

Contents

Preface.....	V
Contents	VII
Nomenclature	XI
1 Introduction.....	1
1.1 Modeling of Combustion Processes	1
1.2 Direct Injection Combustion Engines.....	3
2 Thermodynamic Models	5
2.1 Thermodynamic Fundamentals	5
2.2 Single-Zone Cylinder Model	6
2.2.1 Mass and Energy Balances.....	6
2.2.2 Mass Fluxes	8
2.2.3 Mechanical Work.....	12
2.2.4 Wall Heat Transfer.....	14
2.2.5 Heat Release by Combustion	16
2.2.6 Ignition Delay	21
2.2.7 Internal Energy.....	23
2.3 Two-Stroke Scavenging Models.....	28
2.4 Empirical Two-Zone Combustion Model.....	32
2.5 Typical Applications.....	35
2.5.1 Heat Release Analysis.....	35
2.5.2 Analysis of Complete Power Systems	35
References	37
3 Phenomenological Models	41
3.1 Classification	41
3.2 Heat Release in Diesel Engines	43
3.2.1 Zero-Dimensional Burning Rate Function	43
3.2.2 Free Gas Jet Theory	47
3.2.3 Packet Models	57
3.2.4 Time Scale Models.....	67
3.3 Gas Composition and Mixing in Diesel Engines.....	72
3.3.1 Two-Zone Cylinder Models	72
3.3.2 N-Zone Cylinder Models	75

3.3.3 Packet Models.....	76
3.4 Advanced Heat Transfer Models.....	77
3.4.1 Heat Transfer Mechanisms	77
3.4.2 Convective and Radiative Heat Transfer Model.....	78
3.5 SI Engine Combustion.....	88
3.5.1 Burning Rate Calculation.....	88
3.5.2 Gas Composition.....	91
3.5.3 Engine Knock.....	92
References	96
4 Fundamentals of Multidimensional CFD-Codes	101
4.1 Conservation Equations.....	101
4.2 Numerical Methodology.....	104
4.3 Turbulence Models.....	109
4.4 Boundary Layers and Convective Heat Transfer.....	112
4.5 Application to In-Cylinder Processes	116
References	117
5 Multidimensional Models of Spray Processes.....	119
5.1 General Considerations	119
5.1.1 Spray Processes in Combustion Engines	119
5.1.2 Spray Regimes	120
5.2 The Spray Equation	122
5.2.1 Equations and Exchange Terms	122
5.2.2 Numerical Implementation.....	124
5.3 Droplet Kinematics.....	126
5.3.1 Drop Drag and Deformation	126
5.3.2 Turbulent Dispersion / Diffusion	128
5.4 Spray Atomization.....	130
5.4.1 Breakup Regimes	131
5.4.2 Wave-Breakup Model.....	135
5.4.3 Blob-Injection Model.....	137
5.4.4 Turbulence and Cavitation Based Primary Breakup Model.....	139
5.4.5 Sheet-Atomization Model for Hollow-Cone Sprays	146
5.5 Secondary Droplet Breakup.....	153
5.5.1 Drop Breakup Regimes.....	153
5.5.2 The Reitz-Diwakar Model	154
5.5.3 The Taylor-Analogy Breakup Model.....	155
5.5.4 The Kelvin-Helmholtz Breakup Model.....	158
5.5.5 The Rayleigh-Taylor Breakup Model	159
5.6 Droplet/Droplet and Spray/Wall Interactions	161
5.6.1 Droplet Collision and Coalescence	161
5.6.2 Spray-Wall Impingement.....	165
5.7 Fuel Evaporation	171
5.7.1 Droplet Evaporation.....	172
5.7.2 Multi-Component Fuels	174

5.7.3 Flash Boiling	180
5.8 Grid Dependencies	181
5.8.1 Problem Description	181
5.8.2 Reduction of Grid Dependencies	183
References	186
6 Multidimensional Combustion Models	193
6.1 Combustion Fundamentals	193
6.1.1 Chemical Equilibrium	193
6.1.2 Reaction Kinetics	196
6.1.3 Reaction Mechanisms for Hydrocarbon Flames	198
6.1.4 Combustion Regimes and Flame Types.....	202
6.2 Ignition Processes	205
6.2.1 Ignition Fundamentals.....	205
6.2.2 Autoignition Modeling.....	209
6.2.3 Spark-Ignition Modeling	213
6.3 Premixed Combustion	222
6.3.1 The Flamelet Assumption	222
6.3.2 Eddy-Breakup Models	222
6.3.3 Flame Area Evolution Models	224
6.3.4 The Fractal Model.....	227
6.4 Diffusion Combustion	228
6.4.1 The Characteristic Time Scale Model.....	228
6.4.2 Flamelet Models.....	230
6.4.3 pdf-Models.....	238
6.5 Partially Premixed Combustion in DISI Engines	241
6.5.1 Flame Structure	241
6.5.2 A Formulation based on Lagrangian Flame Front Tracking	242
6.5.3 A Formulation based on the G-Equation.....	246
References	249
7 Pollutant Formation.....	255
7.1 Exhaust Gas Composition.....	255
7.2 Nitrogen Oxides.....	257
7.2.1 Reaction Paths.....	257
7.2.2 Thermal NO	258
7.2.3 Prompt NO	260
7.3 Soot.....	261
7.3.1 Phenomenology.....	261
7.3.2 Semi-Global Mechanisms	264
7.3.3 Detailed Chemistry Mechanisms	269
References	271
8 Conclusions	275
Index.....	279



<http://www.springer.com/978-3-540-00682-4>

Modeling Engine Spray and Combustion Processes

Stiesch, G.

2003, XV, 282 p., Hardcover

ISBN: 978-3-540-00682-4