

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Pressure and thrust oscillations in a segmented solid rocket motor . . . .	1
1.2	Flow–acoustic coupling . . . . .	2
<b>2</b>	<b>Modeling approaches</b>	<b>5</b>
2.1	Acoustic balance . . . . .	5
2.2	Theoretical model of the flow–acoustic coupling in presence of an inhibitor	11
2.3	Modeling of a resonant design in radial injected flow . . . . .	14
2.3.1	Stability criterion for the SVS . . . . .	14
2.3.2	Receptivity criterion . . . . .	16
2.3.3	Stability criterion for the OVS . . . . .	16
2.3.4	Vortex advection and resonance . . . . .	18
2.4	Theoretical model of the effect of the nozzle cavity volume on the resonance level . . . . .	19
2.4.1	The vortex–sound theory . . . . .	19
2.4.2	Application to a booster geometry . . . . .	21
<b>3</b>	<b>Cold flow experiments</b>	<b>25</b>
3.1	Axial injected flow configuration . . . . .	26
3.1.1	Experimental set-up . . . . .	26
3.1.2	Example of flow–acoustic coupling . . . . .	28
3.1.3	The nozzle design effect . . . . .	31
3.2	Radial injected flow configuration . . . . .	35
3.2.1	Experimental set-up . . . . .	35
3.2.2	Investigation of the SVS instability . . . . .	37
3.2.3	Investigation of the OVS/SVS instability . . . . .	37
3.2.4	Interpretation . . . . .	41
<b>4</b>	<b>Numerical simulations</b>	<b>44</b>
4.1	Overview of the numerical tool CPS . . . . .	44
4.1.1	Basic Equations . . . . .	45
4.1.2	Spatial discretization of the inviscid part . . . . .	45
4.1.3	Spatial discretization of the diffusive parts . . . . .	46
4.1.4	Time integration . . . . .	47
4.1.5	Boundary conditions . . . . .	48
4.2	Cold flow simulations . . . . .	48
4.2.1	Methodology of the numerical approach . . . . .	48
4.2.2	Axial flow configuration . . . . .	53
4.2.2.1	Simulation with the submerged nozzle . . . . .	53
4.2.2.2	Influence of the nozzle geometry . . . . .	63
4.2.3	Radial flow configuration . . . . .	67
4.2.3.1	Investigation of the SVS instability . . . . .	68
4.2.3.2	Investigation of the OVS/SVS instability . . . . .	72
4.3	Test case: solid rocket motor . . . . .	76

4.3.1	LP2-C1x computations . . . . .	76
4.3.2	The C3 test case . . . . .	76
4.3.2.1	2D results . . . . .	77
4.3.2.2	3D results . . . . .	77
4.4	State of the art of the full-scaled simulation . . . . .	83
4.4.1	Fluid structure coupling . . . . .	84
4.4.2	Effects of aluminum combustion . . . . .	84
<b>5</b>	<b>Conclusions</b>	<b>86</b>
	<b>Bibliography</b>	<b>91</b>