

CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	iv
ABSTRACT (THAI)	v
LIST OF TABLES	viii
LIST OF FIGURES	x
CHAPTER I INTRODUCTION	1
1.1 Background	1
1.2 Objectives of the research	2
1.3 Conceptual framework	3
1.4 Hypothesis	3
1.5 Scopes of the research	4
1.6 Expected output	4
1.7 Definition	4
CHAPTER II LITERATURE REVIEW	6
2.1 Hydrogen production process	6
2.2 Fermentation process	11
2.3 Substrate	13
2.4 Seed culture	15
2.5 Pretreatment method	16
2.6 A two-stage fermentation process	17
2.7 Factors influencing biohydrogen production	18
2.8 Factors influencing biomethane production	21
2.9 Related researches	23
CHAPTER III MATERIALS AND METHODS	29
3.1 Experimental design	29
3.2 Monitoring	37

CONTENTS (cont.)

	Page
3.3 Analytical method	38
3.4 Statistic analysis	40
CHAPTER IV RESULTS AND DISCUSSION	41
4.1 Characteristics of substrate and seed sludge	41
4.2 Phase I: Feasibility of biohydrogen and biomethane production from food waste by a two-stage fermentation process	42
4.3 Phase II: The optimum of environmental conditions on biohydrogen production	59
4.3.1 Phase IIA: Effect of initial pH and temperature on biohydrogen production	59
4.3.2 Phase IIB: Effect of C/N ratio on biohydrogen production	73
4.4 Phase II: The optimum of environmental conditions on biomethane production	83
4.4.1 Characteristics of hydrogen fermentation effluent	83
4.4.2 Phase IIC: Effect of initial pH and temperature on biomethane production	85
CHAPTER V CONCLUSION AND RECOMMENDATION	100
5.1 Conclusion	100
5.2 Recommendation	101
REFERENCES	102
APPENDICES	109
Appendix A Methodology of analysis	110
Appendix B Standard curves	121
Appendix C Experimental data	130
Appendix D ANOVA statistical analysis	134
BIOGRAPHY	142

LIST OF TABLES

Table		Page
2.1	The comparison of three types of biohydrogen production process	10
2.2	Hydrogen-producing and hydrogen-consuming reactions present in fermentation process	13
2.3	The effect of substrate concentration on biohydrogen production in batch fermentation	19
2.4	The effect of initial pH on biohydrogen production in batch fermentation	20
2.5	The effect of temperature on biohydrogen production in batch fermentation	20
3.1	Analytical methods of seed sludge and food waste characteristics	31
4.1	Physical and chemical characteristics of substrate and seed sludge	41
4.2	Biogas production and biogas component from food waste by a two-stage fermentation process	43
4.3	Cumulative hydrogen production and cumulative methane production from a two-stage fermentation process by the modified Gompertz equation	47
4.4	Biohydrogen and biomethane production from wastes by a two-stage fermentation process	53
4.5	pH values in each stage of a two-stage fermentation process	54
4.6	Concentration of intermediate products during a two-stage fermentation process	55
4.7	Biogas production and biogas component at various initial pH values under the mesophilic and thermophilic temperatures	60
4.8	Cumulative hydrogen production at various initial pH values under the mesophilic and thermophilic temperatures by the modified Gompertz equation	62

LIST OF TABLES (cont.)

Table	Page
4.9 Biohydrogen production from wastes at various initial pH values under the mesophilic and thermophilic temperatures	69
4.10 Final pH and concentration of intermediate products at various initial pH values under the mesophilic and thermophilic temperatures	72
4.11 Biogas production and biogas component at various C/N ratios	74
4.12 Cumulative hydrogen production at various C/N ratios by the modified Gompertz equation	76
4.13 Biohydrogen production from wastes at various C/N ratios	79
4.14 Final pH and concentration of intermediate products at various C/N ratios under initial pH of 7.0 and thermophilic temperature ($55 \pm 2^{\circ}\text{C}$)	82
4.15 Physical and chemical characteristics of hydrogen fermentation effluent	84
4.16 Biogas production and biogas component at various initial pH values under the mesophilic and thermophilic temperatures from biomethane production process	86
4.17 Cumulative methane production at various initial pH values under the mesophilic and thermophilic temperatures by the modified Gompertz equation	89
4.18 Biomethane production from wastes at various initial pH values under the mesophilic and thermophilic temperatures	93
4.19 Final pH and concentration of intermediate products at various initial pH values under the mesophilic and thermophilic temperatures from biomethane production process	95

LIST OF FIGURES

Figure		Page
1.1	Diagram of conceptual framework	3
2.1	Diagram of direct photolysis	9
2.2	Diagram of fermentation process	11
2.3	Diagram of a two-stage process	18
3.1	Diagram of experimental setup (Phase I)	32
3.2	Diagram of experimental setup (Phase II)	33
3.3	Diagram of batch reactor	35
4.1	COD removal efficiency from food waste by a two-stage fermentation process	45
4.2	Hydrogen yield from biohydrogen production (stage I) by the modified Gompertz equation	48
4.3	Methane yield from biomethane production (stage II) of the treatment IC by the modified Gompertz equation	49
4.4	COD removal efficiency at various initial pH values under the mesophilic and thermophilic temperatures	61
4.5	Hydrogen yield by the modified Gompertz equation at various initial pH values under mesophilic temperature ($35 \pm 2^{\circ}\text{C}$)	64
4.6	Hydrogen yield by the modified Gompertz equation at various initial pH values under thermophilic temperature ($55 \pm 2^{\circ}\text{C}$)	65
4.7	COD removal efficiency at various C/N ratios	75
4.8	Hydrogen yield at various C/N ratios by the modified Gompertz equation	77
4.9	COD removal efficiency at various initial pH values under the mesophilic and thermophilic temperatures from biomethane production process	88

LIST OF FIGURES (cont.)

Figure		Page
4.10	Methane yield by the modified Gompertz equation at various initial pH values under mesophilic temperature ($35 \pm 2^{\circ}\text{C}$)	90
4.11	Methane yield by the modified Gompertz equation at various initial pH values under thermophilic temperature ($55 \pm 2^{\circ}\text{C}$)	91