

Table of contents

List of figures	ix
List of tables	xiii
Nomenclature	xv
1 Introduction	1
2 State of the art and basic knowledge	3
2.1 Gas-liquid flows and transport phenomena	3
2.1.1 Gas-liquid flows and bubble columns	3
2.1.2 Single rising bubbles	4
2.2 Boundary Layers	17
2.3 Flow around cylinders	20
2.4 Vortex identification	23
3 Measurement techniques	25
3.1 Particle Image Velocimetry (PIV)	25
3.1.1 Principle and Equipment	25
3.1.2 Application to gas-liquid flows	27
3.1.3 Time-resolved Scanning Particle Image Velocimetry (TRS-PIV)	28
3.2 Laser-induced Fluorescence (LIF)	28
3.2.1 Principle and Equipment	28
3.2.2 Application to gas-liquid flows	30
4 Experimental set-ups and procedure	33
4.1 Momentum transporting vortices within a bubble column: PIV measurements	33
4.2 Wake interactions of a rising bubble pair: TRS-PIV measurements	36

Table of contents

4.3	Interactions of a single fixed bubble with a cylinder wake: PIV, LIF, Videography	37
4.3.1	Flow structure in vicinity of the single bubble	39
4.3.2	Local mass transfer measurements by means of LIF	43
4.3.3	Global mass transfer measurements by means of Videography	45
5	Results and Discussion	51
5.1	Bubbly flow: Hydrodynamics and vortices	51
5.1.1	Liquid phase velocity components	51
5.1.2	Vortex detection in the bubble wake	52
5.2	Wake interactions of a rising bubble pair	56
5.3	Single fixed bubble: Hydrodynamics, mass transfer, and boundary layer dynamics	59
5.3.1	Hydrodynamic boundary layer in absence of a cylinder wake	59
5.3.2	Surface velocity profiles	61
5.3.3	Momentum transport within bubble wakes	67
5.3.4	Instantaneous velocity fields and vortex detection	70
5.3.5	Concentration profiles and boundary layer thickness	76
5.3.6	Local mass transfer	81
5.3.7	Global Sherwood numbers	86
5.4	Measurement uncertainties and experimental shortcomings	87
5.4.1	PIV	87
5.4.2	LIF	89
5.4.3	Videography and volumetric flow rate	89
5.5	Comparative analysis of the results	90
6	Conclusion	93
References		95
Appendix A	Preliminary Experiments	111
Appendix B	Additional velocity profiles	119
Appendix C	Additional concentration profiles	123