

Table of Contents

1	Introduction	1
1.1	Introduction	3
1.2	Motivation of the study	3
1.3	Objectives of the study	5
1.4	Approach and contents of the study	5
1.5	Structure of the document	6
	Bibliography	8
2	Combustion processes in diesel sprays	11
2.1	Introduction	13
2.2	Classical description of diesel combustion phases	13
2.3	Review of the relevant processes during inert spray evolution	14
2.3.1	Atomization of the liquid fuel	15
2.3.2	Mixing and air entrainment	16
2.3.3	Spray evaporation	20
2.4	Review of the relevant processes during the reacting spray evolution	22
2.4.1	Ignition delay	23
2.4.2	Premixed combustion	24
2.4.3	Mixing-controlled combustion	25
2.5	Sequence of the spray processes under engine conditions	28
2.6	Effects of the fuel properties on the spray processes	32
2.7	Outlook	34
	Bibliography	36
3	Experimental and theoretical tools and methodological approach	41
3.1	Introduction	43
3.2	Experimental facilities	43
3.2.1	2-Stroke optical engine	43

3.2.2	High Pressure High Temperature Vessel	45
3.3	Optical techniques applied	47
3.3.1	Mie-scattering	47
3.3.2	Schlieren	48
3.3.3	Broadband radiation	48
3.3.4	OH* Chemiluminescence	49
3.4	1D Spray model for multicomponent fuels	50
3.4.1	General model description	51
3.4.2	State relationships	55
3.4.3	Validation of the liquid-vapour equilibrium	59
3.A	Appendix: Equation of state	65
	Bibliography	67
4	Fuel effects on mixing and evaporation under inert conditions	69
4.1	Introduction	71
4.2	Optical setup	71
4.3	Test conditions and fuel selection	72
4.4	Model calibration with single-component fuels	76
4.5	Studies with binary blends	80
4.6	Studies with a diesel surrogate	91
4.6.1	<i>n</i> -Hexadecane as a diesel surrogate	93
4.7	Normalization of the spray vapour penetration	96
4.8	An engineering correlation for the stabilized liquid penetration	98
4.9	Recapitulation and Synthesis	100
4.A	Appendix: Experimental and correlated liquid length values	103
	Bibliography	111
5	Fuel effects on auto-ignition and combustion	113
5.1	Introduction	115
5.2	Experimental setup	115
5.3	Test conditions and fuel selection	117
5.4	Studies under inert conditions	119
5.5	Analysis of the baseline case	121
5.6	Spray tip penetration	125
5.7	Ignition delay time	131
5.8	Flame lift-off length	134

5.8.1	Relationship between lift-off length and ignition delay time	137
5.9	Flame broadband radiation	139
5.9.1	Relationship between broadband radiation and lift-off length	141
5.9.2	Transition to non-sooting diffusion flame	142
5.10	Stabilized flame length	143
5.10.1	Scaling law for stabilized flame length	146
5.11	Recapitulation and Synthesis	148
	Bibliography	151
6	Conclusions and future work	155
6.1	Introduction	157
6.2	Conclusions	157
6.2.1	Mixing and evaporation under inert conditions	157
6.2.2	Auto-ignition and combustion	159
6.3	Future work	161
	Bibliography	163