Preface

Reactive fluids are present in many situations of great importance, such as in combustion chambers or around spacecraft re-entering the atmosphere. Analyzing the flow properties of such fluids represents one of the most difficult challenges to current technology. Indeed, all of the most difficult aspects of fluid mechanics appear to be grouped together in this research field! Such fluids are complex mixtures with compositions that vary rapidly in time and space. They are not usually at thermodynamic equilibrium, since the reaction times of the chemical reactions involved may not be negligible in comparison with the transit time of the fluid. However, the author of this book limits its scope to typical phenomena that are not very far from local equilibrium but can nevertheless exhibit the most important types of irreversible processes. The production of entropy is highly dependent on the chemical reaction pathway, which is difficult to simplify. Also, most of the classical problems that characterize fluid mechanics—such as turbulence, the presence of thin boundary layers or shear layers, and the propagation of acoustic waves and shock waves—are also present, and are much more difficult to analyze and describe than they are for homogeneous fluids, because reactive mixtures interact with these phenomena. For example, density is highly dependent on the chemical pathway since it is determined by the local and instantaneous production of chemical species, and so its value affects many other quantities through the equation of state and the balances of mass, momentum, and energy.

This book is a remarkable and quite pedagogical synthesis. It presents all of these problems in a logical and systematic way, step by step in the different chapters, without going into the complexities of the very many particular classes of them. Indeed, the author pays more attention to general concepts and to guiding ideas (thus justifying the formulation of a very general theory) than to combining them for particular applications. To be able to follow the text, the reader should understand mathematics to the level required for most graduate courses in fluid mechanics. This involves a knowledge of classical techniques such as multiple-scale analysis and matched asymptotic expansions, but without the need to dwell on their mathematical justification.
Dimensional analysis is proposed as a systematic and powerful tool for reducing the general set of equations to the relevant formulation for a given class of phenomena, and a list of the most important nondimensional numbers is given.

It was a true pleasure to look through this text, noting its good organization and reading some of the chapters and paragraphs in depth. I am convinced that readers of the book—it is aimed at graduate students as well as experienced scientists or engineers—will find an abundance of useful resources, and some will definitely keep it on their desk.

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