The Significance Effect of Peltier Liquid-Cooled Panel System for Air Conditioners Appplication

Mohamad Haniff Harun[1*], Muhamad Faizal Yaakub[1], Mohd Firdaus Mohd Ab Halim[1], Khalil Azha Mohd Annuar[1], Arman Hadi Azahar[1], Mohd Shahrieel Mohd Aras[2], Amar Faiz bin Zainal Abidin[1] and Muhammad Izzat Zakwan Mohd Zabidi[1]

[1] Faculty of Engineering Technology, [2] Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[*]Corresponding e-mail: haniff@utem.edu.my

Keywords: Peltier Effect, Cooling System, Peltier liquid-cooled panel

ABSTRACT – This paper focused on the replacement of the outdoor (compressor) unit with the System panel liquid-cooled air conditioners. The Peltier system is to replace the existing cooling system that uses gas to a cooling system using water by applying Peltier effect. The idea is to prevent from using refrigerant and to simplify the system using water as cooling agent. It will help in lower the cost of maintenance and electricity. The experimental is done in the 10 square feet and using peltier liquid-cooled panel as replacement for conventional outdoor unit (compressor). With the use of Peltier effect it can cool the water inside the water tank and flow it through the main system. This system is capable to produce up to18°C and 1.3 A/h in one hour period by using low fan setting.

1. INTRODUCTION

This research is based on the application of conventional air-conditioning system that used coolant as a medium for cooling system. Hence, the initiative of this system is focused on replacing coolant with Peltier module which able to generate hot and cold system in one device. This unique device is not using any gas that might harmful to the users. There are some products developed based on Peltier module that focused more on cooling system such as cabinet cooling system [1], Enhanced peltier cooling of two-stage thermoelectric cooler via pulse [2] and Peltier Effect Based Solar Powered Air Conditioning System [3]. Most of the new products focus on Peltier itself in order to replace the conventional system. There are other applications that being tested using Peltier such as Portable O-REF system which is used the Peltier as a container that's works in dual mode application [4] and Portable air-conditioning system [5].

The Peltier cells inside Air-Conditioning System is cold so small heat sink unit is mounted at the cold side of the Peltier cells to increase the rate of releasing heat outside of unit. Heat sink is simulated using Comsole Multiphysics to study the fin arrangement in order to optimize heat transfer area [6, 7].

2. METHODOLOGY

In order to develop a cooling system, the base station will operate with a +12V power supply. This voltage will be used as the operating voltage for all of the circuit elements in the base station. It will use a water block to reduce the heat from Peltier and improved the cooling element. After that by using cooling coil is use for water to flow into air conditioner and cold the air at indoor system. Then ,temperature controller are used to controlled the heat and cold at liquid-cooled panel air conditioners because the temperature need to control for more effective when indoor air-conditioner was turn on. Water pumps function to circulate the water from water block to indoor air-conditioner. Figure 1 shows the proposed system for new cooling system.

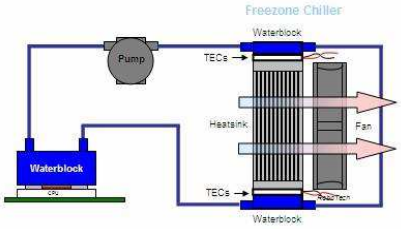

Figure 1 Overall Process for Proposed Cooling System

Radiators are heat exchangers used to exchange heat starting with one medium then into the next with the end of cooling and warming. The larger part of radiators is developed to work in cars, structures, and hardware. The radiator is dependably a wellspring of heat to its surroundings, in spite of the fact that this might be for either the motivation behind warming this environment, or for cooling the liquid or coolant supplied to it, with respect to motor cooling.

3. RESULTS AND DISCUSSION

As a brief functional concept, water will be filled from hose to the right reservoir tank and will flow the water through the water pump and ventilate into water block. In this water block framework, what it does is that it sandwiched the Peltier cell and the water flow in it will experience biasing of water temperature which is hot and cold. The hot water will exit the block and chambers it into the left tank as shown in Figure 2. The left tank consists of hot water will flow back into water block to transform being cold water. So, this cycle is redundant and uses the same amount of water. The cool air is being blown as an air conditioned product. Android application is being used as to initiate the system upon reaching 18ºC and to display temperature data. All data are recorded every 5 minutes for 1 hour as shown in Table 1.

Based on the data collected, the cooling system with four number of TEC1-12706 modules integration with water block and radiator system able to produce cooling system around 18 °C and current up to 1.3 A/h. Figure 3 shows the relationship between current and

final temperature for the proposed cooling system.

Figure 2 A complete liquid-cooled air conditioner systems

Table 1 Current consumed using proposed cooling system with final temperature

Time (min)	Current (A)	T_{Final} (ºC)	$T_{Difference}$ (°C)
5	1.5	24	20
10	1.3	23	27
15	1.4	22	31
20	2.2	22	38
25	1.3	21	42
30	1.3	20	44
35	1.2	20	48
40	1.3	20	51
45	1.4	19	56
50	1.4	19	58
55	1.3	18	70
60	1.2	18	73

In a nutshell, the system has achieved a lowest temperature of 18.60 °C without using the compressing gas as per air conditioner at the market. With its capability of just consuming 1.3 Ampere of current which is ¼ of the consumption of usual air conditioner, it can be said this system is energy efficient. This is also supported with its 56 Watt/hour power consumption whereby normal air conditioner consumes double of it. The effect of this system can be significantly seen during noon time as surrounding is hotter than room temperature. Though that, the system functions is still noticeable

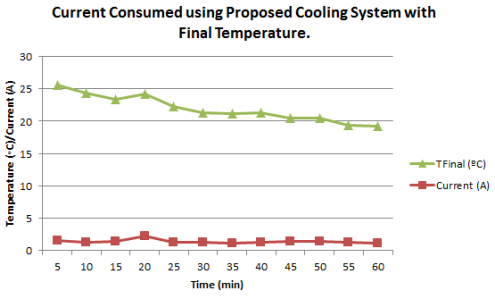

Figure 3 Graph Current versus Final Temperature

The graph explains on Figure 3 depicts the decreasing temperature at the water tank every 5 minutes until one hour. This system did not use any refrigerant in cooling the system. Temperature difference is also being recorded in order to optimize the usage of the temperature. This data can be used for generating low voltage source to minimize the actual current usage.

4. CONCLUSION

In conclusion, that is improvement ways a project by giving opinion and innovation to the project. Generally, every project has the advantage and disadvantage that distinctive to achieve the objective. Moreover, the use ideas and opinion can give new impact in innovating use of material that based on greenhouse system. Lastly the new improvement that can be makes by adding another control system for cooling, the voltage and current for Peltier.

ACKNOWLEDGEMENT

We wish to express our gratitude to MOHE, Universiti Teknikal Malaysia Melaka (UTeM) especially for Centre for Robotics and Industrial Automation (CeRIA), Centre of Research and Innovation Management (CRIM) and to Faculty of Engineering Technology from UTeM to give the financial (RAGS/1/2015/TK0/FTK/03/B00114) as well as moral support for complete this project successfully.

REFERENCES

[1] Nandini, K. (2013). Peltier based cabinet cooling system using heat pipe and liquid based heat sink. *National Conference on Challenges in Research & Technology in the Coming Decades (CRT 2013),* IET, pp. 1-5.

[2] Yan-Wei Gao, Hao Lv, Xiao-Dong Wang and Wei-Mon Yan. (2017). Enhanced Peltier cooling of two-stage thermoelectric cooler via pulse currents. *International Journal of Heat and Mass Transfer*, *114*, pp. 656-663.

[3] Sharma, R., Sehgal, V. K., Thakur, A., Khan, A. M., Sharma, A. & Sharma, P. (2009). Peltier Effect Based Solar Powered Air Conditioning System. *International Conference on Computational Intelligence, Modelling and Simulation*, IEEE, pp. 288-292.

[4] N. Shafiei, M. H. Harun, K. A. M. Annuar, M. F. A. Halim, M. S. M. Aras, A. H. Azahar. (2016) Development of portable air conditioning system using peltier and seebeck effect. *Journal of Telecommunication, Electronic and Computer Engineering*, *8 (2),* pp. 129-133.

[5] M. H. Harun, K. A. M. Annuar, M. F. M. A. Halim, M. H. C. Hasan, M. S. M. Aras, M. F. Yaakub. (2016). Peltier And Seebeck Efficacy Of Hot And Cold Air System For Portable O-REF (Oven & Refrigerator) Application. *Proceedings of Mechanical Engineering Research Day* 2016, pp. 81-82

[6] K. A. M. Annuar, F. S. Ismail, M. H. Harun and M. F. M. A. Halim. (2015) Inline pin fin heat sink model and thermal performance analysis for central processing unit. *Proceedings of Mechanical Engineering Research Day 2015*, pp. 35-36.

[7] K. A. M. Annuar, M. F. M. A. Halim, F. S. Ismail, M. Zahari, S. H. Johari and M. H. Harun. (2015) Thermal Analysis of Staggered Pin Fin Heat Sink for Central Processing Unit. *Australian Journal of Basic and Applied Sciences. 9(19),* pp. 68-73.