

CONTENTS

A. FUNDAMENTALS

I CHEMICAL THERMODYNAMICS

0. Introduction and Nomenclature
1. Mass Conservation and Stoichiometry
2. First Law of Thermodynamics
3. Thermochemistry and Energy Conservation
4. Second Law of Thermodynamics
5. Equilibrium.
6. Chemical Equilibrium
7. Properties of a Mixture of Perfect Gases
8. State of a Reacting System, Non Equilibrium
9. Equilibrium for a Chemical Reaction
10. Van't Hoff's Equation
11. Minimizing Free Energy, the Element Potential Method
12. Equilibrium Composition of Combustion Products

II CHEMICAL KINETICS

1. Rate of Reaction of Elementary Reactions.
2. Reversible Reactions.
3. Chain Reactions.
4. Comprehensive Kinetics Scheme.
5. Chain Branching and Explosion.
6. Kinetics of Hydrocarbon Oxidation
7. Steady State and Partial Equilibrium.
8. Reduced and Overall Mechanisms.
9. Reaction Time Constant.
10. Integration of Kinetics Schemes, Chemkin.
11. Chemical Kinetics of Pollutant Formation

III TRANSPORT PROCESSES, TRANSPORT EQUATIONS AND KINEMATICS OF FLUID MOTION

1. Simple Kinetic Theory of Gases
2. Transport Phenomena
3. Velocity Distribution Function
4. Computation of Transport Coefficients
5. Diffusion Velocity
6. Diffusion of Energy
7. Conservation Principles
8. Species Conservation
9. Momentum Equation
10. Conservation of Energy

11. Kinematics: Deformation and Strain
12. Normalization and Low Mach Number Model
13. Vorticity Dynamics
14. Application of Computational Methods

B SOLUTIONS

IV COMBUSTION IN SPATIALLY GASEOUS MIXTURES (Chemically Controlled Phenomena)

- 0 Introduction
- 1 Classification of Combustion Processes
- 2 Reaction Rate at High Activation Energy
- 3 Spontaneous Thermal Ignition; Steady State Analysis
- 4 Spontaneous Thermal Ignition; Unsteady Analysis
- 5 Spontaneous Chemical Ignition
- 6 Unified Theory of Vessel Explosion
- 7 Well Stirred Reactor Theory
- 8 Well Stirred Reactor, Computation

V LAMINAR COMBUSTION IN NON-PREMIXED GASES (Transport controlled phenomena)

- 1 Preliminaries
 - 2 Flame Structure and Kinetic Rates
 - 3 One D. Unsteady Flames
 - 4 The Laminar Reacting Shear Layer
 - 5 Mixture Fraction Analysis of Diffusion Flames
 - 6 Burke-Schumann Flame
 - 7 Laminar Jet Diffusion Flames
 - 8 Finite-Rate Chemistry effects
 - 9 Unsteady Flame Strained in Its Own Plane
 - 10 Steady strained flames. Asymptotic Expansion
 - 11 Non-premixed Combustion in an Arbitrary Flow
- Appendix: Integration of Reaction-Diffusion Equation

- VI LAMINAR COMBUSTION IN PREMIXED GASES
(Transport-Chemistry balanced Phenomena)
- 0 Introduction
 - 1 Phenomenological Analysis
 - 2 Two-zone Model
 - 3 Detailed Theory Based on Asymptotic Methods
 - 4 Numerical Evaluation of The Eigenvalue
 - 5 The Burning Velocity, Detailed Chemistry and Transport
 - 6 Forced Ignition, Quenching and Flammability
 - 7 Laminar Flame Stabilization
 - 8 Effect of Strain Rate on Flame Speed
 - 9 Curvature Effects on Flame Speed
 - 10 Hydrodynamic Instability of Premixed Flames
 - 11 Numerical Treatment of Premixed Flames
 - 12 Experimental Determination of Burning Velocity

- VII DETONATION WAVES
(gas dynamics-controlled phenomena)
- 1 Hydrodynamic analysis of Combustion Waves
 - 2 Supersonic Waves (Detonation)
 - 3 Detonation Wave Structure (ZND)

C. ADVANCED SOLUTIONS

- VIII MULTI-PHASE COMBUSTION
- 1 Droplet evaporation and combustion
 - 2 Spray Combustion
 - 3 Combustion of Pulverized Coal
- IX. INTRODUCTION TO TURBULENT COMBUSTION
- 1 Scales and Similarity Parameters in Turbulent Combustion
 - 2 Phenomenological Approaches in Premixed Turbulent Combustion
 - 3 The distributed Reaction Zone Model
 - 4 The wrinkled Laminar Flame Theory
 - 5 Averages, Closure, Constants and all that
 - 6 Large-Scale Structures, Entrainment, Diffusion and Mixing
 - 7 Effect of Combustion on the Flow
- X SUPERSONIC COMBUSTION
- 1 Supersonic Mixing
 - 2 Supersonic Premixed Combustion
 - 3 Supersonic Non-premixed Combustion

XII COMBUSTION INSTABILITY AND NOISE

- 1 Review of Acoustics
- 2 Noise in Ducts
- 3 Rayleigh Criterion
- 4 Noise Suppression

XIII FIRES