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Book review

Combustion Science and Engineering, K. Annamalai, I.K. Puri. CRC Press/Taylor & Francis Group, Boca Raton, FL (2007). 1117 pp., Price: US$ 109.95, ISBN: 978-0-8493-2071-2

This book is the eighth in the CRC Press series in Computational Mechanics and Applied Analysis. It is intended basically to be a text for engineering students who in the future will face combustion problems that involve consideration of pollution control and energy efficiency. To address the foregoing uses, engineers will need to be familiar with the fundamental theories, and mathematical and physical concepts of combustion. This book will provide that knowledge and more.

In the first seven chapters (listed below), the authors outline the thermodynamic basis of thermochemistry and chemical equilibrium, describe solid, liquid and gaseous fuels, review chemical kinetics and mass transfer and conclude this comprehensive section with a discussion of applications of the foregoing theory to practical systems. These chapters are as follows:

- Introduction and review of thermodynamics
- Stoichiometry and thermochemistry of reacting systems
- Reaction direction and equilibrium
- Fuels
- Chemical kinetics
- Mass transfer
- First Law applications

Beginning with Chapter 8, the authors enter into detailed discussion of differential forms of conservation equations; analysis of fuel combustion including jet combustion and boundary layer problems; ignition; flame propagation; pollutant formation; etc. The titles of these 11 chapters are as follows:

- Conservation relations
- Combustion of solid fuels, carbon, and char
- Diffusion flames—liquid fuels
- Combustion in boundary layers
- Combustion of gas jets
- Ignition and extinction
- Deflagration and detonation
- Flame propagation and flammability limits
- Interactive evaporation and combustion
- Pollutants formation and destruction
- An introduction to turbulent combustion

I was particularly interested in Chapter 17 as it addresses environmental concerns with combustion systems' emissions of traditional pollutants as well as carbon dioxide. Discussed are emissions of carbon monoxide, nitrogen oxides, sulphur dioxides, particulate (especially PM10), mercury and organics such as (formaldehyde and polycyclic aromatic hydrocarbons). Air pollution impacts, such as the formation of photochemical smog, the greenhouse effect, and acid rain are briefly discussed as are the US laws (Clean Air Act). Even carbon dioxide sequestration is introduced.

To describe the contents of this exceedingly comprehensive text, I paraphrase and condense the authors' notes in the preface as follows:

Chapter 1, contains an outline of the corpuscular aspects of thermodynamics; Chapter 2, discusses the stoichiometry, thermochemistry, and the first law for closed and open systems in mass and molar forms; Chapter 3, criteria for the direction that chemical reactions proceed in are developed; Chapter 4, introduces the background related to properties of solid, liquid, and gaseous fuels; Chapter 5, presents the chemical kinetics for homogeneous and heterogeneous reactions and the pyrolysis of solid fuels, and a discussion on second law when multistep and global kinetics are used; Chapter 6, briefly discusses mass transfer processes and transport properties relevant to combustion; Chapter 7, deals with applications of the global forms of energy and mass conservation equations for simple ignition problems, combustion of gaseous fuels in closed systems (e.g., automobile engines) plug flow reactors and perfectly stirred reactors; the resistance concept is introduced for the combustion of solid and liquid fuels; Chapter 8, presents the conservation relations in differential form for mass, momentum, energy and species for single and two component fuels; Chapter 9, applies the conservation equations to a simple spherically symmetric problem of carbon combustion; Chapter 10, deals with liquid droplet combustion including evaporation and combustion of multicomponent drops; Chapter 11, presents the solutions for combustion within boundary layers for forced, free, and stagnation flows; Chapter 12, extends the solutions obtained in the previous chapter to the combustion of gaseous fuels involving 2D and circular laminar jets; Chapter 13, introduces ignition and extinction during gaseous and solid fuel combustion; Chapter 14, describes limiting flame propagation speeds at subsonic (deflagrations) and minimum supersonic velocities (detonations) of premixed fuels; Chapter 15, discusses the concept of a kinetically limited laminar burning velocity and flammability limits for combustible mixtures; Chapter 16, deals with interactive

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array and cluster combustion; whereas Chapter 17, describes pollution formation and control methods and describes various methods of reporting emissions; Chapter 18, discusses turbulent combustion and various computational approaches.

Additional features of the book include 50 pages of formulae and more than 300 student problems, 400 references, 100 figures, and 150 worked examples. There is no doubt regarding the comprehensive coverage of the topic in this book which, I believe, will be well received by the academic and professional communities.

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