CHAPTER 6

CONCLUSIONS

The motivation of this research has come from today's energy crisis which is the global topic now. The passive cooling may be one of the techniques that can solve this problem. Producing cool water by the nocturnal long wave radiative cooling may be one alternative for residential cooling application. A concept of using thermosyphon heat pipe to extract heat from water in a storage tank to generate cooling water in the nighttime was presented. For this research, the evaporator of the thermosyphon heat pipe was dipped in a water tank and the condenser was exposed to the ambient air. During the nighttime, the condenser was cooled by convection with the surrounding air and by radiation to the sky. Then the water temperature in the tank could be reduced by transferring heat to the evaporator of the thermosyphon. Cool water obtained in the nighttime was used to reduce the room temperature in the daytime. This concept could be applied in an air-conditioned building for reduction of energy used in its air-conditioning system.

The objectives of this research were to study effect of radiator area and storage tank volume on performance of a convective and nocturnal long wave radiative cooling system by thermosyphon heat pipe radiator and to develop the model for predicting performance of a convective and nocturnal long wave radiative cooling system by thermosyphon heat pipe radiator.

The effect of the evaporator length on the heat transfer of thermosyphon heat pipe when dipped in the water storage was studied. Due to the larger evaporator surface area, the L_e/L = 1.00 thermosyphon heat pipe unit could reject heat from the system more than the $L_e/L = 0.67$ and $L_e/L = 0.33$. This condition also gave the lowest water temperature. The ratio $L_e/L = 1.00$ was selected for prototype scale. Then CFD simulation by CFD package was done to verify the spacing between thermosyphon heat pipes in the prototype scale. The averaged convective heat transfer coefficients from an experiment were worked as an input data at the convective boundary conditions for the CFD simulation. The temperature distribution was shown that the spacing between thermosyphon heat pipes in the prototype scale was close enough to maintain the water temperature. Velocity vector was also plotted in the vector form along together with temperature distribution.

A testing unit of 22.5 m^3 room having a nocturnal cooling of a thermosyphon heat pipe radiator with an artificial heater and a 1.0 m^3 storage tank was established. The heat pipe condenser is attached to the metal roof to act as a thermal nocturnal radiator dissipates heat from its evaporator dipping in a water tank to the surrounding ambient. The heat pipe evaporator then generated cool water during the nighttime and the cooled water was served the room cooling load during the daytime. The experimental setup was done to find the stored water temperature and tested room temperature. The theoretical model was also developed and the simulation results agreed well with the experimental data. The percent load reduction of air-conditioning by the passive technique in an air-conditioned room under designed room temperature was also simulated under the weather data of Chiang Mai. The input data were the ambient temperature, the building cooling load, the area of the radiator including its heat transfer data and the volume of cool water. The simulation result showed that the everyday operation gave the highest percent load reduction.

The concept of seasonal cool water storage was conducted. The passive technique will produce and store cool water in the low temperature period such as in winter and rainy seasons for serving cooling load in the high temperature period such as summer. With the input weather data of Chiang Mai, the developed model was used to predict the stored water temperature and the percent load reduction of the air-conditioning under designed room temperature. The cooling performance was expressed in the form of the percent load reduction. Some parameters such as storage tank volume, controlled room temperature, cooling load and radiator area were varied to consider their effect on the output parameters. A correlation for evaluating the percent load reduction with different values of radiator area, storage volume, cooling load and room temperature was also presented. The correlation showed that the radiator area has effect on the cooling performance of the system more than the storage tank volume.

The sensitivity analysis was shown that this kind of passive cooling is suitable for the low ambient temperature area.

Kolaka and Exell (2007) suggested that in the nighttime when the radiator temperature was lower than that of ambient temperature, the ambient air was heat gain to the system, be consistent to our study, so their radiators have the edge around them to prevent some convection heat gain. The future work for this research may build the edge around the radiator so that the stored water temperature will decrease and the system will have more cooling potential.

For the economical analysis, reducing the investment cost such as changing the working fluid and some material are also suggested to make the system more worthwhile to invest.

As mentioned earlier, in this research, the rectangular storage tank was study. For other shape of storage tanks, Equation 5.1 can used to evaluate the percent load reduction when keep the same spacing between thermosyphon heat pipe the same as mentioned in chapter 3.