SOLAR ABSORPTION THERMAL ENERGY STORAGE

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ABSTRACT

In recent years, the global warming and environmental pollutions getting worse and create an awareness to the society to another alternative system which more environmental friendly such as application of solar energy in building cooling system. This thesis, described the simulation of the single stage solar absorption system that was developed by using water lithium bromide solution as refrigerant. The performance of the system will be analyzed based on different parameters. The parameters are evaporator, generator and condenser temperature. For higher evaporator and generator temperature, it will result a higher COP (coefficient of performance) of the system. However, a low condensing temperature will result a higher COP. For generator temperature from 60 to 80℃, the absorption cycle at work efficiently. This simulation also will calculate to estimate cooling load, quantity of solar collector and size of thermal energy storage. Size of solar collector and thermal energy storage depends on cooling load required.

ABSTRAK

Kadar pemanasan global dan pencemaran alam yang semakin membimbangkan pada masa kini telah memberi kesedaran kepada masyarakat untuk beralih kepada penggunaan system altenatif yang lebih mesra persekitaran. Antaranya adalah penggunaan tenaga solar dalam sistem penyejukan bangunan. Dalam tesis ini, simulasi ke atas kitaran tahap tunggal sistem penyejukan solar yang menggunakan larutan air litium bromide telah dibangunakan. Prestasi system akan dianalisa berdasarkan pada keadaan parameter system yang berbeza. Tiga parameter telah dikenalpasti untuk mengawal prestasi kitaran. Parameter tersebut adalah suhu evaporator, penjana and condenser. Bagi suhu evaporator dan penjana yang tinggi ia akan peningkatkan tahap COP (coefficient of performance), manakala suhu condenser yang rendah akan turut meningkatkan COP. Bagi suhu penjana, pemanasan dari 60 ke 80℃, kitaran penyejukan akan berada pada tahap yang terbaik. Dalam simulasi yang dibangunkan ini juga, anggaran beban penyejukan, bilangan pemungut solar dan saiz stor simpanan tenaga terma (air sejuk) boleh dikenalpasti. Saiz pemungut solar dan stor simpanan tenaga terma adalah bergantung tahap beban penyejukan yang diperlukan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	**ii**
	DEDICATION	**iii**
	ACKNOWLEDGEMENTS	**iv**
	ABSTRACT	**v**
	ABSTRAK	**vi**
	TABLE OF CONTENTS	**vii**
	LIST OF TABLES	**x**
	LIST OF FIGURES	**xi**
	LIST OF APPENDICES	**xiii**
	LIST OF SYMBOLS	**xiv**
1	**INTRODUCTION**	**1**
	1.1 Thesis Introduction	**1**
	1.2 Objective	**2**
	1.3 Scope	**2**
2	**LITERATURE SURVEY**	**3**
	2.1 Solar Energy	**3**
	2.1.1 Introduction to Solar Energy	**3**
	2.1.2 Solar Radiation	**4**
	2.1.3 Solar Collectors	**6**

		2.1.3.1	Flat Plate Collectors	**7**
		2.1.3.2	Tracking Collectors	**8**
		2.1.3.3	Focusing (Concentrating) Collectors	**9**
		2.1.3.4	Solar Pond Collectors	**10**
		2.1.3.5	Photovoltaic (PV) Cells	**11**
	2.1.4	Thermal Energy Storage		**12**
2.2	Solar Absorption Refrigeration			**20**
	2.2.1	Introduction Solar Absorption Refrigeration		**20**
	2.2.2	Working Principle of Solar Absorption System		**21**
	2.2.3	Types of Absorption cooling cycle		**22**
	2.2.4	Refrigerants		**25**

3	**MATHEMATICAL MODELING OF SOLAR ABSORPTION SYSTEM WITH LITHIUM BROMIDE SOLUTIONS**	**26**
	3.1 Solar Collectors	**26**
	3.2 Properties of Water Lithium Bromide Solutions	**27**
	3.3 Steady Flow Analysis of Water Lithium Bromide Systems	**27**
	3.4 Practical Problems in Water Lithium Bromide Systems	**32**
4	**RESULT AND DISCUSSION**	**34**
	4.1 Simulation of Solar Absorption System and Thermal Energy Storage	**34**

4.2 Estimating Cooling Loads **34**
4.3 Solar Radiation **35**
4.4 Relation of COP over the Generator Temperature **37**
4.5 Minimum Heat Source Temperature for LiBr-Water System **39**
4.6 Thermal Energy Storage **40**
4.6.1 Hot Water **40**
4.6.2 Chilled Water **42**
4.7 Selection of Thermal Energy Storage (Exergy Analysis) **43**

5 CONCLUSION AND RECOMMENDATION 46
5.1 Conclusion 46
5.2 Recommendation 47

REFERENCE 48
Appendix A 50
Appendix B 51
Appendix C 52
Appendix D 53
Appendix E 55

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Costing for thermal Energy Storage	19
2.2	The Rating for Ice Storage Systems	20
4.1	Minimum Heat Source Temperature for Water Lithium Bromide Vapor Absorption System	39

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Solar energy distribution and utilization	4
2.2	Surface solar radiations	5
2.3	Solar Flat Collectors	7
2.4	Various collectors	8
2.5	Parabolic mirror concentrator of solar radiation	9
2.6	Single surface and equivalent Fresnel lenses	10
2.7	Solar pond	11
2.8	Simple PV cell and resistive load	12
2.9	Storage tank	14
2.10	Double-octagon diffuser for a cylindrical stratified tank: (a) plan view of bottom diffusers; (b) 12-in.diameter PVC pipe diffuser.	18
2.10	Solar absorption cooling system	21
2.11	Vapour absorption refrigeration system with solution heat exchange on *Duhring* plot	22
2.12	Single Effect Cycle	23
2.13	Double-lift half-effect Cycle	24
2.14	Single-Lift Half-Effect Cycles	24
4.1	Solar Irradiation for Some Cities in Malaysia	36

4.2	Heat Generated by Solar Collector for Kuala Lumpur	36
4.1	Relation of COP over Generator Temperature	37
4.2	Components Breakdown over Generator Temperature	38
4.3	Components Breakdown over Evaporator Load	38
4.4	Relation of COP over Condenser Temperature	39
4.5	Calculations of Solar Collector and Hot Water Storage	41
4.6	Calculation of Chilled Water Storage	42

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Insulation Factor $fQ/A\theta$ For Cylindrical Water Tanks	**50**
B	Enthalpy-Temperature-Concentration Diagram H20-LiBr	**51**
C	Enthalpy-Pressure-Concentration Diagram H20-LiBr	**52**
D	Solar Collector factsheet Navitron SFB 20	**53**
E	User Manual For The Simulation	**55**

LIST OF SYMBOLS

I	-	Intensity of radiation arriving at the ground surface from a given direction
θ_z	-	Azimuth angle between the normal to the surface and the direction of the beam
N_d	-	The number of the day corresponding to a given date. It is defined as the number of days elapsed in a given year up to a particular date starting from 1 on 1 January to 365 on 31 December.
R	-	Thermal resistivity of insulation, m2· K/W
f	-	Specified fraction of stored energy that can be lost in time θ
Q	-	Stored energy, J
A	-	Exposed surface area of storage unit, m2
θ	-	Given time period, s
t_{avg}	-	Average temperature in storage unit, °C
t_a	-	Ambient temperature surrounding storage unit during season when it will be heated, °C
σ	-	The atmospheric transmittance for beam radiation,
A	-	Altitude of the observer in kilometers.
q_u	-	Useful energy delivered by collector, W
A_c	-	Total aperture collector area, m^2
I_t	-	Total (direct plus diffuse) solar energy incident on upper surface of sloping collector structure, W/m^2
τ	-	Fraction of incoming solar radiation that reaches absorbing

		surface, transmissivity (dimensionless)
α	-	Fraction of solar energy reaching surface that is absorbed, absorptivity (dimensionless)
U_L	-	Overall heat loss coefficient, W/(m2·K)
t_p	-	Average temperature of absorbing surface of absorber plate, °C
t_a	-	Atmospheric temperature, °C
F_R	-	Correction factor, or collector heat removal efficiency factor, having a value less than 1.0
t_i	-	Temperature of fluid entering collector, °C
m_L	-	Mass of anhydrous lithium bromide
m_W	-	Mass of water
n_L	-	Moles of anhydrous lithium bromide
n_W	-	Mole of water
$\dot{m}$	-	Mass flow rate of refrigerant, kg/s
$\dot{m}_{SS}$	-	Mass flow rate of strong solution (rich in LiBr), kg/s
$\dot{m}_{WS}$	-	Mass flow rate of weak solution (weak in LiBr), kg/s
T_C	-	Condenser temperature
T_E	-	Evaporator temperature
v_{sol}	-	The specific volume of the solution

CHAPTER 1

INTRODUCTION

1.1. Introduction

In recent centuries the types and magnitudes of the energy requirements have increased in an unprecedented manner and mankind seeks for additional energy sources. The energy is a continuous driving power for future social and technological developments. Energy sources are vital and essential ingredients for all human transactions and without them human activity of all kinds and aspects cannot be progressive. Population growth at the present average rate of 2% also exerts extra pressure on limited energy sources. Since energy cannot be created or destroyed and with the expected population increase, it is anticipated that there will be energy crises in the future, which may lead to an energy dilemma due to the finite amount of readily available fossil fuels. Thus, many researchers spend tremendous effort to develop the technology to utilize unlimited energy such as wind energy and solar energy. Conventionally, the solar energy only is being used for agriculture industry such crop drying, salt production and etc. but nowadays, its application expands vigorously for example in electricity generation, heat engines and air conditioning system.

Since Malaysia is situated in the equatorial region with an average radiation of 4,500 KWh per square meter, it is an ideal location for large scale solar power installations. Considering that Malaysia gets on an average 4.5 hours to 8 hours of free and bountiful sunshine every day, the potential for solar power generation is very high.

In this study, the application of solar energy for absorption chiller is explored. The system will be modeled by the Visual Basic programming and at the same time the performance of the system can be evaluated.

1.2 Objective

i. To simulate a solar absorption system and thermal energy storage
ii. To evaluate the performance of such system

1.3 Scope

i. Literature review of solar absorption system and thermal energy storage
ii. Analysis of solar absorption system and thermal energy storage
iii. Lithium bromide-aqueous as the refrigerant
iv. Evaluating the performances of solar absorption system and thermal energy storage

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