



Contents

Figures	viii
Tables	x
Notations	xii
xvii	
Zusammenfassung	xviii
Abstract	xx
1 Introduction	1
1.1 Research Goals.....	2
2 Theoretical Background	3
2.1 Fundamentals of Vortex Development.....	3
2.1.1 Parameters and Dimensionless Numbers.....	7
2.2 Theoretical Vortex Models.....	9
2.2.1 Rankine Model	9
2.2.2 Lamb–Oseen vortex	11
2.2.3 Burgers & Rott	11
2.2.4 Granger model	15
2.3 Empirical Correlations for the Critical Submergence.....	17
2.3.1 Jain et al.	17
2.3.2 Knauss.....	18
2.3.3 ANSI.....	18
2.3.4 Additional correlations.....	19
2.4 Scaling Criteria.....	21
2.4.1 Froude Scaling.....	23
2.4.2 Scaling limitations for vortex investigations	23
2.5 Vortex Prevention.....	25



3 Experimental Setup	29
3.1 General Proceedings.....	29
3.1.1 Experimental Conditions	29
3.1.2 DN200 Pilot Plant	30
3.1.3 DN15 Laboratory Plant	35
3.2 Conducted Experiments.....	39
3.2.1 Investigation of the Gas-Core Lengths.....	39
3.2.2 Dye Experiments.....	42
3.2.3 Particle Image Velocimetry Measurements.....	42
4 Results and Discussion	47
4.1 Measured Gas-Core Lengths.....	47
4.1.1 Gas-Core Formation.....	47
4.1.2 Influence of the Induced Momentum on the Gas-Core Formation	52
4.1.3 Scale-up Comparison.....	54
4.1.4 Vortex Prevention Measures.....	56
4.1.5 Comparison with Literature Data.....	67
4.2 Results of the Particle Image Velocimetry Measurements	69
4.3 Modelling	77
5 Conclusions.....	79
Bibliography.....	81
Publications.....	87
Supervised Student Theses	89
Appendix.....	91
Lebenslauf.....	99