

Evaporation of River Water Using Pyramid Shape Solar Still



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Abstract Solar desalination using solar still is the simplest method to produce clean distilled water but it yield low potable water. Hence, a pyramid shape glazing is modified on the solar distiller is used in this study. River water in front of Politeknik Ungku Omar Ipoh, Perak Malaysia was collected for distillation process for duration of 1 month. The experiment maximum yield of the distilled water output is about 3 l of distilled water from 20 l waste water capacity that comply with WHO clean water requirements. The maximum yield of solar still desalination performance is approximately 15%.

Keywords Solar still · Distilled water · Pyramid shape · Solar energy

1 Introduction

Water is essential for the maintenance of life and also the key to human's prosperity. Nowadays, water is a natural sources that being polluted by human activities, urbanization and industrialization. There is a critical need to improve the safe drinking water and adequate water supply globally. The ground water is often over exploited to meet the increasing demand of the people. Less than 1% of earth's water is available for human consumption and more than 1.2 billion people still have no access to safe drinking water. Estimated more than 50% of the world population is residing in urban areas, and almost 50% of mega cities that having population over 10 million are heavily dependent on ground water [1]. Most of the rural people still live in absolute poverty and often lack access to clean drinking water. When all viable sources of water have been utilized, extracting drinkable water from other water resources can help to solve this problem.

Desalination is one of the method to produce clean water by using sunlight. Thus, it is a method or process of obtaining pure and drinkable water from waste/brackish or saline water. Various desalination techniques are used to purify the water. Solar

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distillation is an easy and cost effective method to provide pure drinking water in rural areas without affecting the nature. Solar distillation process is carried out both in passive and active mode. Solar collector with different inclination angle is seems to contribute to different performance of solar collector [2]. Hence, solar still with pyramid shape is proposed instead of flat glazing that yield 25% more from the conventional solar still [3, 4]. In this paper, pyramid shape solar still experimental work is presented.

The purpose is to analyse the performance of solar still and to analyse the treated water or distilled water contents produced whether it comply with WHO clean water standard requirements.

2 Methodology

Flow chart depicted in Fig. 1 shows the method on designing and performance evaluation of the solar still. Experimental measurement will be carried out for 1 month to collect water temperature data and amount of distilled water produced data based various climate condition. The experimental measurement will be carried out from 7AM to 7PM.

3 Conceptual Design

Figure 2 shows the finalized conceptual design for solar still with pyramid shape glazing. The purpose of glazing designed using pyramid shape was to improve the evaporation and condensation of distilled water production. The 45° inclination angle chosen due to better flow of condensed water into the ducting drainage solar still. Table 1 listed the materials used to build the solar still prototype.

3.1 Working Prototype

Figure 3a shows the solar still prototype that is used for experimental data collection. A portable data logger is used to measure the hourly data of distilled water and waste water inside the solar still. Distilled water produced was collected in the plastic bottle placed at the outlet pipe of the solar still. A weighting device is used to measure the weight of distilled water hourly to convert to litres. While, Fig. 3b shows the inner compartment that is painted with black paint to absorbed more heat from solar radiation. Polystyrene is of inch thick wrap with aluminium foil is attached to the collector to reduce the heat loss. Waste water will be poured into the inner compartment at 7 AM before sunrise then data collection was performed hourly until sunset at 7 PM.

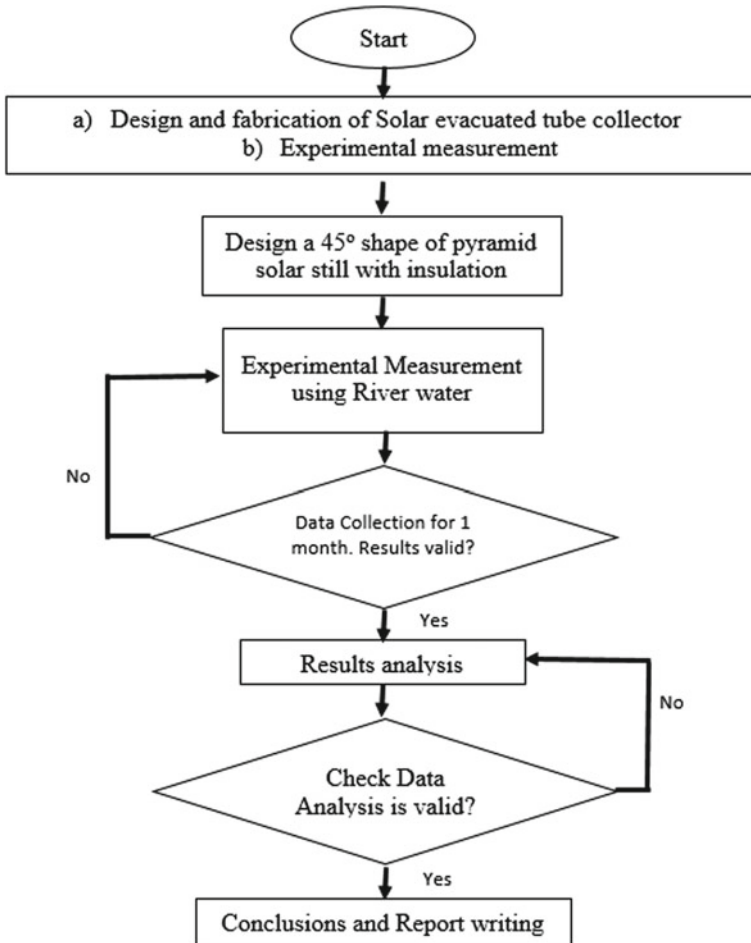


Fig. 1 Solar still design and data collection process

4 Results and Discussions

Distilled water collected by desalinating the river water as shown in Fig. 4. It shows that a clear and clean distilled water was produced by the solar still. The sample of river water and distilled water was analysed at Department of Environmental, Ipoh Perak. Parameters that were analysed was pH, turbidity, salinity and conductivity. The focus on those 4 parameters are to comply Ministry of Health Malaysia clean raw water level standard. Ministry of Health Malaysia raw water for pH is range between 5.5 and 9.0 that neutral to alkaline value, turbidity is 1000 nephelometric turbidity units (NTU) and below that gauge the clearness of water while, salinity or total dissolve solid shows salt contents in the water is less than 1500 mg/L and

Fig. 2 Exploded view of solar still design

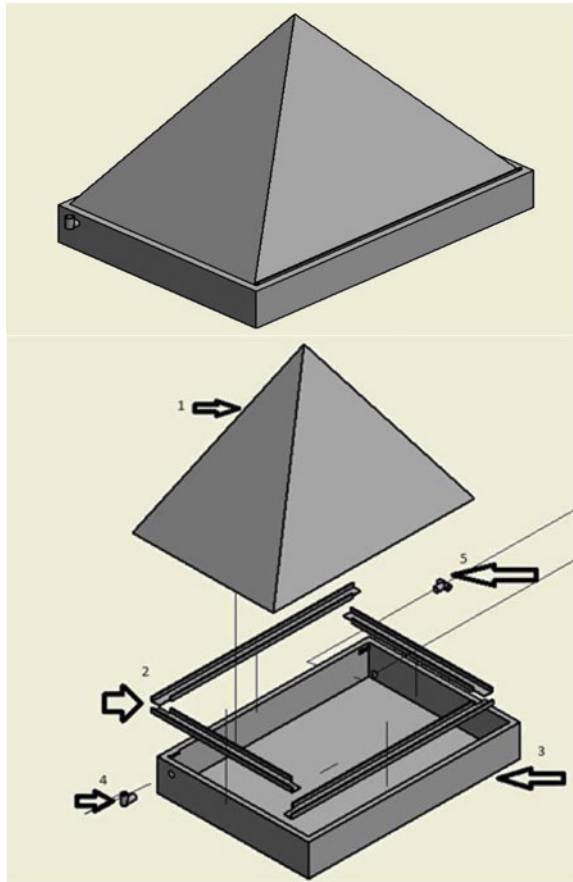
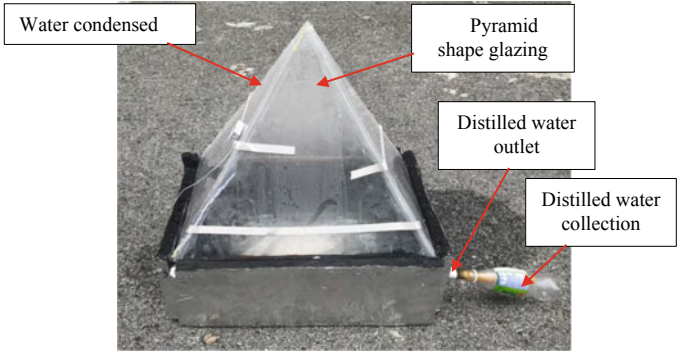
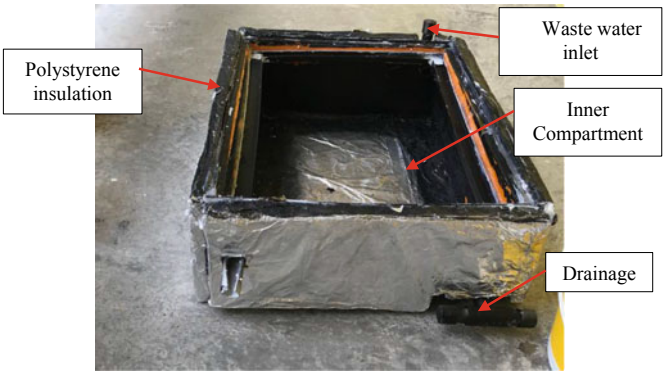


Table 1 Material selection for the solar still

| No. | Part description | Material |
|-----|--------------------|-----------------|
| 1 | Pyramid | Fiber glass |
| 2 | Drainage flow pipe | Plastic PV link |
| 3 | Water container | Plastic basin |
| 4 | Inlet pipe | PVC elbow pipe |
| 5 | Outlet pipe | PVC tee pipe |



(a) Solar still prototype.



(b) Inner compartment of solar still.

Fig. 3 a Solar still prototype. b Inner compartment of solar still

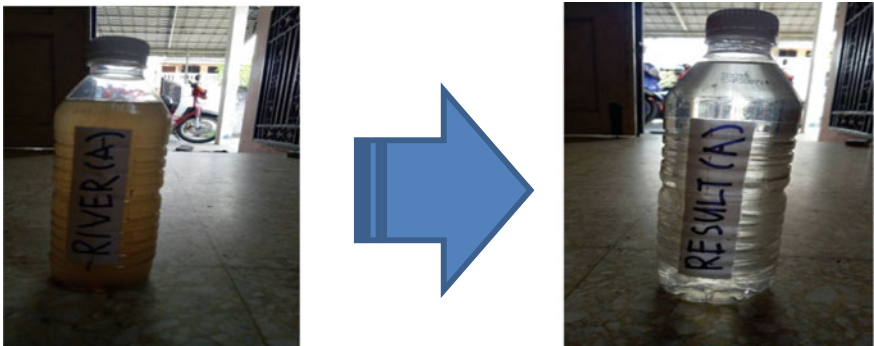


Fig. 4 Distilled water

Table 2 Distilled water analysis

| Parameters | | |
|-------------------------|------------------|--------------------------------|
| Type of water | Water from river | River water after distillation |
| Temperature (°C) | 29.6 | 28.7 |
| Dissolved oxygen (DO %) | 95.0 | 93.5 |
| Conductivity (µmhos/cm) | 0.073 | 0.001 |
| Salinity (mg/L) | 0.03 | 0.00 |
| pH value (pH) | 8.25 | 7.26 |
| Turbidity (NTU) | 8.0 | 6.2 |

conductivity is to measure the dissolve ions such as manganese, chrome, copper etc. inside the water that the value should be below 250 µmhos/cm [5].

Table 2 shows the analysis result from Lembaga Air Perak (LAP), the authority in charge of water utility in Perak state. The distilled water produced after desalination process shows it comply with Ministry of Health Malaysia standard where conductivity is 0.001 µS/cm, salinity is 0.00 mg/L, pH value is 7.26 pH and turbidity is a bit higher from 5.0 NTU mentioned by Ministry of Health since the water has not being treated for drinking yet with value of 6.2 NTU but it is still a clean raw water to be released back to river. Although the results show there is quality improvement of distilled water, however the water still need to be boiled before consumable to kill all the bacteria.

It was observed that the distilled water production yield range between 1.2 and 3 l daily from 20 l of river water used for the experiment. Hence, in a month the average of distilled water produced is 78 l. Figure 5 shows the production of distilled water on 5th of June 2018.

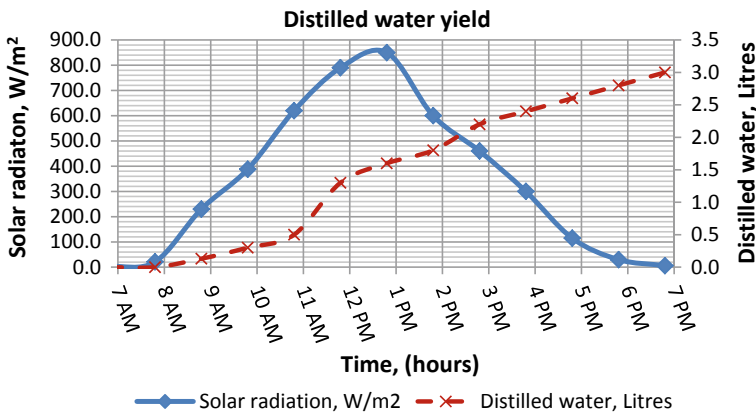


Fig. 5 Experimental data of desalination on 5th of June 2018

5 Conclusions

These results show that the distilled water production yield range between 1.2 and 3 l daily and shows the maximum performance of solar still is about 15%. The reason for the low productivity is the water mass (water depth), higher water depth has an intense effect on the distilled output of the solar still system. Metal absorber too has the effect of absorbed more heat from solar radiation since the current model use plastic absorber.

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