
Contents

Certificate of approval	i
Certificate	iii
Declaration	v
Curriculum vita	vii
Acknowledgements	ix
Contents	xi
List of figures	xiv
List of tables	xix
Nomenclature	xx
Abstract	xxv
1 Introduction and literature review	1
1.1 Literature survey	1
1.1.1 Cavity flow driven by single lid	2
1.1.2 Cavity flow driven by parallel lids	8
1.2 Objective and scope of the present study	9
1.3 Organization of the thesis	11
2 Numerical details	13
2.1 Mathematical formulation	13
2.2 Subgrid-scale models	16
2.2.1 Standard subgrid-scale model	16
2.2.2 Dynamic subgrid-scale model	17
2.3 Computational domain and boundary condition	20
2.4 Discretization scheme and method of solution	23
2.5 Summary	27

3	Cavity flow driven by single lid	29
3.1	Introduction	29
3.2	Averaged velocity profiles at the mid-planes	31
3.3	Second-order turbulent statistics at the statistical symmetry plane	35
3.4	Characterization of turbulence	36
3.5	Time histories at the maximum of turbulence production	45
3.6	Power spectra at the maximum of turbulence production	48
3.7	Conclusion	50
3.8	Summary	51
4	Cavity flow driven by two parallel lids moving in opposite directions	53
4.1	Introduction	53
4.2	Averaged velocity vector and stream traces at the statistical symmetry plane	54
4.3	Averaged velocity vector at the different locations of y-z planes	60
4.4	Transient behavior of corner eddies at statistical symmetry plane	62
4.5	Second-order turbulent statistics at statistical symmetry plane	66
4.6	Characterization of turbulence	68
4.7	Time histories at the maximum of turbulence production	76
4.8	Power spectra at the maximum of turbulence production	78
4.9	Conclusion	79
4.10	Summary	82
5	Cavity flow driven by two parallel lids moving in same direction	83
5.1	Introduction	83
5.2	Averaged velocity profiles at the statistical symmetry plane	86
5.3	Averaged velocity profiles at the mid-plane ($z = 0.5$)	88
5.4	Second-order turbulent statistics at the statistical symmetry plane	89
5.5	Second-order turbulent statistics at the mid-plane ($z = 0.5$)	92
5.6	Swirling and shearing zones at the statistical symmetry plane	93
5.7	Coherent structures at the statistical symmetry plane	94
5.8	Averaged turbulent properties	95
5.9	Time histories and power spectra at the maximum of turbulence production	99
5.10	Conclusion	103
5.11	Summary	104
6	Summary, conclusions and suggestions for future work	105
6.1	Summary and conclusions	105
6.2	Suggestions for future work	107

Bibliography