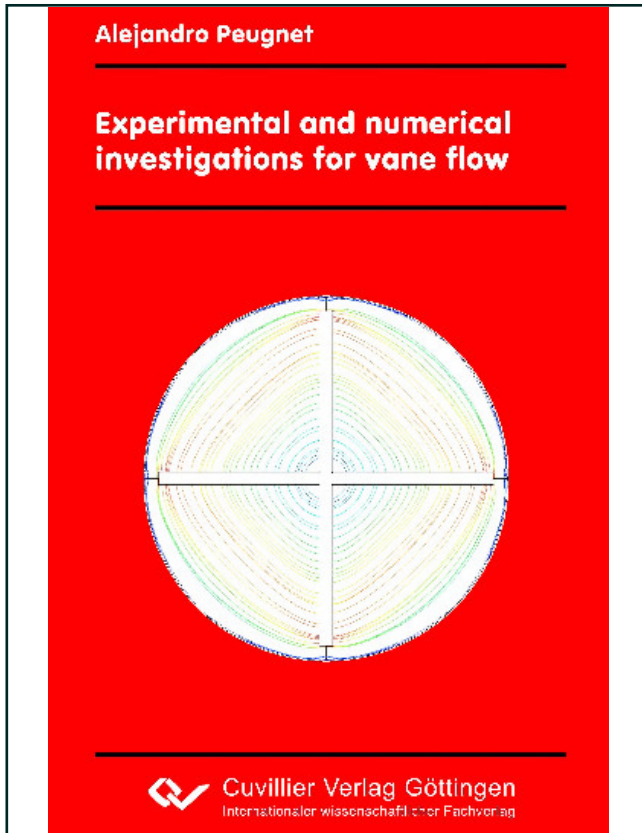




Alejandro Peugnet (Autor)

Experimental and numerical investigations for vane flow



<https://cuvillier.de/de/shop/publications/1052>

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>

Contents

Contents	i
Summary	iv
1 Introduction	1
2 Literature survey	5
2.1 Effect of vane dimensions	14
2.2 End effects	15
2.3 Scope of the thesis	16
3 Numerical method	19
3.1 Finite volume method	19
3.2 General transport equation	20
3.3 Non-dimensional formulation	23
3.4 Discretization of the general transport equation with the FVM	24
3.5 Discretization of the diffusive flux	24
3.6 Discretization of the source term	27
3.7 Software used	27
3.7.1 CFX package	28
4 Vane geometry and statement of the problem	31
4.1 Vane geometry	31
4.2 Idealized assumptions	31
4.3 Torque on a rotating vane	32
4.4 Governing equations	34
4.4.1 Boundary conditions	35
4.5 Mesh for the vane geometry	38
5 Optical method	41
5.1 Particle image velocimetry	41
5.1.1 Image acquisition	42
5.1.2 Interrogation	44
5.1.3 Data validation	45
5.1.4 Data analysis	45
5.1.5 Displacement of the tracer particles	46
6 Materials and equipment	49
6.1 Materials	49
6.1.1 Newtonian fluids	49

CONTENTS

6.1.2	Non-Newtonian fluids	50
6.2	Equipment	52
6.2.1	The rheometer Physica UDS 200	52
6.2.2	Concentric-cylinder measuring system (CC 27)	53
6.2.3	Vane-in-cup measuring system	54
6.2.4	PIV set-up	55
7	Flow curves	59
7.1	Newtonian fluids	59
7.2	Non-Newtonian fluids	60
7.2.1	Preparation of the solutions	61
7.2.2	Hydroxypropyl guar	62
7.2.3	Xanthan gum	62
7.2.4	Polyacrylamide	62
7.3	Characterization with the solvent viscosity	64
8	The vane as viscometer	67
8.1	Non-dimensional formulation	67
8.2	Determining the shear rate in vane flow	73
9	PIV measurements	85
9.1	Flow between the blades	85
9.2	Transformation of coordinates	87
9.3	Velocity profiles	90
10	Numerical simulations for vane flow	95
10.1	Flow field	96
10.2	Profiles of the velocity within the blades	100
10.3	Profiles of the velocities near the vane	104
10.4	Profiles of the velocity along the gap	107
10.5	Vane flow and ideal solid-body rotation	110
10.6	Shear rate along the gap and the edge of the vane	111
10.7	Torque	115
	Bibliography	117
	Table of contents in german	136
A	Cup for PIV measurements	137
A.1	Bob and vane geometries used for the experiments	138
B	Flow curves	139

C	Measurement of the yield stress	142
D	Velocity profiles for the NF and GNF	144
E	Streamlines for a NF and a power-law fluid (Ostwald de Waele)	150
	List of Figures	151
	List of Tables	153
	Index	155