

Table of Contents

ABSTRACT	VII
KURZFASSUNG	VIII
ACKNOWLEDGMENTS	IX
TABLE OF CONTENTS	X
SYMBOLS	XII
ABBREVIATIONS.....	XX
1 INTRODUCTION.....	1
2 STATE OF THE ART	4
2.1 SEPARATION PROCESS IN COMBINE HARVESTER CLEANING DEVICES.....	4
2.1.1 Design and Functionality of Combine Harvester Cleaning Devices	4
2.1.2 Fundamentals of Separation Process in Combine Cleaning Devices	6
2.1.3 Influences on Separation Process and Evaluation of Separation Success.....	8
2.1.4 Fluid Mechanical Process Characterization.....	32
2.2 NUMERICAL METHODS FOR DISPERSED MULTIPHASE FLOWS.....	41
2.2.1 Fundamental Description	41
2.2.2 Approaches with Non-Resolved Particle Surface.....	43
2.2.3 Approaches with Resolved Particle Surface	45
2.3 APPLICATIONS OF NUMERICAL METHODS TO GRAIN-MOG SEPARATION PROCESS.....	45
2.4 SUMMARY OF LITERATURE REVIEW AND CONCLUSIONS.....	47
3 APPROACH AND METHOD	51
3.1 OBJECTIVES AND APPROACH	51
3.2 BASICS OF THE COUPLED CFD-DEM METHOD	52
3.2.1 CFD for the Fluid-Phase	52
3.2.2 DEM for the Solid-Phase	58
4 PROCESS ABSTRACTION, PARAMETERIZATION AND SENSITIVITY	67
4.1 LIMITATION OF PARAMETER RANGE	67
4.2 INITIAL PARTICLE DESIGN AND PARAMETERIZATION	68
4.2.1 Basic Particle Design and Material Properties	68
4.2.2 DEM Contact Model Parameterization.....	70
4.3 NUMERICAL INVESTIGATION OF SEPARATION PROCESS IN A DOWNSIZED DOMAIN	71
4.3.1 Numerical Model.....	71
4.3.2 Test Procedure.....	76
4.3.3 Preliminary Tests	79
4.3.4 Parameter Sensitivity Study	83
4.4 EXPERIMENTAL TESTS OF SEPARATION PROCESS IN A DOWNSIZED CONTAINER.....	89

4.4.1	Structure and Function	89
4.4.2	Measurement Equipment and Data Processing	90
4.4.3	Characterization of Test Material	92
4.4.4	Test Procedure	99
4.4.5	Test Program	99
4.4.6	Experimental Results	101
4.4.7	Comparison of Numerical and Experimental Results	104
5	NUMERICAL AND EXPERIMENTAL TESTS OF SEPARATION IN A COMBINE CLEANING DEVICE	108
5.1	NUMERICAL INVESTIGATION	108
5.1.1	Numerical Model	108
5.1.2	Numerical Test Procedure	119
5.1.3	Visualization of Results and Data Evaluation	121
5.1.4	Preliminary Tests	124
5.2	EXPERIMENTAL INVESTIGATION	140
5.2.1	Structure and Function of Test Rig	140
5.2.2	Properties of Test Material	142
5.2.3	Test Procedure	144
5.3	COMPARISON OF NUMERICAL AND EXPERIMENTAL RESULTS	145
5.3.1	Grain Loss	145
5.3.2	Relative Grain Separation and Separation Efficiency along Chaffer	157
5.3.3	Air Velocity Distribution along Chaffer	162
5.3.4	Material Conveying Velocity on Chaffer	165
5.3.5	Pressure Drop over Material Layer	166
5.3.6	Purity	168
6	SUMMARY, CONCLUSIONS AND OUTLOOK	170
6.1	SUMMARY	170
6.2	CONCLUSIONS AND OUTLOOK	175
7	PUBLICATIONS OF THE AUTHOR	179
8	REFERENCES	180
9	APPENDIX	188