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Maximilian Lackner, Árpád B. Palotás
and Franz Winter

Combustion

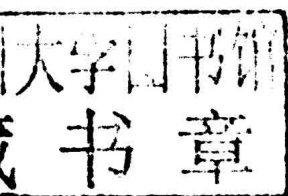
From Basics to Applications



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Combustion

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Foreword

Combustion is a fascinating process which has been quite instrumental in civilization and industrialization. From the hearth fire and cooking stove, via techniques for ore smelting, glass blowing and porcelain making, to steam engines, cars and power plants, combustion has accompanied the history of humankind. Now, in a situation where global warming and air quality deterioration are associated with combustion-generated carbon dioxide and pollutants, it is at the same time important to provide access to affordable but clean and sustainable energy. Combustion as mature technology still dominates today's power generation and transportation, and it is used in a number of important industrial processes and applications. Many professions, trades and businesses are linked to combustion, and many people world-wide depend on their work for car and aircraft manufacturers, for the petroleum, cement or steel industry or even as safety engineers and firefighters. This global situation is not likely to be changed rapidly, in spite of considerable effort to replace fossil by renewable energy, regarding the increase in world population and the desire to raise living standards and productivity accordingly. Combustion thus shows its Janus face today with promises of high-density fuels for an energy-hungry and mobile society on the one hand and threatening pictures of smog-polluted megacities without blue skies on the other.

It is thus time for the present volume as a summary and introduction to combustion fundamentals and applications for the more generally interested reader, including students and practitioners. With a fundament in physics and chemistry, modern concepts of combustion are presented in the necessary detail for a broad overview, without an excess of detail, in coherent and comprehensible fashion. The book provides a clear structure with seven Chapters, starting with some historical facts and interesting details in Chapter 1. The second Chapter introduces fuels with respect to their important properties and physico-chemical characteristics, accompanied by useful tables and literature. With Chapter 3, the fundamental principles of combustion are provided in an instructive form with some illustrative and facile calculation examples. The reader is introduced to the concepts of stoichiometry, the conservation equations and transport processes as well as to the basics of chemical reaction mechanisms and ignition processes. Pollutants are characterized in Chapter 4, which mainly gives some classifications and describes the main sources for specific emissions. For a more in-depth understanding of the different categories

of pollutants and their chemical formation and destruction pathways, readers are referred to relevant original literature. The very important aspect of carbon dioxide formation from combustion processes and concepts for carbon dioxide management are presented in Chapter 5. The next Chapter is very instructive regarding the typical technical environments in which combustion is encountered, and it explains many interesting features of combustion devices including those found in heating, power generation, transportation, and in certain industries. As a modern concept, combustion and gasification are seen as somewhat related subjects, with a short access also to gasification strategies. The book concludes with important safety aspects, especially also regarding industrial-scale applications.

In a timely manner, the book offers an overview on an introductory level, and in this respect, it will be useful to a broad community. Certainly, huge tomes could be written for each subject treated in these Chapters, and substantial reviews and literature exists on individual facets of combustion – as for example, conventional and bio-derived fuels, combustion kinetics or specific combustion systems and applications. For a field that is as complex as that of combustion, a guided tour – as in the present case – is helpful to not lose orientation! I wish that you, the reader, may find combustion, not only at a candle-light dinner or for a barbecue, a fascinating object for study, in spite or because of the many challenges presented by its use. I also hope that by understanding the fundamental principles and limitations of combustion better, the community might find suitable replacement strategies for the systems in use today to contribute to a more efficient and cleaner energy use in the near future.

Bielefeld, April 2013

Prof. Dr. Katharina Kohse-Höinghaus

Preface

Combustion, the source of comfort and fear, warmth as well as devastation, has always fascinated mankind. It has been and still is one of the most important and most widely used technologies. In 2010, the authors published the “Handbook of Combustion” [1], a five-volume reference work that was very well received by the scientific community. Soon the idea was born to distill the knowledge from the approximately 3200 pages into a digestible textbook for students.

This book is designed to be a compilation of up-to-date knowledge in the field of combustion in a way that even a reader from a different field of expertise can understand the basic principles and applications. The purpose of this textbook is to provide an introduction to combustion science and technology, spanning from fundamentals to practical applications. It deliberately does not dwell too much on the details, although the book aims at providing the necessary knowledge for those wishing to move further into the various sub-disciplines, such as energy efficiency, oxyfuel combustion, gasification, pollutant reduction, or combustion diagnostics.

This book is written not only for undergraduate and graduate students of chemistry, chemical engineering, materials science, engineering and related disciplines, but also for practitioners in the field.

Topics covered are:

- History of combustion
- Fuels
- Combustion principles
- Environmental impacts
- Measurement methods
- Applications
- Safety issues

Each chapter can be studied independently. For further reading, web resources are suggested at the end of each chapter.

The authors are proud to present this textbook and hope that it will serve many technicians, scientists and engineers throughout their studies and careers.

Vienna, June 2013

M. Lackner, Á. B. Palotás, F. Winter

Reference

- 1 Lackner, M., Winter, F., and Agarwal, A.K. (eds) (2010) *Handbook of Combustion*, Wiley-VCH Verlag GmbH, Weinheim, 978-3527324491.

Contents

Foreword *XIII*

Preface *XV*

1 History of Combustion 1

1.1 Introduction 1

1.2 Timetable 3

1.3 Outlook 10

1.4 Web Resources 15

References 15

2 Fuels 19

2.1 Introduction 19

2.2 Gaseous Fuels 19

2.2.1 Density 21

2.2.2 Specific Heat Capacity 21

2.2.3 Molar Weight 22

2.2.4 Gas Constant 23

2.2.5 Thermal Conductivity 23

2.2.6 Viscosity 23

2.2.7 Heating Values 24

2.2.8 Ignition Temperature 25

2.2.9 Ignition Limits 26

2.2.10 Laminar Flame Velocity 26

2.2.11 Wobbe Index 27

2.2.12 Methane Number 28

2.3 Liquid Fuels 29

2.3.1 Chemical and Physical Characteristics 30

2.3.2 Sulfur Content 30

2.3.3 Ash Content 31

2.3.4 Water Content 31

2.3.5 Carbon Residue 31

2.3.6 Density and Specific Gravity 31

2.3.7 Viscosity 32

2.3.8	Pour Point	32
2.3.9	Cloud Point	32
2.3.10	Flash Point	33
2.4	Solid Fuels	33
2.4.1	Origin of Solid Fuels	34
2.4.2	Biomass	35
2.4.3	Waste or Opportunity Fuels	36
2.4.4	Coal	36
2.4.5	Peat	37
2.4.6	Solid Fuels Characterization	37
2.4.7	Proximate Analysis	38
2.4.8	Ultimate Analysis	39
2.4.9	Physical Properties	41
	References	41
3	Combustion Principles	43
3.1	Basic Combustion Calculations	43
3.1.1	Determination of the Quantity of Normal and Oxygenated Air Necessary for Complete Combustion	43
3.1.1.1	Air Requirement of Gaseous Fuels	43
3.1.1.2	Air Requirement for the Combustion of Liquid and Solid Fuels	45
3.1.1.3	Calculations for the Case of Oxygenated Air	47
3.1.2	Calculation of the Volume and the Composition of the Flue Gas	47
3.1.2.1	Flue Gas of Gaseous Fuels	47
3.1.2.2	Combustion Products of Liquid and Solid Fuels	48
3.1.2.3	The Effect of Oxygen Enrichment	49
3.1.2.4	Effect of Temperature and Pressure (Ideal Gas Law)	49
3.1.2.5	Determination of the Actual Excess Air Factor	50
3.1.3	Determination of the Combustion Temperature	51
3.1.4	Heating Values	55
3.1.5	Laminar Flame Velocity	56
3.2	Heat-, Mass- and Momentum Transport and Balance	57
3.2.1	Transport	57
3.2.2	Mass Transport	58
3.2.2.1	Diffusive Mass Transport	58
3.2.2.2	Convective Mass Transport	58
3.2.3	Mass Transfer	59
3.2.4	Heat Transport	60
3.2.4.1	Heat Conduction	60
3.2.4.2	Thermal Radiation	61
3.2.5	Heat Transfer	64
3.2.6	Momentum Transport	65
3.2.7	Balance	67
3.2.7.1	Mass Balance	67
3.2.7.2	Heat Balance	68

3.2.7.3	Momentum Balance	69
3.3	Elementary Reactions and Radicals	69
3.3.1	Elementary Reactions	69
3.3.2	Reaction Rates	70
3.3.3	Temperature Dependence	71
3.3.4	Collision Theory	72
3.3.5	Three-Body Reactions	73
3.3.6	Chemical Equilibrium	74
3.3.7	Gibbs Enthalpy	74
3.3.8	Radicals	75
3.3.9	Development and Analysis of a Set of Reactions	76
3.3.10	Simplification of a Set of Reactions	78
3.4	Ignition	79
3.4.1	Introduction	79
3.4.2	Autoignition	79
3.4.3	Induced Ignition	80
3.4.4	Theoretical Models for Ignition	82
3.4.5	Explosives	83
3.4.6	Flammability Limits	84
3.4.7	Minimum Ignition Energy	85
3.4.8	Quenching and Maximum Experimental Safe Gap (MESG)	85
3.4.9	<i>p</i> T Explosion Diagram	87
3.4.10	Ignition Delay Time	89
3.4.11	Ignitability	90
3.4.12	Octane Number	91
3.4.13	Cetane Number	92
3.4.14	Ignition in Various Combustion Devices	93
3.4.15	Undesired Ignition	94
	References	95

4 Environmental Impacts 97

4.1	Pollutants: Formation and Impact	97
4.1.1	Introduction	97
4.1.2	Description of Most Relevant Pollutants	98
4.1.2.1	Unburnt Hydrocarbons (UHC)	98
4.1.2.2	CO	99
4.1.2.3	NO _x	100
4.1.2.4	SO ₂	102
4.1.2.5	Dioxins	102
4.1.2.6	Particulate Matter (PM)	103
4.1.2.7	Soot	106
4.1.2.8	Ash	110
4.1.2.9	Alkali Metals	110
4.1.2.10	Heavy Metals	111

4.1.3	Concepts for Pollutant Reduction	112
4.1.4	Summary	117
4.1.5	Web Resources	118
4.2	Combustion and Climate Change	118
4.2.1	Introduction	118
4.2.2	Primary Energy Production	120
4.2.3	Combustion and Global Warming by Sectors	120
4.2.4	Mitigation of Global Warming in the Context of Combustion	121
4.2.4.1	Energy Efficiency	121
4.2.4.2	Reduction of CO ₂ Emissions	123
4.2.4.3	Use of Renewable Fuels	123
4.2.4.4	Other Measures Against Climate Change	126
4.2.5	Carbon Sequestration	126
4.2.6	Web Resources	128
	References	130
5	Measurement Methods	137
5.1	Introduction	137
5.2	<i>In Situ</i> versus <i>Ex Situ</i> Measurements	139
5.3	Fuel Characterization	140
5.3.1	Proximate and Ultimate Analysis	140
5.3.2	Thermal Analysis (TGA/DSC)	141
5.3.3	Ash Melting	142
5.3.4	Laminar Flame Speed	144
5.4	Investigation of Combustion Processes	144
5.4.1	Selection of Non-optical Methods	145
5.4.1.1	Suction Probe Coupled with GC/MS	145
5.4.1.2	Hot Wire Anemometry	146
5.4.1.3	Thermocouple	147
5.4.1.4	Gas Potentiometric Sensors	147
5.4.1.5	Paramagnetic Analyzer for O ₂	148
5.4.2	Selection of Optical Techniques	149
5.4.2.1	Chemiluminescence	149
5.4.2.2	Schlieren Photography	150
5.4.2.3	Non-Dispersive Infrared Spectrometer	150
5.4.2.4	Fourier Transform Infrared Spectrometer	151
5.4.2.5	Laser-Induced Absorption Techniques	153
5.4.2.6	Laser-Induced Emission Techniques	157
5.4.2.7	Laser-Induced Scattering Techniques	159
5.4.3	Particle Diagnostics	162
5.4.4	Spray Diagnostics	162
5.4.5	Other Techniques	164
5.4.6	Test Beds	164
5.4.6.1	Open Flames on Laboratory Model Burners	164

5.4.6.2	Combustion Bombs	168
5.4.6.3	Shock Tubes	168
5.4.6.4	Optical Engines	169
5.4.6.5	Pilot Plants	171
5.4.6.6	Combustors Placed on a Test Rig	172
5.4.6.7	Industrial Furnaces with Optical Access Ports	172
5.4.7	Advanced Combustion Control	174
	References	176
6	Applications	185
6.1	Burners	185
6.1.1	The Evolution of Combustion Processes	185
6.1.2	The Flame	185
6.1.3	Fuel Preparation, Pre-Processing	186
6.1.4	Requirements of a Burner	187
6.1.5	Burner Classification by the Fuel Used	188
6.1.6	Burner Categories	189
6.1.6.1	Classification Methods for Gas Burners	189
6.1.6.2	Generalized Classification of Gas Burners	191
6.1.7	Burner Control, Automation	193
6.1.8	Flares	193
6.1.9	Categorization of Oil Burners	195
6.1.10	Atomization of the Fuel	196
6.1.11	Mixed Fuel and Alternative Burners	197
6.2	Industrial Boilers	198
6.2.1	Firing Systems for Steam Generation	200
6.2.2	Fixed Bed Combustion	202
6.2.3	Fluidized Bed Combustion (FBC)	206
6.2.3.1	Bubbling Fluidized Bed Combustion (BFBC)	207
6.2.3.2	Circulating Fluidized Bed Combustion (CFBC)	208
6.2.3.3	Dust Firing	210
6.2.4	Summary of Combustion Technologies for Boilers	212
6.3	Industrial Technologies	213
6.3.1	Characteristics of Industrial Heating Installations and Furnaces	213
6.3.2	Metal Industry	214
6.3.2.1	Shaft Furnaces	214
6.3.2.2	Aluminum Melting Furnaces	214
6.3.2.3	Crucible Furnaces	216
6.3.2.4	Annealing and Heat Treatment Furnaces	216
6.3.3	Ceramic Industry	218
6.3.3.1	Glass Melting Furnaces	218
6.3.4	Furnaces Used in Various Industries	220
6.3.4.1	Cylindrical Rotary Kilns	220
6.3.4.2	Chamber Furnaces	221

6.3.4.3	Indirectly Fired Chamber Furnaces	221
6.3.5	Heat Treatment Systems, Heat Treatment Furnace Plants	222
6.3.5.1	Complex Heat Treatment Systems	222
6.3.5.2	Continuous Heat Treatment Furnace Plants	223
6.3.6	Petroleum Industry Tube Furnaces	223
6.3.7	Internal Combustion Engines	223
6.3.7.1	Introduction	223
6.3.7.2	Four-Stroke Engines	224
6.3.7.3	Two-Stroke Engines	225
6.3.7.4	Spark Ignition Engines	226
6.3.7.5	Compression Ignition Engines	227
6.3.7.6	Cycle Analysis and Key Parameters	228
6.3.7.7	Ideal Air Standard Otto Cycle	229
6.3.7.8	Ideal Air Standard Diesel Cycle	230
6.3.7.9	Engine Emissions	231
6.3.8	Gasification and Pyrolysis	231
6.3.8.1	Introduction to Gasification and Industrial Applications	231
6.3.8.2	Fuel Conversion During Gasification	232
6.3.8.3	Gasification Chemistry and Reactions	234
6.3.8.4	Gasification Technologies	235
	References	239
7	Safety Issues	241
7.1	Introduction	241
7.2	Fundamentals	241
7.3	Fire Classes	243
7.4	Working Mechanism of Fire Extinguishing Media	244
7.5	Fire Detectors	245
7.6	Deflagrations and Detonations	245
7.7	Dust Explosions	247
7.8	Legal Framework: Example of ATEX in Europe	248
7.9	Preventing and Mitigating the Effect of Explosions in Industry	252
7.10	Aspects of Preventive Fire Protection	253
7.10.1	Flame Retardants Containing Phosphorus	253
7.10.2	Flame Retardants Based on Hydroxides of Al and Mg	254
7.10.3	Organic, Halogen-Containing Compounds	254
7.10.4	Intumescence-Based Systems	254
7.11	Fire Suppression by Oxygen Reduction	255
7.12	Safety by Process Design	255
7.13	Other Important Terms Related to Fire Safety	256
7.13.1	Flashover	256
7.13.2	Loss-of-containment and Fires	256
7.13.3	Flammable Substance Release	257
7.13.3.1	Boiling Liquid Expanding Vapor Explosion (BLEVE) and Vapor Cloud Explosion (VCE)	257

7.13.4	Burning Index (Danger Class, Rating)	258
7.13.5	K Value (K_G , K_{ST})	258
7.13.6	Dust Explosion Class	258
7.13.7	Explosion Pressure	259
7.13.8	Limiting Oxygen Concentration (LOC)	259
	References	260

Index	261
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