Book Reviews

Numerical and Physical Aspects of Aerodynamic Flows III, Tuncer Cebeci, Editor, Springer-Verlag, Inc., New York, 1986, 484 pp., $49.00.

Numerical and Physical Aspects of Aerodynamic Flow III is a collection of articles based on papers presented at the third symposium bearing that name, held in Long Beach, California, in January 1985. The advertised intent of the book is "to provide a clear indication of the range of procedures available (for three-dimensional flows)..., their physical foundation, and their predictive ability." This is certainly a lofty goal, made more difficult by the rapidly changing state-of-the-art. As might be expected, the book falls short of achieving its goal. Only about one-quarter of the book pertains to three-dimensional flows; and, of that, only four articles show meaningful three-dimensional results. Another one-fourth of the book is devoted to two-dimensional unsteady flows; although time-dependency introduces a new set of physical phenomena to explore, the numerical aspects are but slightly different from those of steady two-dimensional computations.

The dominant theme of the book is viscous-inviscid interaction techniques; all but a handful of articles pertain to this subject, to the neglect of the rapidly growing capability to solve the thin-layer or full Navier-Stokes equations. Although a powerful methodology, viscous-inviscid interaction is hardly all-encompassing as to satisfy the stated purpose of this book. Indeed, the state-of-the-art in even this area is not represented well; fully three-dimensional interaction methods, which include all weak viscous-inviscid interaction effects for wings, were published over five years ago and yet were not discussed. In the review article in the beginning of the book, the editor doesn't mention the code which has become the standard for high Reynolds number airfoil computations (GRUMFOIL—of Melnik et al.).

This isn't to say that there aren't a number of interesting and worthwhile articles presented here. The review of hydrodynamic stability and transition by Stuart, delivered in memory of Keith Stewartson, is interesting reading and contains many useful references. Articles by Melnik and Brook, Drela et al., LeBalleur and Girodroux-Levigne, and Wai et al. on viscous-inviscid interaction techniques, and by Ghia et al. and Horstman et al. on Navier-Stokes solutions are also well written and describe significant developments. Many of these articles, however, appear to be quite abridged due to space limitations and have appeared elsewhere in the literature.

This book unfortunately suffers to some degree from the following problems: The goal is to show methods for three-dimensional flows, but few results are shown; interaction methods are emphasized, but their scope is not well represented. The difficulty is that this book is a limited compendium selected from the proceedings of a conference. For timely reporting of new works, the proceedings themselves are far preferable; to show the range of capability in a particular field, this format lacks cohesiveness and scope.

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Flowfield Modeling and Diagnostics, by Ashwani K. Gupta and David G. Lilley, Abacus Press, Cambridge, MA, 1985, 414 pp., $56.00.

The accurate prediction of turbulent reacting flows remains as one of the most challenging subjects in engineering science and technology. There is no text on this subject which brings together the essential fundamentals and technological issues in a way that could serve as a single comprehensive source for the subject matter involved in combustion analysis and system design. This text does not attempt to accomplish this most difficult, if not impossible, task. Rather, the book encompasses a significant segment of the state-of-the-art of modeling practical combustion systems in concert with experimental data derived through the use of appropriate intrusive and nonintrusive diagnostics.

Although the authors state that the text is intended for undergraduate as well as graduate students and practitioners, I see it as an important reference book for graduate students and others who have studied the fundamentals and have matured to a point where the advantages and limitations of current modeling and diagnostics can be appreciated. However, the book is a welcome addition to the void that exists between combustion fundamentals and practical combustion system design tools. In this context the book can serve to stimulate interest in more fundamental research or promote the development of improved models, numerical techniques, and diagnostics. Unfortunately, there is a noticeable lack of results showing predictions and comparisons with data which would help to set the direction for high pay-off developments.

Chapter 1 clearly states the challenge in understanding turbulent flows both with and without the presence of chemical reactions. The role of modeling, quantitative measurements, and flow visualization as a set of tools required by the complexity of the problem is well stated and underscores the theme of the remainder of the book.

In Chapters 2 and 3, the describing equations and predictive techniques are stated and described for certain specific problems. Although the Imperial College approach is emphasized, other contributions are cited providing the readers with a wealth of references to pursue to broaden their knowledge. The k-ϵ approach to turbulence modeling is central to the discussion while other models are briefly addressed, providing a nice hierarchical flavor to the overall presentation. Chemical kinetics modeling is discussed in a similar fashion that includes global, quasiglobal, and detailed reaction approaches for finite rate combustion and emissions chemistry. Radiation heat transfer is addressed in terms of the zone and flux model approaches. Unfortunately, improved models such as the discrete ordinates method is not discussed, while Monte Carlo techniques are passed over lightly. Again, the lack of comparisons between predictions and data, although a dearth of data exists, somewhat weakens this discussion in the book. Multiphase flow is barely touched on although here again, ample references are provided.

Chapter 4 describes, in good detail, diagnostic techniques presenting an excellent ballance between the underlying theory and the implementation of the methods that are presented. A number of methods including intrusive and non-intrusive laser-based diagnostics are discussed. Measurements for pressure, temperature, velocity, density, species concentrations and droplets/particles as well as flow visualization methods are well covered in this chapter.

Chapter 5 concludes the book with a review of problems and progress. A number of practical problems are cited with major emphasis on chemistry and too little on fluid dynamics and turbulence. Unfortunately, high-speed combustion and the unique problems encountered, for example, at hypersonic speeds in scramjet propulsion systems are not mentioned.

Overall, the book is well written. The lack of certain information, which constitute extensive areas in themselves, does not detract from the value of the book. It makes a useful addition to the few existing texts on combustion for use by combustion scientists and engineers.

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