

LIST OF CONTENTS

Title	Page No.
List of Figures	xiii-xvii
List of Tables	xviii
List of Symbols	xix-xxii
List of Abbreviations	xxiii-xxiv
PREFACE	xxv
1 INTRODUCTION	1-7
1.1 Introduction to the Problem	2
1.2 Aims and Objectives	5
1.3 Organisation of the Thesis	6
2 LITERATURE SURVEY	8-56
2.1 Flow Regime	9
2.1.1 Homogeneous Flow or Bubbly Flow Regime	9
2.1.2 Heterogeneous Flow Regime	9
2.1.3 Slug Flow Regime	10
2.2 Use of Dimensionless Numbers	11
2.2.1 Effect of Sparger Geometry on Gas Holdup	21
2.2.2 Effect of Fluid Properties on Gas Holdup	22
2.3 Gas-Liquid Mass-transfer Coefficient (k_{LA})	27
2.4 Bubble diameter	33
2.5 Specific Interfacial Area	35
2.6 Measurement Techniques for Bubble Behaviuor	43

2.6.1 Visualization Techniques	43
2.6.1.1 High Speed Photography (HSP)	43
2.6.1.2 Dynamic Gas Disengagement Technique	45
2.6.2 Probe Techniques	45
2.6.2.1 Optical Probe	46
2.6.2.2 Resistivity Probe	46
2.6.2.3 Conductivity Probe	46
2.6.2.4 Capillary Suction Probe	47
2.6.3 Cross Sectional Wire Mesh (CSWM)	47
2.6.4 Laser Doppler Anemometry	48
2.6.5 Pressure Fluctuation	48
2.6.6 Particle Image Velocimetry(PIV)	49
2.6.7 Tomography	50
2.6.7.1 X-Ray Computed Tomography (XRCT)	50
2.6.7.2 Optical Tomography (OT	51
2.6.7.3 Ultrasonic Computed Tomography(UCT)	51
2.6.7.4 Gama Ray Computed Tomography (GRCT)	51
2.6.7.5 Electrical Resistance Tomography (ERT)	52
2.6.7.6 Electrical Impedance Tomography (EIT)	52
2.6.7.7 Electrical Capacitance Tomography (ECT)	53

2.6.7.8 Electrical Capacitance Volume Tomography	53
2.6.8 Radiography	53
2.6.9 Acoustic Emission	53
2.7 Objective of the present work	56
3 EXPERIMENTAL SETUP AND PROCEDURES	57-66
3.1 Experimental Set-Up	57
3.2 Physical Properties of the System	60
3.3 Experimental Procedure	62
3.3.1 Single Bubble Experiments	62
3.3.2 Bubble Column Study	63
3.4 Acoustic Signal Analysis	64
3.5 Mass Transfer Studies	65
3.5.1 Titration method	65
3.5.2 DO Meter Method	66
4 RESULTS AND DISCUSSION	67-128
4.1 Single Bubble studies	67
4.1.1 Visual Observation	67
4.1.2 Acoustic measurements	69
4.2 Acoustic Signal in Bubble Column	71
4.2.1 Analysis of Acoustic Signal	71
4.3 Bubble Size Distribution (BSD)	73
4.3.1 BSD for Distilled Water	75
4.3.1.1 Effect of U_g	76
4.3.1.2 Effect of H_s	78

4.3.1.3 Effect of Z	79
4.3.2 BSD for Ethylene Glycol solution	81
4.3.2.1 Effect of U_g	82
4.3.2.2 Effect of H_s	83
4.3.2.3 Effect of Z	83
4.3.3 Bubble-Size Distribution for air/CMC Solution (aq.) system	85
4.3.3.1 Effect of U_g	86
4.3.3.2 Effect of Z	87
4.3.3.3 Effect of H_s	87
4.3.3.4 Effect of Concentration	87
4.3.4 BSD for NaOH solution	90
4.3.4.1 Effect of U_g	91
4.3.4.2 Effect of Z	91
4.3.4.3 Effect of H_s	91
4.3.4.4 Effect of Concentration	93
4.4 Statistical Analysis of Bubble Size Distribution	94
4.4.1 Variance, σ , for air-water system	96
4.5 Sauter-mean bubble diameter	100
4.5.1 Effect of H_s on d_{32}	100
4.5.2 Effect of Z on d_{32}	102
4.5.3 Air-Ethylene Glycol soln. System	103
4.5.3.1 Effect of Z on d_{32} :	104

4.5.3.2 Effect of H_s on d_{32}	104
4.5.4 Sauter-Mean Bubble Diameter for Air/aq. CMC Soln	106
4.5.4.1 Effect of H_s on d_{32}	106
4.5.4.2 Effect of Z on d_{32} :	107
4.5.4.3. Effect of Concentration of CMC on d_{32}	108
4.5.5 Air-NaOH soln. system	109
4.5.5.1 Effect of Z	109
4.5.5.2 Effect of H_s	110
4.5.5.3 Effect of NaOH conc	110
4.6 Gas holdup	111
4.7 Specific interfacial area, a_i	113
4.7.1 a_i for air-water system	113
4.7.1.1 Effect of Z on a_i	113
4.7.1.2 Effect of H_s on a_i	115
4.7.2 Specific Interfacial Area for Air/aq. CMC Soln.	116
4.7.2.1 Effect of H_s on a_i	116
4.7.2.2 Effect of Z on a_i	116
4.7.2.3 Effect of Concentration on a_i	117
4.7.3 Specific Interfacial Area for Air/aq. EG Soln.	118
4.7.3.1 Effect of U_g and Z on a_i	118
4.7.3.2 Effect of H_s on a_i	119
4.7.4 Specific Interfacial Area for Air/aq. NaOH Soln.	119
4.7.4.1 Effect of U_g and Z on a_i	119
4.7.4.2 Effect of H_s on a_i	121

4.7.4.3 Effect of NaOH conc. on a_i	121
4.8 Mass Transfer Coefficient	122
4.9 Model for Mass-Transfer Coefficient	124
4.10 Estimation of $k_L a_i$	127
 3 SUMMARY AND CONCLUSIONS	129-132
REFERENCES	133-143
APPENDIX-I	144-173
APPENDIX-II	174-190
APPENDIX-III	191-194