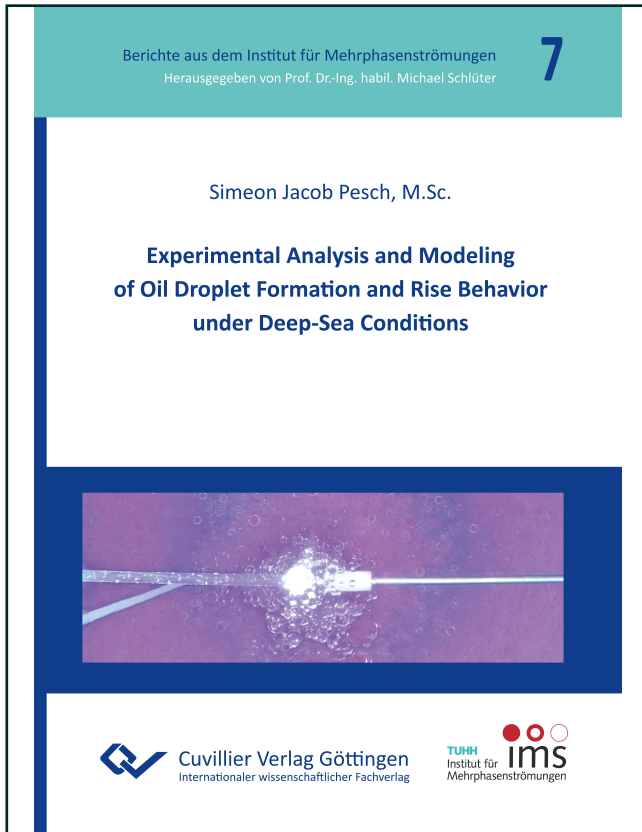




Simeon Jacob Pesch (Autor)
**Experimental Analysis and Modeling of Oil Droplet
Formation and Rise Behavior under Deep-Sea
Conditions**



<https://cuvillier.de/de/shop/publications/8297>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,
Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Table of Contents

List of Figures	xi
List of Tables	xv
Nomenclature	xvii
Abstract	xxiii
Zusammenfassung	xxv
1 Introduction	1
2 State of Knowledge	3
2.1 Subsea Oil Production and Oil Spills	3
2.1.1 Oil Reservoirs	4
2.1.2 Types and Properties of Crude Oil	4
2.1.3 Gas Solubility and Phase Behavior of Live Oil	6
2.1.4 Oil Spill Modeling	8
2.1.5 Oil Spill Response	13
2.2 Free Jets	14
2.2.1 Features of Turbulent Round Free Jets	15
2.2.2 Turbulence in Free Jets	17
2.3 Droplet Breakup and Drop Dynamics	22
2.3.1 Breakup Mechanisms and Breakup Regimes	22
2.3.2 Droplet Deformation and Breakup	26
2.4 Droplet Size Distributions	28
2.4.1 Mathematical Description of Size Distributions	28
2.4.2 Characteristic Values of Size Distributions	29
2.4.3 Typical Distribution Functions	30

Table of Contents

2.5	Rise Behavior of Fluid Particles	32
2.5.1	Parameters Influencing the Particle Rise	33
2.5.2	Correlations for the Rise Behavior of Single Fluid Particles	33
2.5.3	Swarm Effects, Breakup, and Coalescence	36
3	Model Development	39
3.1	Oil Dispersion	39
3.1.1	Model Formulation for the Oil Dispersion	40
3.1.2	Contributions to the Energy Dissipation Rate	41
3.1.3	Comparison with the Modified Weber Scaling Model	43
3.2	Drop Rise	44
3.2.1	Underlying Assumptions	44
3.2.2	Model Formulation for the Drop Rise	46
3.2.3	Input Data and Mathematical Modeling	47
3.3	Oil Distribution	48
3.3.1	CMS – Hydrodynamic Module	48
3.3.2	CMS – Buoyant Particle Tracking Module	49
3.3.3	CMS – Degassing Module	49
3.3.4	Deepwater Horizon Hindcast Simulation	50
3.3.5	Case Study of DWH Scenarios	50
3.3.6	Post-Processing	52
4	Experimental Methods	53
4.1	Experimental Setups	53
4.1.1	Lab-Scale Jet Facility	54
4.1.2	Scale-Up from Lab Scale to Pilot-Plant Scale	55
4.1.3	Pilot-Plant-Scale Jet Facility	58
4.1.4	Counter-Current Flow Cell	60
4.1.5	Experimental Setups for the Determination of Substance Properties	64
4.2	Substance Systems	66
4.2.1	Surrogate System	67
4.2.2	Crude Oil System	67
4.3	Measurement Technologies	68
4.3.1	Droplet Size Measurements	68
4.3.2	Drop Rise Measurements	71
4.4	Experimental Procedures	72
4.4.1	Lab-Scale Jet Experiments	72

4.4.2	Pilot-Plant-Scale Jet Experiments	72
4.4.3	Drop Rise Experiments	73
4.5	Image Evaluation	75
4.5.1	Droplet Size Evaluation	76
4.5.2	Single Drop Volume Evaluation	76
5	Results and Discussion	79
5.1	Jet-Induced Droplet Breakup and Size Distributions	79
5.1.1	Characterization of Breakup Mechanism and Breakup Regime . . .	80
5.1.2	Droplet Size Distributions and Proportionalities	81
5.1.3	Analysis of Suitable Modeling Parameters	84
5.1.4	Applicability and Limitations of the Developed Model	85
5.1.5	Phenomenological Observations	92
5.1.6	Transfer to the Field Scale: Estimate of DWH Droplet Sizes	92
5.2	Pressure-Dependent Droplet Rise Behavior	95
5.2.1	Dead Oil Results	95
5.2.2	Live Oil Results	96
5.2.3	Live Oil Blowout Results	101
5.2.4	Discussion with Regard to Subsea Blowouts	102
5.3	Oil Distribution in the Far Field	104
5.3.1	Surface Layer Oil Concentration	104
5.3.2	Vertical Oil Mass Profile	106
5.3.3	Evolution of the Droplet Size Distribution	107
6	Conclusions and Future Perspective	111
	Bibliography	115
	Appendix A Flowsheet Simulation of the Degassing Process	131
	Appendix B Physical Properties of the Surrogate System	135
	Appendix C Physical Properties of the Crude-Oil System	137
	Appendix D Calibration of the Endoscopic Probe for the Pilot-Plant-Scale Jet Ex- periments	145
	Appendix E Measurement Settings for the Jet Experiments	147

Table of Contents

Appendix F	Experimental Matrix of the Jet Experiments	151
Appendix G	Result Data of the Jet Experiments	155
Appendix H	Result Data of the Drop Rise Experiments	159
Appendix I	Initial Droplet Size Distribution for the Far-Field Simulations	161
Appendix J	Depth Evolution of the Droplet Size Distribution over Time	163