

Alternative Energy

Edited by

A.K.M. Mohiuddin

Asif Hoda



IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

A.K.M. Mohiuddin and Asif Hoda
Alternative Energy
A.K.M. Mohiuddin and Asif Hoda
Include index
Bibliography: p.

ISBN 978-967-418-158-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

Table of Contents

Table of Contents	v
Preface	viii
Chapter 1	
The Impact of energy utilization on environment.....	1
M.N.A. Hawlader	
Chapter 2	
Desalination of Seawater to provide fresh water	9
M.N.A. Hawlader	
Chapter 3	
A solar assisted desalination system using heat pump.....	16
M.N.A. Hawlader, Leong Chiing Yang	
Chapter 4	
An experimental study of a phase change storage system.....	23
M.N.A. Hawlader and Smita Panga	
Chapter 5	
Moisture migration in a grain column subjected to drying	30
M.N.A. Hawlader and Md. Shafique J. Chowdhury	
Chapter 6	
Solar Drying of Guavas, Papayas and Apples	38
M.N.A. Hawlader and Lee Hwee Peng	
Chapter 7	
Drying under inert environment: the quality of Mango and Rockmelon.....	47
M.N.A. Hawlader and Pan Jiahe	
Chapter 8	
A low temperature flat plate solar collector	53
M.N.A. Hawlader, M. Zakir Ullah and Maung Than Htut	
Chapter 9	
Optimization of an integrated solar heat-pump system.....	60
M N A Hawlader and Ye Shaochun	
Chapter 10	
Comparative study of performance characteristics using <i>Jatropha</i> Oil Methyl Esters Biodiesel and Diesel.....	69
A.K.M. Mohiuddin and Azan Mohd	
Chapter 11	
Comparative Study of Emission Characteristics using <i>Jatropha</i> Oil Methyl Esters Biodiesel and Diesel	74
A.K.M. Mohiuddin and Azan Mohd	
Chapter 12	
Waste Cooking Oil Utilization for Biodiesel Production.....	79
A.K.M. Mohiuddin and Nabeel Adeyemi	
Chapter 13	
Flow Characteristic of Mixing Impeller for Liquid-Liquid Mixing	85
A.K.M. Mohiuddin and Nabeel Adeyemi	
Chapter 14	
Solar Energy Management for Poverty Alleviation and Income Generating Activities.....	91
A.K.M. Mohiuddin	

Chapter 15	
Turbulence model for axial mixing impeller in unbaffled vessel.....	97
A.K.M. Mohiuddin, Nabeel Adeyemi and Muhamad Husaini	
Chapter 16	
Optimization and economic analysis of a solar assisted heat pump drying system.....	103
M.N.A. Hawlader, S. M. A. Rahman and K.A. Jahangeer	
Chapter 17	
A solar heat pump water heater for rural hospitals.....	117
M.N.A. Hawlader and M. Zakir Ullah	
Chapter 18	
A solar heat-pump system for air-conditioning, water heating and drying.....	126
M N A Hawlader, K A Jahangeer, Ye Shaochun and Choy Tack Hoon	
Chapter 19	
Engineering design – An approach to the development of creativity.....	132
M.N.A. Hawlader	
Chapter 20	
Analysis of Engine Performance with NGV.....	140
Sany Izan Ihsan, Nabila Sulaiman, AKM Mohiuddin and Maizirwan Mel	
Chapter 21	
Analysis of Engine Performance with Enhanced Fuel.....	147
Sany Izan Ihsan, Khairussani Farid, Maizirwan Mel, and AKM Mohiuddin	
Chapter 22	
CFD analysis of an evacuated solar still.....	156
Ahmad F. Ismail, Mirghani I. Ahmed, Yousif A. Abakr	
Chapter 23	
Developments on Solar Operated Water Desalination.....	163
Mirghani I. Ahmed, Yousif A. Abakr and Ahmad F. Ismail	
Chapter 24	
Theoretical and experimental evaluation of LPG as refrigerant for domestic refrigerators and freezers.....	169
M.M. El-Awad, M.I. Ahmed	
Chapter 25	
Preliminary investigation of biodiesel reactor optimization using combine CFD-Taguchi method.....	179
A.K.M. Mohiuddin and Nabeel A Adeyemi	
Chapter 26	
Alternative mixing strategy for biodiesel production: mixed flow impeller characterization.....	188
A.K.M. Mohiuddin and Nabeel Adeyemi	
Chapter 27	
Experimental Investigation of a Multistage Evacuated Solar Still.....	197
Yousif. A. Abakr, Ahmad F. Ismail and Mirghani I. Ahmed	
Chapter 28	
Modelling of electronics heat sink – Influence of the wake function generation on the accuracy of CFD analysis.....	203
M. I. Ahmed, A. F. Ismail, Y. A. Abakr	
Chapter 29	
The effect of the operating conditions on the apparent viscosity of crude palm oil during separation.....	213

Sulaiman Al-Zuhair, Yousif A. Abakr and Mirghani I. Ahmed

Chapter 30

Thermal analysis of a micro device used for detection of colorectal cancer..... 220

Mirghani I. Ahmed, Meftah Hrairi

Chapter 31

Performance of different photovoltaic cells operating under the meteorological conditions of Singapore..... 229

M.N.A Hawlader, Lee Poh Seng and Chua Kok Kiang

Chapter 32

Analyses of motion and drag coefficient of water droplets in a natural draught cooling tower..... 240

Liu Baomin and M. N. A. Hawlader

Chapter 33

A solar assisted heat pump system for desalination..... 252

Zakaria Mohd. Amin, M N A Hawlader and Azharul Karim

Chapter 34

Comparative study of combustion characteristics using Jatropha oil methyl esters biodiesel and diesel..... 261

A.K.M. Mohiuddin and Azan Mohd

Chapter 35

Performance of evaporator collector and air collector in a solar assisted heat pump dryer.
..... 269

S. M. A. Rahman and M. N. A. Hawlader

Chapter 17

A solar heat pump water heater for rural hospitals

M.N.A. Hawlader and M. Zakir Ullah*

*Department of Mechanical Engineering, National University of Singapore

Department of Mechanical Engineering, International Islamic University Malaysia

Abstract

For the meteorological condition of Singapore, a solar heat pump water heater for rural hospitals was designed, fabricated and tested. In this project, the potential of using solar heat pump for water heating has been investigated. A simulation model has been developed to predict the thermal performance of the system under the meteorological condition of Singapore for different load requirements. Also, a series of parametric studies have been performed to identify important variables that affect the system performance. Refrigerant 134a is used as a working fluid both in simulation and experiment. The results have been compared with those obtained from experiments and a good agreement was found. It was observed that solar irradiation, speed of the compressor, storage volume and collector area have a significant effect on the thermal performance of the system. Average values of COP ranged from about 4 to 9, and solar collector efficiency was found to vary between 40 and 75 percent. From the economic analysis of the system, it was found that the system could provide 70% of the designed water heating load required for a rural hospital with a collector area of about 8 m² and a minimum pay back period of 21/2 was obtained.

Keywords: Solar heat pump, simulation model, performance, economic analysis, rural hospital.

INTRODUCTION

Singapore is located near the equator and it has abundant supply of solar energy with high ambient temperature throughout the year [1]. Among the alternative energy sources, solar energy is considered cheap, readily available, and nonpolluting. It is also considered suitable for low temperature thermal applications. Solar energy systems and heat pumps are, therefore, promising means of reducing the consumption of nonrenewable energy resources. To increase the evaporation temperature, the unglazed solar collectors can act as an evaporator to increase the thermal performance. Chaturvedi and Abazeri [2] found a variation of the evaporator temperature from 0 to 10°C above the ambient temperature under favourable solar conditions. Morgan [3] reported that, for the ambient temperature of above 25°C, the evaporator could be operated at an elevated temperature. It was discovered that proper matching between collector/evaporator load with compressor size is very important, as found