AIAA JOURNAL
Vol. 34, No. 8, August 1996

Book Reviews

Instrumentation for Flows with Combustion

edited by A.M.K.P. Taylor, Academic Press, London, 521 pp., $70.00

This book is a valuable resource for anyone studying combustion processes. For the experimentalist, it should be considered required reading. The eight chapters provide one-stop shopping on state-of-the-art instrumentation being used for measurements in combusting flows. Each topic is presented by experts who have struggled untold hours with their colleagues refining the various types of instrumentation. They provide the nonspecialist a great service by condensing their combined experience, the wide body of relevant literature, and a brief historical perspective into a highly readable up-to-date summary that explains both the how and the why of each particular measurement.

In the first chapter R. W. Bilger outlines in some detail the important combustion concepts that require advanced diagnostic techniques to advance the understanding of combustion. A concise review of recent combustion literature is followed by a short discussion of available techniques and the importance of experiment design. A brief tutorial on laminar and turbulent processes is presented, along with current modeling approaches and the measurements required to validate those calculations.

H. A. Becker gives an excellent discussion of physical probes in Chapter 2. He points out that although optical techniques are widely used, in many applications the physical probe is more than adequate. The discussion deals entirely with probes for gas sampling and provides both the theory and the practical considerations involved in the proper selection and use of this common diagnostic instrument. Because physical probes are probably the most commonly used instrument for combustion measurements, the background and examples given in this chapter are highly relevant and should not be overlooked.

Laser Doppler velocimetry (LDV) is discussed in the context of combusting flows by M. V. Heitor, S. H. Stårner, A. M. K. P. Taylor, and J. H. Whitelaw in Chapter 3. The difficulties of introducing seed particles into a combusting flow is briefly addressed, followed by more thorough discussions of the optical components and signal processing systems required for LDV. Measurements of particle size, flux, and concentration and a section on scalar-velocity correlations are reviewed before examples of LDV measurements in premixed and diffusion flames as well as gas turbine combustors are presented.

In the fourth chapter, L. P. Goss discusses coherent anti-Stokes Raman spectroscopy (CARS) as a practical engineering tool to provide precise point temperature and species concentration measurements. The chapter provides a theoretical background sufficient for the nonspecialist to consider application of the complex nonlinear technique. Practical instrumentation considerations are emphasized in the discussion, as well as the advantages of a combined CARS–LDV instrument. Flame measurements are also presented to illustrate the utility of the technique.

Light scattering for particle characterization is discussed by A. R. Jones in Chapter 5. A fundamental description of the light-scattering process is presented before a review of the general principles behind the specific methodologies. The practical considerations of integral and particle counting methods are addressed in the context of particle sizing. Several problems particular to combustion are discussed concisely, and the limitations or required conditions of each particular method are called out.

In Chapter 6 laser-induced fluorescence (LIF), in particular, planar LIF (PLIF), is discussed by J. M. Seitzman and R. K. Hanson. After a review of imaging systems and the basic considerations of laser-based two-dimensional scattering, the authors illustrate how PLIF is a modern form of flow visualization that can also provide quantitative information. An image may consist of more than a million simultaneous measurements that represent spatially precise distributions of species concentration, temperature, or velocity. There is a thorough discussion of equipment considerations, and strategies for each measurement are discussed based on work pioneered in the authors' laboratories. Presentation of the PLIF results using color contours provides striking confirmation of the utility of this powerful instrument.

M. L. Long continues the discussion of imaging techniques based on Lorenz–Mie, Rayleigh, and Raman scattering in the last chapter. As in the previous chapter, these techniques rely on a laser as a source to measure planar concentration, temperature, and density. The practical considerations associated with each scattering technique are discussed, followed by a section on high-speed imaging that allows three-dimensional (x, y, z) and even four-dimensional (x, y, z, t) measurements. Results are presented using color contours that again illustrate the detailed planar information that can be obtained in combusting flows.

Each of these chapters contains a wealth of information for the novice or seasoned researcher. By now experimentalists have realized that they need this treatise, but it is also highly relevant for all who have questions about combustion.

David S. Liscinsky
United Technologies Research Center