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BOOK REVIEWS

Viscous Hypersonic Flow: W. H. DORRANCE, McGraw-Hill, New York, 1962, 97*s*.

STANDARD textbooks on heat transfer and boundary layer theory all stop short of the high-Mach-number flows which aerospace developments have made topical. The appearance of the present book therefore fills a gap that has been felt by students and teachers alike. The fact that the author has himself made notable contributions to the research literature of the subject, and is in close touch with U.S. aerospace activities, adds importance to this publishing event.

In the present context, viscous hypersonic flow means the boundary-layer flow of a chemically reacting gas mixture. The author is mainly concerned to review and present the best theories which are available for calculating drag, heat transfer and mass transfer in these circumstances. Eight of the ten chapters are directly or indirectly concerned with these problems; the remaining two provide useful introductions to the methods by which the thermodynamic and transport properties of gases may be calculated from statistical mechanics and kinetic theory.

Compared with thermodynamics, say, or heat conduction, viscous hypersonic flow is a new subject. This means that the author of a textbook on it has to make his own decisions about which are the points to emphasize and which theories, though often cited in the literature, are too idiosyncratic to be of lasting value; he has no earlier book which can serve as a model, or as a warning example. If he gives the subject a firm shape of his own, critics who prefer a different shape, or no shape at all, can find innumerable reasons for complaint; and inevitably the author will be unable to anticipate, and so remove, all the difficulties which the student will find; nor can he provide a secure foundation for every one of the next generation of developments. The reviewer therefore wishes to record his gratitude to Dr. Dorrance for writing this book; though unlikely to become a classic, it is a valuable pioneering work and will be of assistance to many, not least to future authors.

One of the difficulties about the present subject is that aerodynamics, transfer processes, and chemistry are closely intertwined in it; the individual strands have to be disentangled and examined separately, and then reunited in a manner which permits clear perception of how calculations are to be carried out. The author shows awareness of this, particularly by providing an early chapter, on surface-material-boundary-layer interactions, which includes a few pages on thermochemistry. It might be argued that he has not gone far enough in this regard. Thus some important and general results about chemical kinetics and the role of the enthalpy driving force are included in a chapter on the laminar boundary layer; yet they are applicable to the turbulent boundary layer as well, and might economically have been dealt with separately.

The treatment of the theory of the turbulent boundary layer is a particular version of the Couette-flow analysis, making use of the Prandtl form of the mixing-length theory and a density–velocity relation which takes account of the possibility of dissociation. Three criticisms might be made here: First, the doubt which attaches to any Couette-flow analysis of heat transfer in a boundary layer could have been more clearly emphasized; secondly, the reader ought to have been told that other authors have made rather different decisions about the starting point (e.g. von Kármán's mixing-length expression is favoured by many), and about how the arbitrary constants should depend upon Mach number, etc.; thirdly, Dr. Dorrance's procedure (p. 194) is such as to use numerical evaluation for the momentum-thickness quadrature, so losing the closed-form simplicity given by any one of the more popular approximate integrations, and in the next step to throw away the resultant gain in exactness by equating the local to the overall drag coefficient. Nevertheless, the author's closing remarks should be quoted. They are: "While the author is not completely satisfied with the assumptions . . . it is gratifying to note that the expressions which result agree with experiment. . . ." Such honesty is refreshing.

It is hard to judge whether novices in the subject will find this book helpful. The reviewer found it necessary to mark his copy so as to make the important equations stand out from the mere algebra in which they were often embedded; and sometimes the construction of sentences was such as to necessitate their being read through twice. Probably the reader will have to work rather harder than is usually considered proper if full benefit is to be obtained from the text. Nevertheless, such benefit can be gained; and many readers will undoubtedly feel that their effort has been well rewarded.

D. B. SPALDING

Molecular Energy Transfer in Gases: T. L. COTTRELL and J. C. MCCOURBEY, Butterworths, 1961.

THIS book is concerned with the transfer of energy between molecules during collisions in the gas phase. Except for the last chapter, attention is confined to the exchange of energy between the translational, rotational and vibrational degrees of freedom of molecules in their electronic ground states.

Information on the probability of energy transfer occurring during a collision can be obtained from measurement of the relaxation time of the gas when it is