discussion of methods for calculation of blunt-body flow fields. Towards this end, the chapters on thin shock-layer theory and on numerical methods have been considerably enlarged.

As with the first edition, this volume is devoted to the fundamentals of the theory rather than to applications. The material it contains is essential to the hypersonic aerodynamicist.

MAURICE TUCKER

Le Rôle de la Mécanique des Fluides dans les Progrès Récents des Techniques. Eyrolles, Paris, 1967. 846 pp. 216 F.

That the reviewer favours meetings with programmes such as this is shown by the fact that at least three of the Iowa hydraulics conferences with which he was associated from one to three decades ago adopted similar themes. It is impossible, of course, to cover the many fields included by the title, and hence a few related ones are best chosen for any one meeting. Seven 'Questions' were treated on the 1966 programme of the Société Hydrotechnique de France: I, Long-distance piping of fluids; II, Gas bearings and rotating seals; III, Hydraulic power transmission systems; IV, Fluid control and automation systems; V, Automobile engineering; VI, Ship engineering; and, VII, Chemical

engineering. Their relationship lay solely in their presentation of the state of the art in the industrial application of flow principles. The point of view expressed is essentially French, for very few papers were contributed by people of other nationalities.

The session on Question I consisted of nine papers on the transport of liquids, gases, non-Newtonian fluids, and two-phase mixtures, followed by three on measurement and control. Question II involved three papers on bearing operation and five on various applications including nuclear. Question III dealt with transmission characteristics (five papers) and applications (one paper on railways, three on aviation and missiles, one on locks, and one on a testing machine). Included under Question IV were two papers on automatic systems for generating plants, three for engineering plants, and one for chemical factories, and five papers on special equipment and components. Question V encompassed a paper on engine air-intake systems, another on hydraulic transmissions, six on rolling gear, brake controls, and pneumatic and hydraulic suspensions, and two on test simulators and methods. Question VI was made up of nine papers ranging from wave resistance through air-cushion craft to jet propulsion. Finally, the subject-matter of Question VII included five papers on pumping and metering, five on mixing and separation, two on evaporation and condensation, three on flow in porous media, and three on dimensional analysis and similitude. The papers themselves are rather irregular in quality, usually of a survey rather than a research nature, and often not even documented. All are in French, with English translations of their titles and abstracts.

Though not so stated, the volume appears to be a post-conference assembly of preprinted papers, for the roughly 800 pages are not numbered consecutively, and the reporters' summaries that precede the groups of papers and the discussions collected at the end are thoroughly reminiscent of the practice of presentation by title only so that sufficient time may be available at the meetings for discussion. In these circumstances it must be assumed that the material has already served its major purpose and is now published collectively merely for infrequent reference. Because the paper-bound volume is very bulky and unwieldy, the unbalanced marginal spaces are unsightly, and the lack of continuous pagination and index renders it difficult to use, the reviewer sees little future for it beyond a place in library stacks.

HUNTER ROUSE