CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the performance analysis results of the activated carbon-methanol adsorption cooling system based on experimental and theoretical studies. The recommendation for future work are also discussed at the end.

6.1 Conclusions

The research is composed of three parts of performance analysis on:

(1) a modular adsorption cooling system having a sonic vibration at the evaporator.

(2) a modular adsorption cooling system with sonic vibrations at the adsorber.

(3) a system simulation analysis of a modular adsorption cooling system with sonic vibrations at the adsorber and evaporator.

The results could be concluded as follows:

6.1.1 A modular adsorption cooling system having a sonic vibration at the Evaporator.

A vertical module of an adsorption cooling was experimented on in the batch (pseudo-continuous) process. The ultrasonic wave generator producing sonic wave vibrations was attached to the end of an evaporator. There was a thermosyphon installed in the adsorber to help its cooling process. The influence of heat source temperature on the adsorber and heat sink temperature at the condenser, during the desorption and condensation phases, was interpreted. The adsorber was cooled down appropriately during a cooling phase with a combination of two methods, cooling water and thermosyphon heat pipe.

The frequency of the sonic wave adjusted was in a range of 8 – 14 kHz and it could reduce the evaporation temperature and cycle time at the evaporator so that the system performance, indicated by COP, SCP and VCP, were improved. The system performance was closely comparable to take in the literature. The highest COP, SCP and VCP values obtained from this system were 0.718, 248.90 W/kg and 12.22 cm^3/W, respectively.

6.1.2 A modular adsorption cooling system with sonic vibration at the adsorber

The application of a sonic wave generator was tested with the adsorber in the same adsorption cooling system. Desorption was accomplished using two methods: circulating hot water through the water jacket and the application of the sonic wave in a range of 8 – 14 kHz. The sonic wave was used to increase the temperature in the adsorber to improve the system performances, as indicated by the COP, SCP and VCP at 0.619, 229.15 W/kg and 17.61 cm^3/W, respectively.

6.1.3 System simulation analysis

The simulations were conducted on the base cases from the experiments (maximum COP) to predict the cold production capacity (Q_{evap}) of the adsorption cooling system. The first case where the evaporator was vibrated by sonic wave, was performed with the operating conditions of $T_{b,ads}= 90^0C$, $T_{b,valve}= 70^0C$, $T_{cw,ev} = 20^0C$, $T_{cw,cd} = 20^0C$ and a sonic wave frequency of 8 kHz. However, the second case (the adsorber was equipped with sonic wave) was carried out at the operating conditions of $T_{b,ads}= 90^0C$, $T_{b,valve}= 70^0C$, $T_{cw,ev} = 20^0C$, $T_{cw,cd} = 20^0C$ and sonic wave frequency of about 14 kHz. The predictions from both cases showed that the expected cooling capacities of this adsorption cooling system were 61.38 and 81.17 W per unit, respectively. The simulated results were in good agreement with the experimental data.

The application of the adsorption air-conditioner would provide an appropriate breakeven point that lead to decision making on the investment into the selected industry. In brief, the adsorption cooling system enhanced by the sonic wave generator, at either the evaporator or adsorber, has potential to be implemented for the air-conditioning purposes.

6.2 Recommendations

The research demonstrated that an adsorption air-conditioner could sufficiently supply the cold effect in a case study factory. Its performance can compete with those from literatures. However, the operation was more difficult compared to the vapor compression system leading to barriers in the actual application. To enhance the system operation, both sonic wave vibration and thermosyphon heat pipe were already applied. So the system performance could be improved. Nevertheless, we found some room to further improve its performance as follows:

1) Seeking the bearings is appropriate in the installation for the sonic wave.
2) Seeking the materials that are appropriate in heat and mass transfer for the adsorber construction.
3) Enhancing heat and mass transfer by attaching fin that thermosy heat pipes or adsorber set.
4) Developing the plate heat exchanger design of the adsorption air conditioner in the commercial building.