

A Comprehensive Look at Flame Research

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FLAME STRUCTURE AND PROCESSES

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Published by Oxford University Press, New York, 1995, 510 pp., \$97.83

I, and I suspect most people in the field of combustion, have eagerly awaited this update of Robert Fristrom and Arthur Westenberg's classic volume, *Flame Structure*. Long out of print, it has become the object of many a search for the "how-to" and "what about" aspects of flames.

In the 30 years since its first issue, literally thousands of scientific papers and reviews have been published in this field. Advances in flame and combustion research have been as diverse as in any field of scientific or engineering endeavor, posing a Herculean task for any author to capture within the bounds of a single cover. The experienced combustion community will not be disappointed with the author's effort, and many a new student will get a jump start on a career from reading this publication.

The book begins with a chapter entitled "The Science of Combustion: Its History, Scope, and Literature." In a way, it is analogous to H. G. Wells's *The Outline of History*. It covers major contributions to the field over several millennia, saving the details for later and allowing the reader to develop an appreciation for the importance of flame phenomena and the breadth of scientific accomplishment needed to develop

understanding of the topic. The second chapter, "Macroscopic Flame Behavior," examines the nature of flames, their various types, and the scientific phenomena that surround them.

The following 11 chapters are full of what we would expect from a successor to the 1965 book. Chapter III discusses burner systems. Although brief (probably due to space limitations mentioned in the acknowledgments), it is the best overview I have seen and is appropriately referenced for those seeking more detailed information. Chapter IV provides an excellent qualitative exposition on flame visualization and aerodynamics, including a variety of insights on measurement methods.

Chapter V examines the pivotal discipline of flame temperature measurements, enumerating the range of techniques developed over the years. Here, I regret the omission of a more forceful presentation of the importance of flame temperatures. The quantitative accuracy of species measurements and the validity of all flame kinetic schemes rely acutely on an accurate temperature profile. New combustion researchers would benefit from a more in-depth discussion of this topic as well as commentary on the relative precision and accuracy of the various methods. By contrast, the author provides a valuable analysis of uncertainties in the use of thermocouples and how to minimize them, presenting just what the experimentalist needs from such a resource.

Chapter VI examines composition measurements in flames, and Chapter VII (written by Owen I. Smith of UCLA) describes the use of extractive probes to obtain such data. Also included is an overview of laser diagnostics, which are used for measuring temperature, concentration, and velocity fields in flames. Both chapters offer valuable information to the new researcher and

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reassurance to the veteran. Chapter VIII covers laser diagnostics and cites 35 helpful review articles in the field.

Chapter IX sets forth the analytical methods needed to derive flame profile data from measured quantities. Whereas other combustion texts discuss the same phenomena well in conceptual or formalistic terms, readers of this chapter will find the relation to data reduction especially pleasing. Chapter X on flame processes covers the knowledge one can obtain from using the earlier-discussed measurements and mathematical reduction methods.

The remaining three chapters examine a diversity of flame types: halogen flames, common flames in which molecular oxygen is the oxidizer, and fuels ranging from "ordinary" carbon/hydrogen/oxygen composition to more complex systems. It is all too easy to be overwhelmed by the vast combustion literature, but these pages contain a wealth of information on which to confidently proceed into one's chosen research project. Of particular value (and encouragement to the

newcomer) are appendixes containing numerous tables of flame property data. The 60-page bibliography is extensive.

The unique strength of *Flame Structure and Processes* is the way it affords the reader a sense of the context and integrity of the subject, accumulated over the author's 40-plus-year career in the field. Passing on this wisdom will help free future combustion scientists from devoting excess effort on what the experts already know and will enable them to break their own new ground.

This is not to say that the book is without faults. Despite the 1995 publication date, few references from the past 10 years are included. Thus, contributions on many more recent advances are not noted. In addition, the figures, although generally informative, are of highly variable quality, and the usual number of editorial errors can be found.

Nonetheless, this is a book that all combustion researchers will want on their shelves. I am pleased that it is on mine.