

Table of Contents

1	Introduction	1
1.1	Explosively driven dispersion	1
1.2	Objective and structure of the thesis	4
I	Blast Propagation in an Urban Environment	7
	Nomenclature	9
2	Part I - Introduction	11
3	Theory and Literature Survey	15
3.1	Theory on explosions	15
3.2	Blast wave propagation in air	18
3.3	Blast wave scaling	24
3.4	Investigations on the blast propagation	29
3.5	Conclusion	32
4	Experimental Methodology	33
4.1	Safety	33
4.2	Experimental setup	35
4.3	Condensed-phase explosives	38
4.4	Pressure measurements	45
4.5	Optimization of the experimental system	48
4.6	Conclusion	51
5	Numerical Methodology	53
5.1	Solver and modeling	53
5.2	Discretization and solution procedure	54
5.3	Initial conditions	55
5.4	Boundary conditions	56
5.5	Tested configurations	58
5.6	Conclusion	58

6	Experimental Results	59
6.1	Propagation in free field	59
6.1.1	Geometry and repeatability of the explosives	60
6.1.2	Experimental TNT equivalent	67
6.1.3	Hopkinson scaling law	70
6.1.4	Comparison with numerical results	70
6.2	Propagation in a complex environment	73
6.2.1	Scaling factor	73
6.2.2	Effects of a straight street	74
6.2.2.1	Experimental results	74
6.2.2.2	Numerical results	78
6.2.3	Effects of the building height	80
6.2.4	Effects of a T junction	82
6.2.4.1	Experimental results	82
6.2.4.2	Numerical results	86
6.2.5	Effects of a cross junction	88
6.2.6	Blast reflections on streets	90
6.2.7	Effects of the channeling configuration	91
6.2.7.1	Experimental results	91
6.2.7.2	Numerical results	94
6.2.8	Hopkinson scaling law applied on straight streets	95
6.3	Propagation inside a confined environment	97
6.4	Conclusion	99
7	Part I - Conclusion	101
 II Explosively Driven Dispersion in an Urban Environment		103
Nomenclature		105
8	Part II - Introduction	109
9	Theory and Literature Survey	111
9.1	General overview	111
9.2	Early stage dispersal	113
9.3	Advanced stage dispersal	119
9.4	Experimental techniques to characterize the dispersion	120
9.5	Conclusion	126
10	Experimental Methodology	127
10.1	Experimental set-up for techniques validation	127
10.1.1	Near-field investigation of a subsonic jet	128
10.1.2	Near and far-field investigation of a supersonic jet	130
10.2	Experimental environment for the explosively driven dispersion	134

10.2.1	Safety	134
10.2.2	Experimental setup	135
10.2.3	Atmospheric boundary layer	140
10.2.4	Test repeatability	144
10.2.5	Effect of a confined environment on measurements	147
10.2.6	Urban environment	147
10.3	Image processing methodology	148
10.3.1	Contour-based image processing	148
10.3.1.1	Contour detection	148
10.3.1.2	Contour expansion velocity	148
10.3.1.3	Plume position	150
10.3.1.4	Dispersion area	151
10.3.2	Large-Scale Particle Image Velocimetry	151
10.3.3	Mie-Scattering technique	154
10.4	Conclusion	158
11	Experimental Results	159
11.1	Investigation on LS-PIV and Mie-Scattering	159
11.1.1	Large-scale particle image velocimetry	160
11.1.1.1	Validation on a fictive displacement	160
11.1.1.2	Validation on an under-expanded supersonic jet	162
11.1.2	Mie-Scattering technique	169
11.1.2.1	Light absorption compensation	169
11.1.2.2	Validation on a subsonic jet in near field	179
11.1.2.3	Tests on an under-expanded supersonic jet	182
11.1.2.4	Limits of the technique	187
11.1.3	Conclusion	191
11.2	Investigation on the explosively driven dispersion	192
11.2.1	Preliminary considerations	192
11.2.2	Free field - dispersion analysis	197
11.2.2.1	Effect of the detonation energy	197
11.2.2.2	Effect of the wind	200
11.2.2.3	Effect of the powder mass	205
11.2.2.4	Concentration maps	210
11.2.3	Dispersion inside a T-configuration	219
11.2.3.1	Effect of a street	219
11.2.3.2	Effect of the powder	221
11.2.3.3	Effect of the wind	224
11.2.3.4	Concentration maps in a straight street	226
11.2.4	Scaling factor	229
11.2.5	Conclusion	230
12	Part II - Conclusion	233

13 General Conclusion and Perspectives	235
13.1 General conclusion	235
13.2 Perspectives	238
13.2.1 Experimental perspectives	238
13.2.2 Numerical perspectives	238
References	241