

Contents

1	Introduction	1
1.1	Background	1
1.2	Motivation	5
1.3	Research Objectives and Scope	8
1.4	Research Methodology	11
1.5	Thesis Outline	16
2	Literature Review	19
2.1	Theoretical Framework	19
2.2	Background	25
2.2.1	Automotive Acoustics	25
2.2.2	After-treatment Systems	28
2.3	Historical Evolution of Studies in Atfertreatment Systems	34
3	Materials and Methods	39
3.1	Studied Devices: Exhaust Systems	39
3.1.1	Devices in detail	40
3.1.2	Preparations required	53
3.2	Experimental Test Facilities and their usage	54
3.2.1	Pressure Drop Measurement: Cold Flow Test Bench	54
3.2.2	Acoustic Characterization: Impulse Test Rig . .	61
3.2.3	Analysis of reflective and dissipative effects . .	71
3.2.4	Engine-like Condition Validation: Unsteady flow gas stand	77
3.2.5	Soot loading of devices	81
3.3	Modelling and Computational Tools and Approaches .	82
3.3.1	Programs and tools used	83

3.3.2	Previous Steps for Modelling	86
3.3.3	CAD Handling	104
3.3.4	3D Approach	107
3.3.5	1D Approach	114
3.3.6	1D-3D Coupled Simulation Approach	118
4	Significance of Cold Condition Measurements to actual in-engine conditions	121
4.1	Introduction	121
4.2	Background	123
4.3	Assessment Procedure	125
4.4	Results and Discussion	134
5	Case study on a complete SCR exhaust line with static swirl mixer	141
5.1	Introduction & Background	141
5.2	Assessment of individual devices containing monoliths .	144
5.3	The overlooked effect of auxiliary devices	160
5.4	Assessment of combined devices	183
5.5	Assessment of additivity or interactions	198
6	Assessment of Individual After-treatment Devices	211
6.1	Introduction & background	211
6.2	Devices with flow-through monoliths, bends and irregular geometries	215
6.3	Devices with wall-flow monoliths	232
6.4	Comparative analysis of results	250
6.5	The very early life of GPF	256
6.6	Validation of the developed 1D methodology on most complex devices	268
7	Conclusions and Future Work	291
7.1	Conclusions	291
7.2	Future Works	311
	Bibliography	312