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Storage Tank Entrance Effect on Solar Hot Water System

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Extended Abstract

In this study, a three-dimensional CFD program is employed to simulate the thermal and flow fields in the storage tank of a large solar hot water system. The purpose is to study the effect of the storage tank hot water inlet position on the performance of a large solar hot water system operated in Taiwan. Computer simulation with the CFD simulation for the storage tank, coupled with TRNSYS program simulation for the entire solar hot water system, is performed to study the system performance (solar fraction) for three representative cities of Taiwan, i.e. Taipei, Taichung and Kaohsiung (represents northern, central and southern Taiwan). The daily load supplying time studied was from 12:00 to 24:00. The hot water inlet positions studied were at 1/4 H (tank height), 2/4 H, 3/4 H and 4/4 H. The results are also compared with the simulation purely by TRNSYS with fully mixed storage tank and two stratification nodes tank.

Considering the buoyancy effect, it is commonly expected that the hot water from the solar collector flows into the storage tank at higher position can give a better thermal stratification in the tank than flows into the tank at lower. However, the results of the present CFD simulation for the storage tank show that no matter what position the hot water flows into the tank, circulation flow is always created to break down the thermal stratification. Both hot water inlet jet and cold makeup water inlet jet can cause the flow circulation in the tank. The results of the thermal and flow fields show that the flow circulation causes the bottom outlet of the tank to collector has higher temperature than the central portion of the tank. Therefore, the solar collector is not operated in high efficiency status. Also, the hot water to load is not at the highest temperature, especially when cold makeup water inlet jet is present, which may results in increased auxiliary energy consumption. Owing to these two effects, pure TRNSYS simulation overestimates the system performance. For example, for Taipei city, the present method gives the annual solar fraction of 0.51, while the pure TRNSYS method gives 0.57 and 0.60 for fully mixed tank and 2 stratification nodes tank, respectively [1]. The annual solar fractions are 0.6, 0.69 and 0.72 for Taichung, and 0.68, 0.75 and 0.78 for Kaohsiung for the present method, the fully mixed and the 2 stratification nodes pure TRNSYS methods, respectively.

The results of the present study indicate that the hot water inlet position of the storage tank has little effect on the system performance of a large solar hot water system operated in Taiwan for all three representative cities. The differences of annual solar fraction are within 5% for four hot water inlet positions. Therefore, we conclude that the system performance has no significant difference for various hot water inlet positions. It is suggested that the stratification baffles be applied to create stratification effect and to increase the system performance [2].

***Keywords*:** large solar hot water system, storage tank design, numerical simulation, hot water inlet position effect

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