

CHAPTER FIVE

CONCLUSION

This chapter summarizes the major findings and conclusion deduced from the research work. It will also highlight some recommendations for further studies.

5.1 Conclusion

It has been demonstrated that inexpensive concentrated solar thermal (CST) using parabolic trough collector (PTC) made of low-cost aluminum foil material couple with aluminum/copper tube receivers enclosed inside a vacuum box cover has been successfully developed. The system performed adequately with maximum outlet temperature is approximately 100 °C could be obtained under Malaysian climate. It has been shown as well that the output temperature of water heating system increases significantly by employing the automatic tracking in the system. The maximum outlet temperature produced by automated PTC tracking system is 20 % higher than manual PTC system that only produced maximum outlet temperature is approximately 80°C at the same solar insolation.

The efficiency of the water heating system based on PTC had been evaluated under open and closed system. The maximum temperature difference achieved under flowing water at a rate of 0.0025 kg/s is ~30°C compared to closed system which is only around 15°C. This investigation is important to evaluate the effectiveness of heat

absorption of the design developed. Heat absorption in closed system is limited due to accumulated heat at tube receiver whereas heat absorption for open system will drive away that heat through water flowing.

The thermal performance of the system can be further improved by using smaller diameter tube receiver, using a 1 cm diameter tube and encapsulated inside a black box. Smaller diameter reduced contact area to surrounding and vacuum encapsulation prevents heat loss through convection to the surroundings. On top of that, if the tube receiver is made of copper, the transfer of heat into water can be done much quicker than using aluminum tube due to its lower thermal conductivity. However, the efficiency of the system is not solely dependent on solar insolation only, but also affected by other factors, which include surrounding humidity and wind speed. It has been found that the rate of humidity increases the thermal efficiency of the uncovered receiver while the wind speed increases the rate of heat losses from both covered and uncovered receiver tube and consequently affect the thermal efficiency of the system.

5.2 Recommendation

Experimental evaluation of the solar thermal system in a tropical environment like Malaysia is very challenging due to the characteristic nature of the environment. The results obtained from this research work raised some interesting questions that need to be answered for improvement in PTC design, construction and analysis. Some of the recommendations raised here are as follows:

- From the experiment conducted, fabricated custom box used to enclose the receiver tube has significantly minimized the heat losses from the receiver. However, using evacuated glass tube to enclose the PTC receiver will definitely improve the thermal performance of the PTC. This will ensure beam of incident solar radiation transferred to heat transfer fluid with minimum losses and consequently prevent the heat losses through convection and improve the system's ability to deliver usable steam.
- A computer designed based program to measure intercept factor at various angles of the absorber would assist in determining the exact intercept factor and will definitely enhance maximum utilization of incident solar insolation. The method employed in this work is less accurate especially when variations of beam component are dominant.
- The reflecting materials used in this study provided a significant result of about 100 °C. But using other highly reflective materials such as mirrors and stainless-steel reflectors for future study are recommended.

5.3 Future Works

1. Use of numerical analysis to compare the results of both theoretical and experimental investigation to optimize the collector design.
2. Investigate parabolic trough collector coupled with linear Fresnel lens under tropical environment.
3. Extension of parabolic trough collector (PTC) design embedded with thermoelectric module for power generation system under Malaysian environment condition.