

Contents

List of Figures	xiii
Preface	xv
1 Introduction	1
1.1 Background	1
1.1.1 Linear and Nonlinear Waves	1
1.1.2 Hyperbolic system of PDEs	2
1.1.3 The Riemann Problem	5
1.1.4 Dusty Gas	8
1.1.5 Chaplygin Gas	11
1.2 Motivation	12
1.3 Literature Review	15
1.4 Aims and Thesis Objectives	19
2 Solution of generalized Riemann Problem for hyperbolic p-system with damping	21
2.1 Introduction	21
2.2 Differential constraint method	24
2.3 Exact solution	26
2.4 Generalized Riemann Problem	29
2.5 Conclusion	32
3 Riemann solutions to the Logotropic system with a Coulomb-type friction	33
3.1 Introduction	34
3.2 Riemann solution of modified homogeneous system	36
3.2.1 Rarefaction wave solution	38
3.2.2 Shock wave solution	41
3.3 Conclusions	50

4 Delta shock wave solution of the Riemann Problem for the non-homogeneous modified Chaplygin gasdynamics	53
4.1 Introduction	54
4.2 Riemann Problem for modified system	57
4.3 Riemann Problem for the original system (4.1)	71
4.4 Conclusions	79
5 The Phenomena of Concentration and Cavitation in the Riemann Solution for the Isentropic Zero-pressure Dusty Gasdynamics	81
5.1 Introduction	82
5.2 Delta - shocks and vacuum states for the system (5.4)	86
5.3 Solution of Riemann Problem (5.5) and (5.6)	89
5.3.1 Smooth solution	90
5.3.2 Bounded discontinuous solution	92
5.4 Concentration in Riemann solution to (5.5) and (5.6) under flux approximation	96
5.4.1 Limiting behavior of the solution of Riemann Problem as α_1, α_2 tends to 0	96
5.4.2 Delta - shock wave	98
5.5 Cavitation in Riemann solution to (5.5) and (5.6) under flux approximation	102
5.6 Conclusions	104
6 The propagation of shock wave in planar and non-planar polytropic reacting gas with dust particles	107
6.1 Introduction	108
6.2 Governing equations and its characteristics	111
6.3 Shock waves in characteristic plane	114
6.4 Amplitude of the disturbance	116
6.5 Results and discussion	118
6.6 Conclusions	126
7 Summary and Future scope	129
7.1 Overall Summary	129
7.2 Future Scope	132
Bibliography	135
List of Publications (SCI/SCIE)	153

List of Figures

1.1	Structure of the Riemann solution for a system of conservation laws.	8
3.1	The (ϱ, u) phase plane for the model (1).	43
3.2	Solution structure of system (3.1) and (3.2) for case I.	47
3.3	Solution structure of system (3.1) and (3.2) for case II.	48
3.4	Solution structure of system (3.1) and (3.2) for case III.	49
3.5	Solution structure of system (3.1) and (3.2) for case IV.	50
4.1	The (ϱ, u) phase plane for the model (4.6).	63
4.2	The Riemann solution to the system (4.1) and (4.2).	72
4.3	Delta shock wave solution to the Riemann Problem (4.1) and (4.2) for (a) $\eta > 0$ and (b) $\eta < 0$.	74
5.1	Structure of the Riemann solution for $v_- < v_+$.	87
5.2	Characteristic analysis of delta shock.	87
5.3	The (ϱ, v) phase plane for the model (1).	95
6.1	Variation in compressive wave for planar case with $Z_0 = 0.001, \gamma = 1.4, \delta = -0.1, \beta = 0.5$ and $k_p = 0.2$.	119
6.2	Variation in compressive wave in reacting and non-reacting gas for planar case with $Z_0 = 0.001, \gamma = 1.4, \delta = -0.1, \beta = 0.5$.	119
6.3	Variation in expansive wave for planar case with $Z_0 = 0.001, \gamma = 1.4, \delta = 0.1, \beta = 0.5$ and $k_p = 0.2$.	120
6.4	Variation in expansive wave in reacting and non-reacting gas for planar case with $Z_0 = 0.001, \gamma = 1.4, \delta = 0.1, \beta = 0.5$.	120
6.5	Variation in compressive wave in reacting gas for cylindrically symmetric case with $Z_0 = 0.001, \gamma = 1.4, \delta = -1, \beta = 0.5$.	122
6.6	Variation in expansive wave in reacting gas for cylindrically symmetric case with $Z_0 = 0.001, \gamma = 1.4, \delta = 0.1, \beta = 0.5$.	123
6.7	Variation in compressive wave in reacting gas for spherically symmetric case with $Z_0 = 0.001, \gamma = 1.4, \delta = -1, \beta = 0.5$.	124
6.8	Variation in expansive wave in reacting gas for spherically symmetric case with $Z_0 = 0.001, \gamma = 1.4, \delta = 0.1, \beta = 0.5$.	124
6.9	Compressive wave in reacting gas with dust particles with $k_p = 0.2, \gamma = 1.4, \delta = -1, \beta = 0.5$ and $\Theta = 0.2$.	125

6.10 Expansive wave in reacting gas with dust particles with $k_p = 0.2, \gamma = 1.4, \delta = 0.5, \beta = 0.5$ and $\Theta = 0.2$.	126
--	-----