

TABLE OF CONTENTS

BACHELOR THESIS	i
AUTHENTICATION	ii
DECLARATION OF AUTHORSHIP	iii
FINAL TASK MANUSCRIPT	iv
DEDICATION	v
ACKNOWLEDGMENT	vi
TABLE OF CONTENTS	viii
LIST OF FIGURES	xi
LIST OF TABLES	xv
NOMENCLATURE	xvi
ABSTRACT	xix
CHAPTER I INTRODUCTION	1
CHAPTER II LITERATURE STUDY	6
CHAPTER III THEORETICAL BASIS	14
3.1. Bubbly flows	14
3.1.1. Bubble Forces	14
3.1.1.1. Surface tension	15
3.1.1.2. Buoyancy	15
3.1.1.3. Drag force	16
3.1.1.5. Lift force	18
3.1.1.6. Wall force	19
3.1.1.7. Turbulent dispersion force	20
3.1.2. Bubble movement	21

viii

3.1.3.	Bubble size	21
3.1.4.	Bubble shape	22
3.1.5.	Bubble rise velocity	23
3.2.	Contaminations	25
3.2.1.	Organic and inorganic surfactants	25
3.2.1.1.	Salts	26
3.2.1.2.	Surfactant adsorption mechanism	26
3.2.1.3.	Surfactant distribution	27
3.2.1.4.	Marangoni effect	28
3.2.1.4.1.	Effects on the bubble shape	29
3.2.1.4.2.	Effects on the drag and rise velocity	32
3.2.1.5.	Suggested lift force behavior	34
CHAPTER IV RESEARCH METHODOLOGY		37
4.1.	Location	37
4.2.	Research Material	37
4.3.	Experimental Setup	37
4.4.	Research equipment	40
4.4.1.	Working fluid equipment	40
4.4.3.	Image capturing and processing devices	42
4.5.	Image processing procedure	44
4.6.	Flowchart	52
CHAPTER V RESULTS AND DISCUSSION		54
5.1.	Sharpness field calibration	54
5.2.	Clean water	57
5.2.1.	Bubbles	57

5.2.2.	Liquid Velocity	59
5.2.3.	Lift coefficient results	60
5.3.	Sodium chloride z.A. (99% NaCl) with 0.2 mol/l concentration	62
5.3.1.	Bubbles	62
5.3.2.	Lift coefficient	65
5.4.	Sodium chloride z.A. (99% NaCl) with 0.4 mol/l concentration	67
5.4.1.	Bubbles	67
5.4.2.	Lift coefficient	69
5.5.	Lift coefficient results for three different sodium chloride concentrations	70
CHAPTER VI CONCLUSIONS AND FUTURE WORKS		72
5.1.	Conclusions	72
5.2.	Future works	72
REFERENCES		74