

CONTENTS

	PAGE
ENGLISH ABSTRACT	ii
THAI ABSTRACT	iv
ACKNOWLEDGEMENTS	vi
CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xi
NOMENCLATURE	xv
CHAPTER	
1. INTRODUCTION	1
1.1 State of Problem	1
1.2 Aims and Objectives	3
1.3 Scope of the Research	3
1.4 Thesis Outline	4
2. THEORY AND LITERATURE REVIEW	5
2.1 Hydrogen	5
2.1.1 Properties of Hydrogen	6
2.1.2 Heating Value	10
2.2 Hydrogen Production Processing	10
2.2.1 Thermal Process	10
2.2.2 Electrochemical Process	11
2.2.3 Photolytic Process	12
2.3 Principle of Electrolysis	12
2.3.1 Reversible Potential	16
2.3.2 Ohmic Potential	17
2.3.3 Concentration Potential	19
2.3.4 Activation Potential	19
2.4 Modes of Mass and Ions Transfer in Electrolytes	21

CONTENTS

	PAGE
2.4.1 Faraday's Law	22
2.4.2 Rate of Reaction	23
2.4.3 Fick's Laws of Diffusion	24
2.4.4 Electrical Double Layer	24
2.5 Electrolyte Conductivity	26
2.6 Model of Void Fraction	27
2.7 Pulse Signal	29
2.8 Statistical Analysis	30
2.8.1 Procedure of Decision Analysis	31
2.8.2 The Fitting Regression Model	35
2.9 Literature Review	37
3. MODELING	40
3.1 Development the Mathematical Models	40
3.1.1 Mathematical Model of the Conductivity and Void Fraction	40
3.1.2 Mathematical Model of Ionic Resistance	43
3.2 Results and Discussion	46
3.2.1 The Conductivity Model and Void Fraction Model	46
3.2.2 Ionic Resistance Model	49
3.2.3 Modeling Validation	53
3.3 Summary	56
4. EFFECT OF OPERATING TEMPERATURE, FLOWING ELECTROLYTE, MATERIALS, FREQUENCY AND DUTY CYCLE IN KOH	57
4.1 Experimental Apparatus	57
4.2 Experimental Design	58
4.3 Experimental Setup	59
4.3.1 The Effect of Flowing Electrolyte	59

CONTENTS

	PAGE
4.3.2 The Effect of Solution Temperature	60
4.3.3 The Effects of Electrode Materials	61
4.3.4 The Effects of Frequency and Duty Cycle	62
4.4 Results and Discussion	62
4.4.1 Correlation between Current Density and Operating Temperature on Potential of electrolyzer and Hydrogen Production Rate	63
4.4.2 The Effect of Frequency and Duty Cycle	66
4.4.3 The Effect of Temperature	75
4.4.4 The Effect of Materials	78
4.4.5 The Effect of Flowing Electrolyte	80
4.4.6 Correlation between Current Density, Operating Temperature Frequency, Duty Cycle and %wt on Hydrogen Production Rate	83
4.5 Summary	84
5. GENERAL CONCLUSIONS	85
REFERENCES	88
APPENDIX	
A STANDARD REDUCTION POTENTIALS AT 298.15 K	96
B EFFECT OF CURRENT DENSITY, CONCENTRATION AND DISTANCE BETWEEN ELECTRODES IN NaOH AND NaCl	110
C EXAMPLE FOR CALCULATION	114
D EXPERIMENTAL DATA	116
E PUBLICATIONS AND CONFERENCES	127
CURRICULUM VITAE	154