Alternative Energy

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IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011
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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

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Chapter 9

Optimization of an integrated solar heat-pump system

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Abstract

This paper describes a method of economic optimization of an integrated solar heat pump system for space cooling, water heating and drying. The system can serve three functions simultaneously or independently. A simulation model for this system was developed to study the influence different variables. The results were validated by a series of experiments carried out under the meteorological conditions of Singapore. Based on this simulation model, an economic optimization was performed to identify the best collector size for a given load and its distribution, using two methods, life cycle savings (LCS) and payback period. The load pattern is determined based on a typical small hotel with the air-con room area of 500m2, daily hot water demand of 18m3 and daily drying demand of 90 kg. It was seen that the life cycle saving method lead to the prediction of the optimum collector area of 55 m^2. The payback period analyses predicted the optimum collector area of 50 m2. The minimum payback period is about 1.5 years.

Keywords: optimization, solar, heat-pump, evaporator-collector, life cycle savings, payback period

INTRODUCTION

Solar energy is clean and most inexhaustible of all known energy resources. Solar systems are normally characterized by a high initial investment followed by low operating cost. The initial investment and operating cost are dependent upon the system design. Therefore, system optimization is necessary to maximize the economical advantage of solar systems compared with conventional ones.

The combination of solar energy and heat pump system can bring various thermal applications. Hawlader et al.[1] used refrigerant 134a in the heat pump for water heating application and the evaporator was used as a solar collector leading to a significant improvement in system COP. Hawlader et al.[2] also developed a solar-assisted heat-pump dryer and water heater. The COP of the system was about 5.0 to 7.0. The first 3-in-1 solar heat pump system for space cooling, water heating and drying was developed by