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The Effect of Heat Load on the Performance of a Solar Assisted Heat Pump with Hybrid Thermal Collectors

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Extended Abstract

In the present work, the effect of heat load on the performance of a solar assisted heat pump (SAHP) with hybrid thermal collectors was investigated. By combining a heat pump as part of a solar thermal system, it becomes more efficient because currently used auxiliary heaters can be replaced with a heat pump that consumes much less electrical energy [1]. Many researchers have investigated the performance and economic feasibility of SAHPs [2-4]. The SAHP considered here is used for a domestic hot water supply system and mainly consists of the hybrid thermal collector loop, water-water heat pump unit, and hot water storage tank. The hybrid thermal collector has the solar thermal receiver part and the air source receiver part which can operate as an efficient heat exchanger with outdoor air when solar radiation does not exist. When solar radiation is strong enough, the hybrid thermal collector loop directly supplies the hot water heating load through the solar thermal receiver part. On the other hand, solar radiation is not enough to generate high-grade thermal energy on cloudy day or at night, the water-water heat pump unit starts to operate and air source receiver part attached to the hybrid thermal collector acts as the evaporator of the heat pump unit.

In order to analyze and quantitatively estimate the performance the SAHP with hybrid thermal collectors, numerical simulations were performed using commercial software TRNSYS 17. For the water-water heat pump unit, R410A was selected as refrigerant and the performance data of the compressor were obtained from manufacturer's data. IWEC data of Daejeon, Korea based on the hourly weather data provided by ASHRAE were used to consider the environmental conditions. To examine the effect of heat load on the performance of the SAHP with hybrid thermal collectors, daily domestic hot water consumption pattern was included as an input variable. Transient analysis was carried out for the typical day of each season. The heat transfer rate and COP were chosen as the performance metrics.

Numerical results showed that the SAHP with hybrid thermal collectors has several kinds of operation modes. When solar radiation is sufficiently supplied, solar thermal receiver part directly produces the hot water. Otherwise, the heat pump unit generate high-grade thermal energy and either the solar thermal receiver part or the air source receiver part of the hybrid thermal collects act as the evaporator of the heat pump unit. In addition, the daily averaged heat transfer rate was maximized in the spring due to the increase in solar radiation. Based on the simulation results, heat load variation of the hot water storage tank significantly affects the performance of the SAHP system.

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