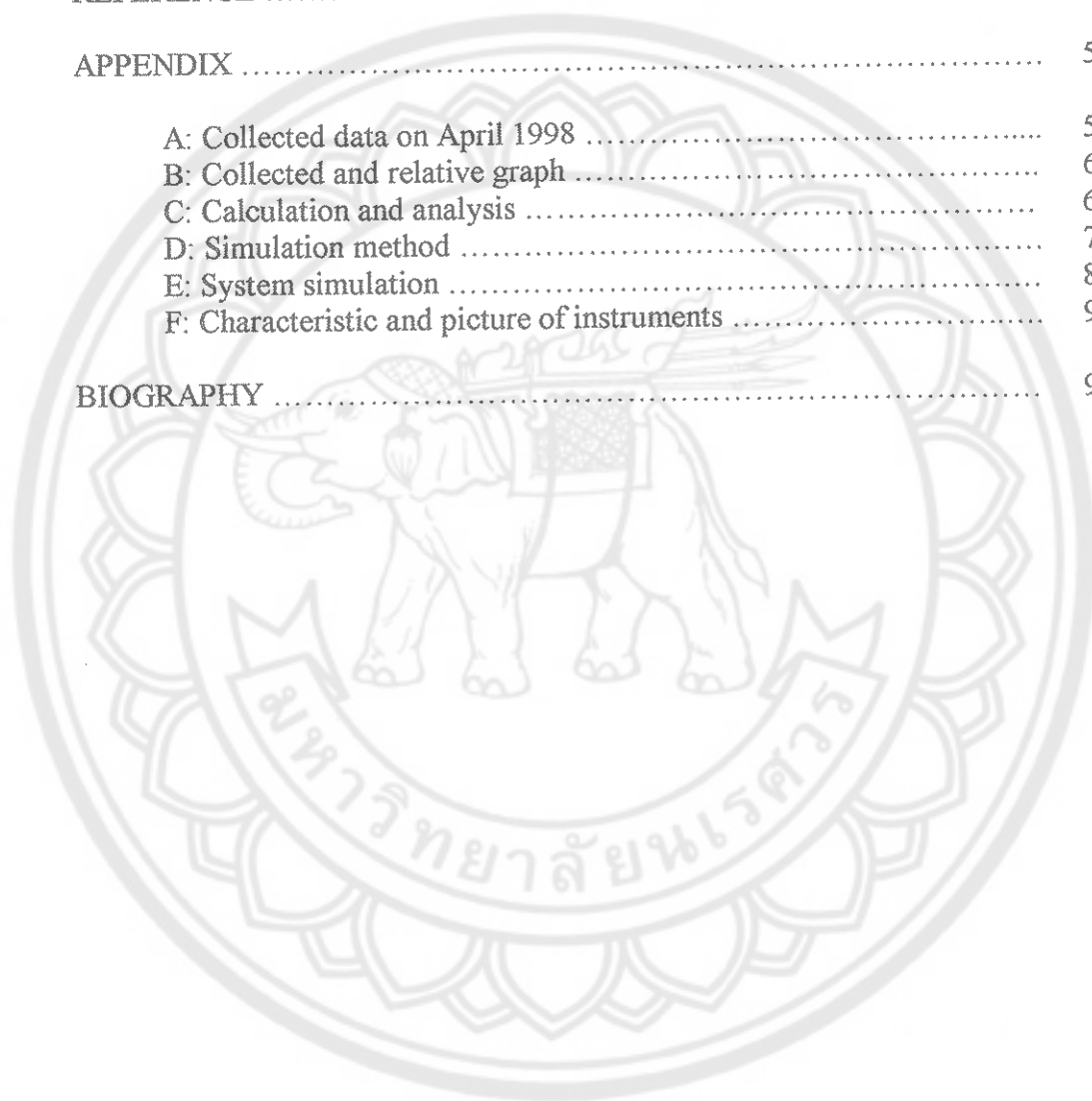


## LIST OF CONTENTS

Chapter	Page
1 INTRODUCTION .....	1
Background .....	1
Objective .....	2
The place of study .....	2
Scope of work .....	2
2 LITERATURE REVIEW .....	3
Comparative study of direct coupled and battery connected photovoltaic water pumping systems .....	3
PV water pumping direct coupling with AC motor .....	3
Modeling System for the efficiency of solar-pumping .....	4
PV water pumping .....	4
Irrigation system .....	5
Dynamic system – head loss .....	5
Experience from the previous works .....	6
3 THEORY .....	7
Solar energy supply .....	7
PV water pumping system .....	8
PV pumping analysis .....	12
4 SYSTEM DESCRIPTION AND METROLOGY .....	18
Photovoltaic water pumping station at Nong Sanuan village .....	18
The technical information and characteristic of instruments .....	19
Data collection .....	21
Measuring instrument .....	22
Data analysis .....	22
System simulation .....	23
5 RESULTS AND DISCUSSION .....	25
Short term analysis .....	25
Middle term analysis .....	37
Long term analysis .....	37
System Simulation .....	42

<b>Chapter</b>	<b>Page</b>
6 CONCLUSION AND SUGGESTION	48
Conclusion .....	48
Suggestion .....	48
REFERENCE .....	50
APPENDIX .....	53
A: Collected data on April 1998 .....	54
B: Collected and relative graph .....	60
C: Calculation and analysis .....	67
D: Simulation method .....	79
E: System simulation .....	83
F: Characteristic and picture of instruments .....	90
BIOGRAPHY .....	97



## LIST OF TABLES

<b>Table</b>		<b>Page</b>
1	Installed PV capacity in Thailand .....	1
2	General information of PV pumping at Nong Sanuan village .....	19
3	PV characteristic of PV pumping at Nong Sanuan village .....	20
4	Inverter characteristic of PV pumping at Nong Sanuan village ...	20
5	Motor/pump characteristic of PV pumping at Nong Sanuan village .....	21
6	Tank characteristic of PV pumping at Nong Sanuan village .....	21
7	Measuring information of PV pumping at Nong Sanuan village ..	22
8	The average condition data on each month .....	25
9	The average data of PV and inverter system on each month .....	25
10	The average data of motor pump and pipe system on each month .....	26
11	The average efficiency of system on each month.....	26
12	The average radiation analysis data on each month .....	27
13	The average collected data on each season .....	37
14	The efficiency of each season .....	37
15	The average collected data .....	38
16	The efficiency of system .....	38
17	Reference yield and performance ratio of system.....	38
18	Collected data table of 16 April 1998 from 7.00 to 18.00 with 10 mean time .....	55
19	The average collected data table in monthly of PV pumping at Nong Sanuan village .....	58
20	Sum collected data table in season and yearly of PV pumping at Nong Sanuan village .....	59
21	The average collected data from 7.00 - 18.00 from 3 October 1997 until 30 September 1998 .....	68

## LIST OF PICTURES

Pictures		Page
1	Direct radiation on a tilted receiver .....	8
2	Typical head in water pumping system .....	9
3	Schematic illustration of the PV water pumping system.....	18
4	The pipeline diagram of the system at Nong Sanuan village .....	19
5	Measuring diagram of PV water pumping system at Nong Sanuan village .....	21
6	The water level in the pond of this system that will decrease until the water level is very low. So, the system can not operate from June 1998 to August 1998 .....	27
7	Global and tilt angle radiation on 16 April 1998 .....	28
8	Ambient and cell temperature on 16 April 1998 .....	28
9	Electrical power from PV system on 16 April 1998 .....	29
10	Pressure in each pipe on 16 April 1998 .....	30
11	Flow rate in each pipe on 16 April 1998 .....	30
12	Relation of electrical output from PV system and tilt angle radiation on 16 April 1998 .....	31
13	Relation of pressure and tilt angle radiation on 16 April 1998 .....	32
14	Relation of flow rate and tilt angle radiation on 16 April 1998 .....	32
15	Relation of inverter frequency and PV output current on 16 April 1998 .....	33
16	Relation of PV output power and AC power on 16 April 1998 .....	33
17	Relation of water volume and AC power on 16 April 1998 .....	33
18	Relation of tilt angle radiation and PV output voltage .....	34
19	Relation of PV output voltage and efficiency of inverter .....	34
20	Relation of PV output current and frequency .....	35
21	Relation of tilt angle radiation and AC power .....	35
22	Relation of tilt angle radiation and system efficiency .....	36
23	The relation of tilt angle radiation and system efficiency .....	36
24	Comparison of the global and tilt angle radiation of each month ..	39
25	Comparison the ambient and cell temperature of each month .....	39
26	Comparison of the PV efficiency of each month .....	40
27	Comparison of the inverter efficiency of each month .....	40
28	Comparison of the total head of each month .....	40
29	Comparison of the motor and pump efficiency of each month .....	41
30	Comparison of the reference yield of each month .....	41
31	Comparison of the performance ratio of each month .....	41
32	Relation of PV output voltage and cell temperature .....	42
33	Relation of PV output current .....	42
34	Relation of PV power and tilt angle radiation and PV system simulation .....	43
35	Relation of AC power and PV output power .....	44
36	Relation of flow rate and AC power .....	44
37	Relation of total head and flow rate and pipeline simulation .....	45

**Pictures****Page**

38	Relation of flow rate and tilt angle radiation and system equation	46
39	Average global and tilt radiation on each month .....	61
40	Average ambient and cell temperature on each month .....	61
41	Average PV output voltage of each month .....	61
42	Average PV output current of each month .....	62
43	Average PV output power of each month .....	62
44	Average AC power of each month .....	62
45	Average frequency of each month .....	63
46	Average water level of each month .....	63
47	Average pressure of each month .....	63
48	Average suction head of each month .....	64
49	Average delivery head of each month .....	64
50	Average flow rate of each month .....	64
51	Average total head of each month .....	65
52	Average PV system efficiency of each month .....	65
53	Average inverter efficiency of each month .....	65
54	Average motor and pump efficiency of each month .....	66
55	Average system efficiency of each month .....	66
56	The static head diagram of system .....	70
57	Show steps 1 of simulation method .....	80
58	Show step 2 of simulation method .....	81
59	Show steps 3 of simulate method .....	81
60	Show steps 4 of simulate method .....	82
61	Show final steps of simulate method .....	82
62	Relation of PV output voltage and cell temperature .....	84
63	Relation of PV output current and tilt angle radiation .....	85
64	Relation of PV power and tilt angle radiation .....	85
65	Relation of AC power and PV output power .....	86
66	Relation of flow rate and AC power .....	87
67	Relation of total head and flow rate and pipeline simulation .....	88
68	Relation of flow rate and tilt angle radiation .....	89