



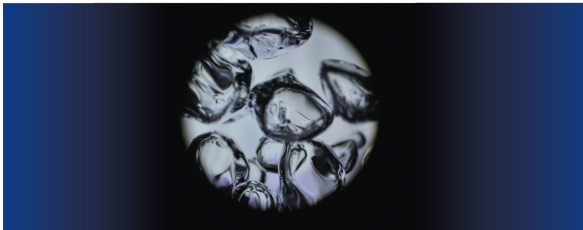
Melanie Bothe (Autor)  
**Experimental Analysis and Modeling of Industrial Two-Phase  
Flows in Bubble Column Reactors**

Berichte aus dem Institut für Mehrphasenströmungen  
Herausgegeben von Prof. Dr.-Ing. habil. Michael Schlüter

1

Dipl.-Ing. Melanie Bothe

**Experimental Analysis and Modeling  
of Industrial Two-Phase Flows  
in Bubble Column Reactors**



Cuvillier Verlag Göttingen  
Internationaler wissenschaftlicher Fachverlag



<https://cuvillier.de/de/shop/publications/7181>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany  
Telefon: +49 (0)551 54724-0, E-Mail: [info@cuvillier.de](mailto:info@cuvillier.de), Website: <https://cuvillier.de>



# Contents

Nomenclature . . . . .	v
Abstract . . . . .	xi
Zusammenfassung . . . . .	xiii
<b>1 Introduction</b>	<b>1</b>
<b>2 State-of-the-Art</b>	<b>3</b>
2.1 Design and Operation of Bubble Column Reactors . . . . .	3
2.1.1 Types of Bubble Column Reactors . . . . .	3
2.1.2 Gas Distribution . . . . .	6
2.2 Modeling of Bubble Column Reactors . . . . .	7
2.2.1 Flow Regimes . . . . .	8
2.2.2 Gas Holdup . . . . .	10
2.2.3 Liquid Velocity . . . . .	13
2.2.4 Bubble Velocity . . . . .	15
2.2.5 Bubble Size . . . . .	27
2.2.6 Mass Transfer . . . . .	32
2.2.7 Influence of a Chemical Reaction on Mass Transfer . . . . .	34
2.3 Bubble Columns Under Elevated Pressure . . . . .	36
2.3.1 Single Bubbles . . . . .	36
2.3.2 Bubbly Flow . . . . .	39
2.4 Conclusion . . . . .	41
<b>3 Experimental Analysis of Bubbly Flows</b>	<b>43</b>
3.1 Facilities . . . . .	43
3.1.1 Laboratory-Scale Bubble Column . . . . .	43
3.1.2 High-Pressure Measurement Cell . . . . .	44
3.1.3 Pilot Bubble Column . . . . .	47
3.2 Experimental Methods for Single Bubble and Bubbly Flow Acquisition . . . . .	50
3.2.1 Experimental Method of the Photo-Optical Single Bubble Acquisition . . . . .	52
3.2.2 Experimental Method of the Photo-Optical Bubbly Flow Acquisition . . . . .	54
3.2.3 Development of Two Different Illumination Setups for EBIV and EPIV . . . . .	65



<b>4</b>	<b>Experimental Study</b>	<b>69</b>
4.1	Influence of Pressure on Rising Behavior of Single Bubbles . . .	69
4.1.1	Material System Water/Air at Elevated Pressures . . .	70
4.1.2	Material System Cumene/Nitrogen at Elevated Pressures	74
4.1.3	Comparison of Different Material Systems at Elevated Pressure . . . . .	76
4.2	Investigation of Hydrodynamic Parameters in Bubbly Flows . .	78
4.2.1	Experimental Investigation of the Gas Holdup . . . . .	78
4.2.2	Experimental Investigation of the Bubble Size Distribution	81
4.2.3	Experimental Investigation of the Bubble Velocity . . .	94
<b>5</b>	<b>Modeling of the Specific Interfacial Area</b>	<b>99</b>
5.1	Characterization of the Bubble Size . . . . .	101
5.2	Gas holdup with Respect to Bubble Velocity . . . . .	103
5.3	Specific Interfacial Area in the Compartment . . . . .	107
	<b>Bibliography</b>	<b>110</b>
	<b>Appendix</b>	<b>I</b>