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ANALYSIS OF PASSIVE COOLING TECHNIQUE FOR SMALL ROOM

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Abstract

In order to maintain an appropriate Indoor thermal comfort, the air needs to be conditioned using any means to circulate and discharge heat out from the room. However, with world descending into a global energy crisis and rising of global temperature, air conditioning approach need to be reconsidered as it's used big amount of energy. An Earth to Air Heat Exchanger (EAHX) known as passive cooling is a system or technique to cool a building with small or almost zero energy consumption. The main objective of this research is to analyses the passive cooling technique for small room by reducing indoor temperature of the room. Galvanized Iron Steel was used as EAHX pipe. It is hypotheses that the temperature difference depends on the thermal conductivity and depth of buried EAHX pipe. Two different setups of pipe were applied. Pipe A was setup without water proof barrier while pipe B consists of water proof barrier. It was found that the pipe B reached the highest temperature difference about 6.42°C.

Keywords: Passive Cooling, EAHX, thermal comfort

1 INTRODUCTION

Malaysian has been categorized as a Tropical Rainforest climate country by Koppen Climate Classification (Hess and McKnight, 1999) and also known as a country which undergo hot and humid environmental condition with an average temperature of 27°C due to the fact that this country is located near to the equator line which will cause exposure from radiation of the sun compare to other country. The presence of global warming phenomenon will affect thermal comfort throughout the country.

Due to the presence of complex system in air conditioner it required high energy consumption in order to fulfill the wanted human comfort level. Passive cooling is a technique using natural cooling by maintaining comfortable environment in a room or building. This passive cooling technique can develop eco-friendly and almost zero energy consumption.

Passive cooling operates using natural process to prevent heat from entering the building or it can also act as heat remover without using much electrical device by maintaining a comfortable environment within a closed area like buildings and encourage the removal of access heat from buildings (Kamal, 2012).

2 Experiment Setup

The location of the experiment setup to analyse passive cooling system was carried out on the area of Faculty of Engineering which is located in University Selangor (UNISEL) at Bestari Jaya Campus. The soil at this location expose to the solar radiation and suitable for the experiment due to high air flow at this location.

This research consists of two buried earth- to-air-heat exchanger with galvanized iron pipe as the material. A layout plan for experimental setup is shown in Figure 1. The diameter of the pipe is fixed at 4 inch (10.2 cm) and buried at 2.5-meter underground from the surface. This two pipe laid out in parallel with gap of 60 cm from one to another. The pipe inlet was attach to a nozzle with inlet diameter 10.2 cm outlet in order to increase the air volume through the pipe.

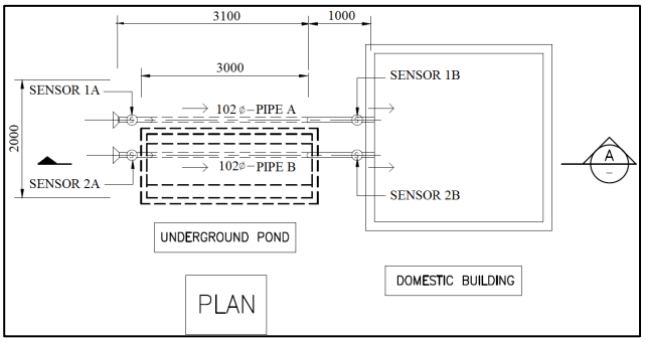

Figure 1: Apparatus setup layout plan (Top View)

The underground pipe was fixed at 2.5 m and connected with a 90° flanged elbow. The outlet pipe attach to a small room with insulation to prevent any losses from the pipe. The extractor fan was fitted at the end of the pipe in order to pull air through the pipe. There are four sensors need to be fitted in this experiment. Two sensors were installed on each of the pipe, one on the inlet pipe and another one on outlet pipe. The inlet sensor is used to measure the air temperature through the inlet pipe. The outlet sensor is used measure the air temperature through the building. There are three more sensors need to be fitted, one on the soil to measure the soil temperature and the other two at environment area to measure the air temperature and the last one at the small room.

There are two types of pipe condition using same type of material. The experiment layout without waterproof barrier is notated as pipe A. The first condition is pipe A without waterproofing barrier and the second condition shown in Figure 2 with waterproofing as pipe B. Waterproofing barrier is mainly used to maintain the humidity of the soil in order to keep the buried pipe to stay cool.

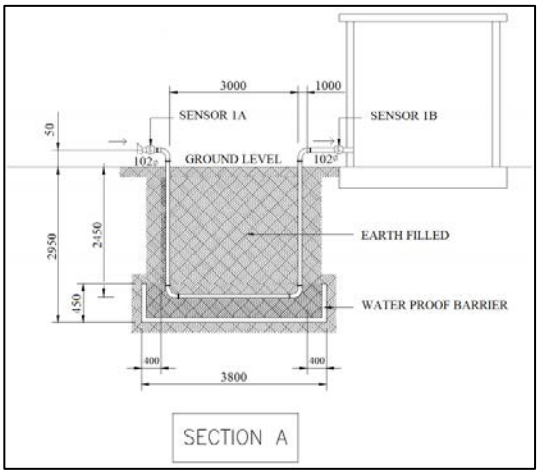

Figure 2: Experiment layout with waterproof barrier

3 Result

The selected results are in range of 7th November 2015 to 11th November 2015. The reason that this particular time range were selected for result because the data during this period were the most viable and comparable throughout the experiment.

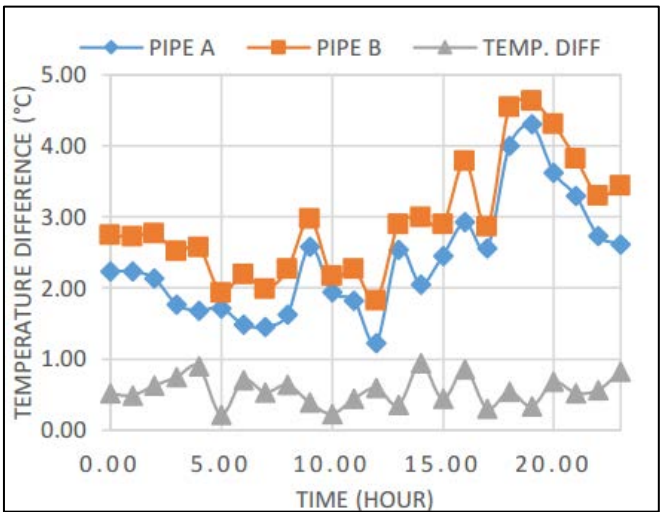

Figure 3: Temperature difference for both pipe setups at 7th November 2015

From figure 3, the highest temperature difference recorded is 4.63°C, that produced by Pipe B at 1900H while 4.30°C produced by Pipe A at the same time. From the graph shows that the lowest temperature difference for Pipe A are 1.23°C while for Pipe B are 1.82°C at 1200H.

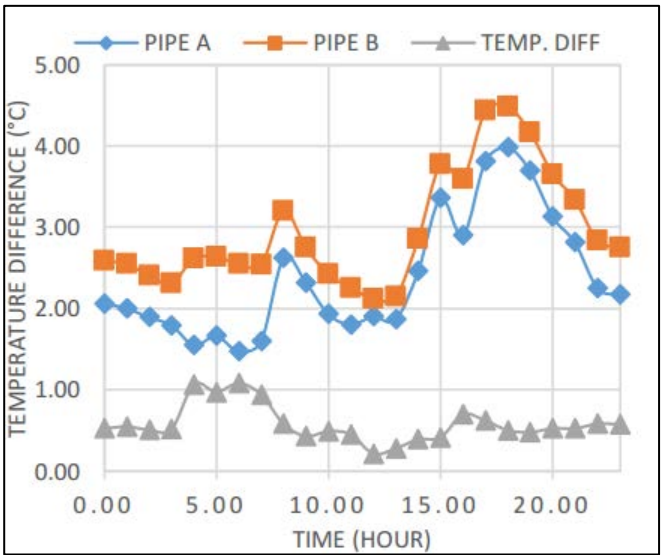

Figure 4: Temperature difference for both pipe setups at 8th November 2015

As shown in Figure 4, the data collection period was continued for another 24 hours was presented. The temperature reading was maintain at one hour interval. The highest temperature difference that produced by Pipe A was 3.98°C while Pipe B produce temperature difference 4.48°C.

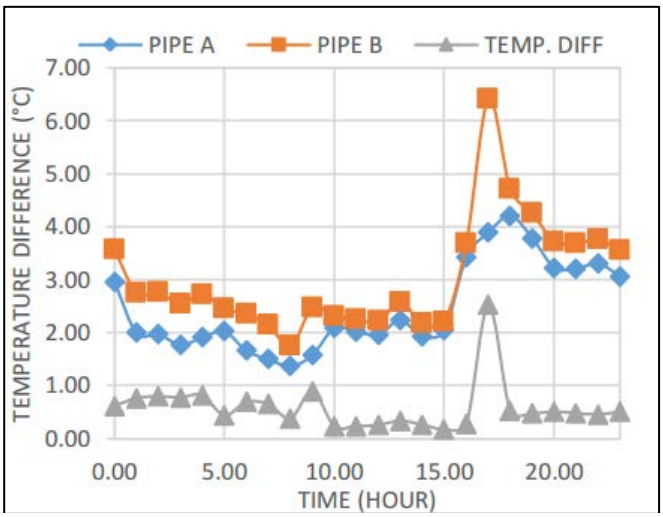

Figure 5: Temperature difference for both pipe setups at 9th November 2015

Figure 5 shows the data for this particular date having highest temperature difference produced for Pipe A was 4.20°C while Pipe B produce higher reading which is, 6.42°C at 1700H.

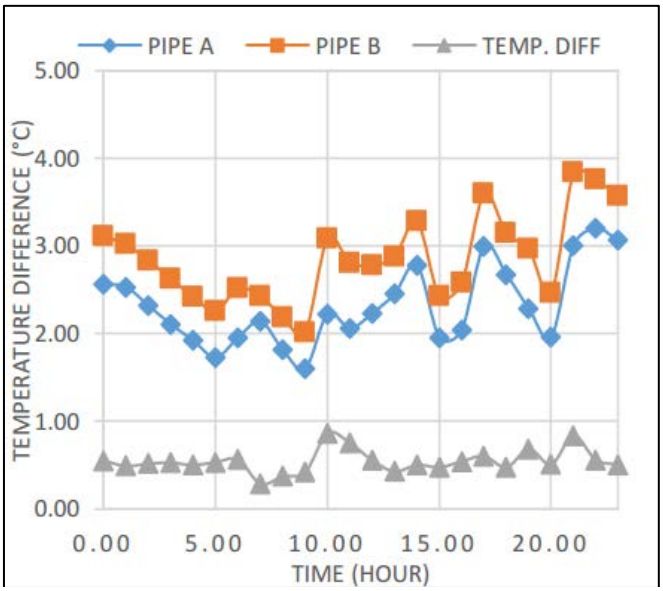

Figure 6: Temperature difference for both pipe setups at 10th November 2015

The highest temperature difference that been produce for Pipe A was 3.20°C at 2200H while the Pipe B produce 3.84°C at 2100H as shown in figure 6.

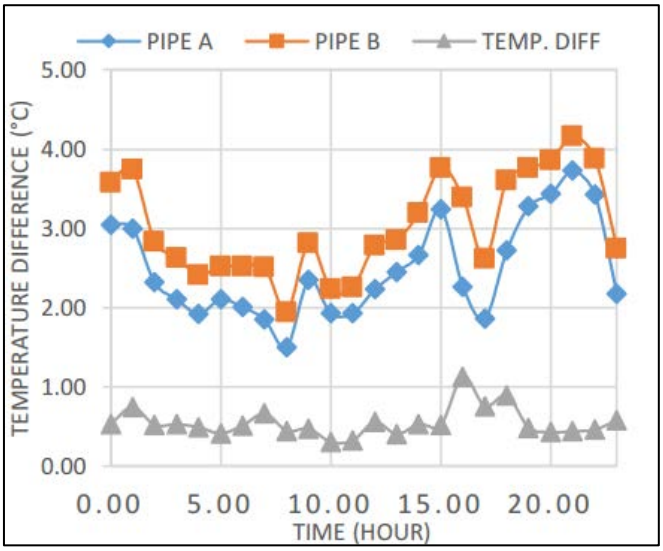

Figure 7: Temperature difference for both pipe setups at 11th November 2015

Figure 7, shows the data for the last day with the highest temperature reading is 3.73°C for Pipe A while Pipe B produce 4.16°C at the same time.

4 Discussion

The five days data of collection the highest and lowest temperature difference was compared between both set and shown in Table 1.

Table 1: Comparison between highest and lowest temperature difference

Day	Pipe	71115	81115	91115	101115	111115
Highest	A	4.30	3.98	4.20	3.20	3.73
ΔT	B	4.63	4.48	6.42	3.84	4.16
Smallest	A	1.23	1.55	1.37	1.72	1.50
ΔT	B	1.93	2.11	1.75	2.01	1.94

It is shown that the highest temperature difference between outlet and inlet for all five days data on 9th November 2015 that were produced by Pipe B. Figure 4.19 shown that temperature difference on 9th November 2015 were focus on 1500H to 1900H.

Pipe B have the highest temperature difference of the five days this is due to heavy rain on the 1700H. Thus with the raining effect, Pipe B creating a large temperature difference between the inlet pipe and the outlet pipe. This is due to Pipe B consist water proof barrier while Pipe A only produce 3.89 °C from the rain effect. Theoretically prove that inside the water proof barrier consist higher humidity compared with without water proof barrier. Pipe B which consist water proof barrier will have more ability to undergo heat transfer with help from thermal conductivity of the material that will maximize heat transfer through the humid soil this also may have ability to conduct heat much faster than other.

5 Conclusion

The passive cooling technique used in this experiment manage to produce significant temperature difference between the room and the environment, all the data collection of the temperature between the environment and room were successfully measured. From the data analysis and discussion, it was found that water proof barrier set (Pipe B) produce higher temperature difference and is dominant in reducing the room temperature. Pipe B manage to produce 6.42°C on 9 November 2015 of temperature difference, which was the highest temperature difference recorded throughout the experiment duration. In conclusion, from this research the material thermal conductivity with existence of water proof barrier will produce wider gap in temperature difference and this causes transferring heat be more efficient.

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FUTURE WORKS

From data obtain, it seems the temperature difference was not consistent. The values fluctuation as it seems it will be difficult to maintain the temperature difference at a constant value. Research on how to maintain the temperature difference at a optimum value should be considered as future research.

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