Abstract

Development of a built-in-storage solar water heater

The objectives of this study are (i) to develop a simple built-in-storage (BIS) solar water heater which can reduce heat losses from reverse circulation at night, and (ii) to develop a simple mathematical model for predicting the BIS system thermal performance operated under varied weather conditions.

The developed BIS system has adopted a check-valve in the flow passage to act as a thermal diode for preventing reverse thermosyphon flow of hot water out from the storage tank during the night. An insulation partition has been installed between the collector channel and the storage tank to prevent the losses of heat through its front transparent cover. Several experimental test runs on the constructed BIS system show that the check-valve in the system can reduce the reverse circulation and its storage efficiency increases about 5 % comparing to the case without the check-valve. It has been found that the developed BIS system can produce a comparable amount of heat contained the tank for uses in next morning to that provided by a conventional solar water heater conducted simultaneously during the tests.

A mathematical model for BIS system thermal performance simulation has been developed based on the energy balances on three main components: absorber plate, collector channel and storage tank. The thermosyphon flow rate of water in the system has also been modeled and an overall flow coefficient K_f is introduced in the flow model as a system performance parameter, which must be predetermined from the experimental tests on the system. Procedure to determine the values of K_f has also been established. Good agreement has been obtained from the comparison between the system thermal performance results predicted by the simulation model and those observed from the experimental tests conducted on the developed BIS system. The BIS system performance parameters can be predicted by the developed model with errors not more than 12 % for most sky conditions except very overcast sky. It is hoped that the developed simulation model can be used as a tool for analyzing the thermal performance of BIS solar water heaters and for further development in sizing the BIS system to meet the load requirements.