

Table of contents

1. Objectives and methodology	1
1.1 Motivations	4
1.2 Objectives	5
1.3 Methodology	6
Chapter 1 Bibliography	9
2. State of the art	11
2.1. Introduction	14
2.2. Air pollution and regulation.....	16
2.3. Pollutant formation.....	25
2.4. After-treatment systems	29
2.5. EGR.....	29
2.5.1. Definition and objective	29
2.5.2. EGR and PM-NOx trade-off	30
2.5.3. Strategies (HP EGR and LP EGR)	31
2.5.4. Advantages and disadvantages	32
2.5.5. New standards: Low temperatures and transient cycles.....	32
2.6. Modeling approach	33
2.6.1. Filling and emptying models.....	34
2.6.2. Wave action models	35
2.6.2.1. Method of the Characteristics.....	35
2.6.2.2. Conservative centered schemes	35
2.6.2.3. Upwind schemes and Riemann solvers	36
2.6.2.4. High resolution schemes	38
2.6.3. Multidimensional models	39
2.7. HP EGR dispersion	40
Chapter 2 Bibliography	43
3. Methodology	55
3.1. Experimental setup	58
3.2. 1D modeling.....	75
3.3. Metrics definition	86
Chapter 3 Bibliography	91

4. Results and discussion.....	95
4.1. Influence on engine performance	98
4.1.1. Determination of the reasonable EGR dispersion levels	98
4.1.2. Assessment of constant input values.....	103
4.1.3. Influence on opacity of exhaust gases	111
4.1.4. Influence on fuel consumption.....	125
4.1.5. Influence on the IMEP	132
4.1.6. Influence on the exhaust gases composition	135
4.1.7. Dimensionless opacity	138
4.2. 1D model performance	143
4.2.1. Model assessment.....	143
4.2.2. Influence of the manifold layout modeling	148
4.2.3. Influence of wave dynamics	150
4.2.4. Influence of the size of the manifold	158
4.2.5. Results with controlled EGR dispersion	161
4.2.6. Model sensitivity to EGR rate variations	168
4.2.7. 1D engine model performance	173
Chapter 4 Bibliography	185
5. Conclusions and future work	187
5.1. Introduction	190
5.2. Conclusions	190
5.3. Future work.....	195
Chapter 5 Bibliography	197
Bibliography.....	201