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Book Review

Unsteady Combustion

Edited by F. Culick, M. V. Heitor, and J. H. Whitelaw, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1996, 561 pp., $275.00

The subject matter of this book is of great importance since in reality most occurrences of combustion, either accidental or intentional, are "unsteady." This book is a collection of papers presented at a NATO Advanced Study Institute on Unsteady Combustion. Thus the editors have been able to provide an international perspective on the topic, with contributions from several European countries and Japan. Traditionally, unsteady combustion is closely associated with combustion instabilities. Although the book also has this emphasis, a significant number of papers (more than half) deal with other aspects of unsteady combustion.

The book is broadly divided into three parts dealing with a) combustion-induced oscillations, b) combustion in internal combustion engines, and c) advanced tools. The first part starts with an excellent overview of the coupling between heat addition and pressure waves, which is at the heart of the problem of combustion instabilities. A good explanation of the classical Rayleigh's criterion with practical examples is provided. In another chapter, several modeling methods for the study of combustion instabilities are described, though the coverage on more recent approaches is very brief. There are also several chapters dealing with the active suppression of combustion instabilities, a topic that is very timely. Two papers discuss pulse combustors, in which unsteady combustion is exploited for increased performance and reduced pollution. In another chapter the mathematical analysis of combustion instabilities is covered extensively. At times, the first part of the book suffers from repetition of the background and some of the analytical techniques employed. Perhaps this is difficult to avoid in a book composed of papers presented at a meeting. The last chapter of the first part provides an interesting overview of NO_x emissions in aircraft engines but is somewhat out of place in a section on combustion-induced oscillations.

The second part is composed of seven papers on various aspects of both spark-ignition and diesel engines. These include basic studies such as fuel impingement on a hot surface and flame-turbulence interactions, as well as discussion of code development efforts such as in the IDEA (Integrated Diesel European Action) program. Diagnostics issues, including tools that can be used in production model spark-ignition engines because they require no machining of the head, block, or piston, are discussed in several papers. Some contributions address the overall unsteadiness or cyclic variations, whereas most others deal with inherent unsteadiness during a cycle. Overall this part of the book is a valuable contribution to the combustion literature especially because people dealing with combustion instabilities in propulsion systems do not often interact with people dealing with internal combustion engines.

The third part of the book is titled "Advanced Tools" but, except for the first article, is a discussion of the modeling of turbulent combustion. Although very informative, these chapters emphasize traditional methods and what has been achieved rather than unsteady combustion and what is needed or available to capture the effects of unsteadiness. The first paper in this section provides a good review of laser diagnostics for temperature and species measurements in unsteady combustion.

Although the book is titled *Unsteady Combustion*, the primary focus is on unsteady combustion in engines, and the book does not deal with the basic phenomena of unsteady combustion such as in flames or detonations or other practical phenomena such as fires, which are usually unsteady. More uniformity in the fonts used in the different articles and the elimination of several blank sections in the middle of articles would have enhanced the appearance of this volume. Overall, this is an unusual collection of papers dealing with unsteady combustion in engines and will be a valuable reference for a graduate student or researcher in combustion.

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