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A solar heat pump water heater for rural hospitals

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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